



STREAMLINE SL PRO² 125 WATERJET INTENSIFIER

OPERATION AND MAINTENANCE MANUAL



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KMT WATERJET SYSTEMS 2012



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SECTION 1

INTRODUCTION

1.1 Overview

The Streamline SL Pro² 125 combines all the unique capabilities and advantages of waterjet cutting systems with the reliability, ease of operation and service support that have made KMT Waterjet Systems a leader in waterjet technology.

The SL Pro² 125 accommodates a wide range of applications. From small, single head requirements to high volume production requiring multi-head systems; from intricate detailed cutting, to rapid hole drilling; from titanium to produce, the SL Pro² provides the solution.

Table 1-1
Streamline SL Pro² 125

Model	Motor Horsepower Rating		Maximum Operating Pressure	Maximum Flow Rate (at full pressure)	Maximum Single Orifice Diameter (at full pressure)
	HP	Kw			
SL Pro ² 125	125	93	85,000 psi (5,860 bar)*	1.53 gpm (5.8 L/min)	0.015 inch (0.3814 mm)

***Note:** Maximum pressure with cutting head valve open is 85,000 psi (5,860 bar). Maximum pressure with cutting head valve closed is 90,000 psi (6,200 bar).

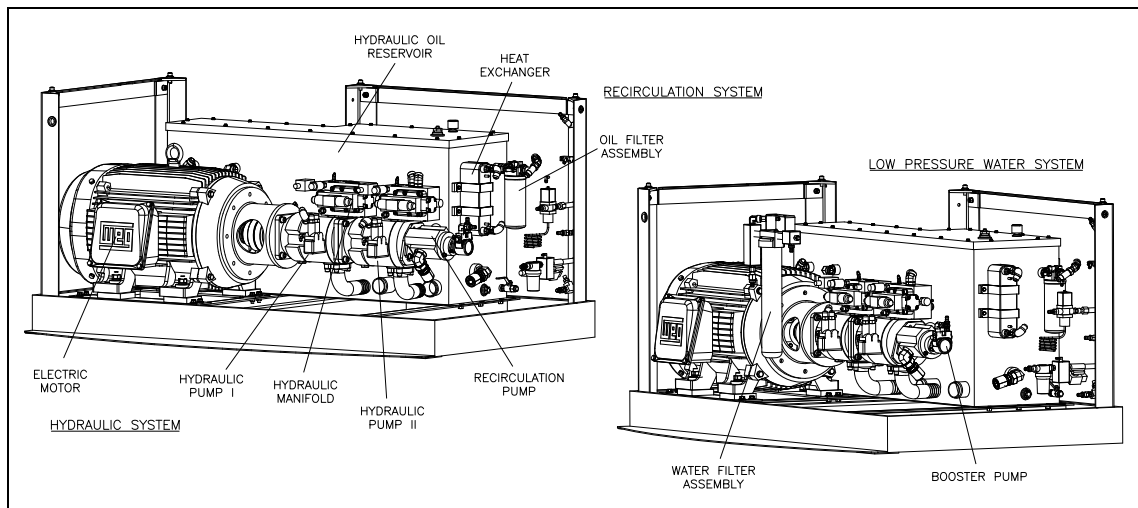
1.2 Operational Overview

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 9.

Low Pressure Water System

The low pressure water system supplies the cutting water flow to the intensifier. Major system components include the water filter assembly and the booster pump.

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

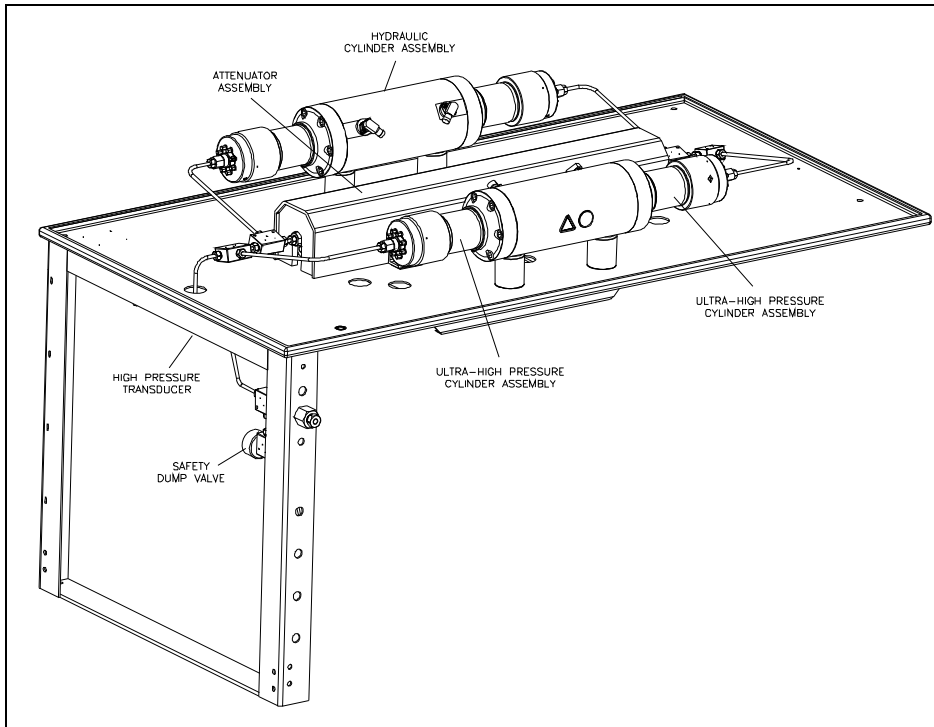
The hydraulic system supplies the intensifier with the hydraulic oil required to produce high pressure water. Major system components include the electric motor, two hydraulic pumps with 4-way directional control valves mounted on the hydraulic manifolds.

Ultra-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 safety dump valve.

Figure 1-2: Ultra-High Pressure System Components



Operating System

A programmable logic controller (PLC) provides basic intensifier shift control and monitors out of limit conditions. Operator interface is through the control panel display where operating parameters are set and monitored.


Figure 1-3: Control Panel Main Menu



1.3 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 work area around the equipment shall be 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 by pressing the stop button, 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. Lockout and tag the circuit breaker/disconnect on the electrical enclosure door.

4. 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



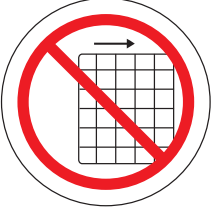
1		<p>The electrical enclosure and motor junction box can present an electrical shock hazard. Always disconnect and lockout the main power before opening the enclosure.</p> <p>Always disconnect and lockout the main power and the circuit breaker/disconnect on the electrical enclosure door before performing any type of maintenance</p>
2		<p>The surface of high pressure water and hydraulic components becomes hot during normal operation. Failed, or failing components, can become extremely hot during operation.</p>
3		<p>Ensure that all protective guards, shields or covers are in place on the equipment at all times. Never operate the pump with the guards removed.</p>

Table 1-2
Warning Label Precautions

4



P/N 05098017

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.

Pressing the emergency stop button turns the control power to the intensifier off, stops the pump and bleeds the high pressure water through the safety dump valve.

Depressurization of the high pressure system creates a loud hissing sound when the dump valve opens. The sound fades quickly as the pressure drops.

5



P/N 20415794

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.

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
PO Box 231, 635 West 12th Street
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This person has been working with water jetting at pressures to 90,000 psi (621 MPa, 6,205 bar, 6328 Kg/cm²) with a jet velocity of 3,69 fps (1100 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.

1.4 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.

USA Customer Service Department

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1.5 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.

1.6 Manual Organization

This manual contains operating and maintenance procedures for the complete SL-V series. Information is organized as follows:

- 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. Systematic 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.
- Section 4, Operation, explains the control functions and the display panel where operating parameters are set and monitored.
- Sections 5 through 9 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 provided.
- Section 10, Troubleshooting, is a comprehensive guide containing the information required to diagnose problems and repair the machine.
- Section 11, 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 12, Parts List, contains part numbers, descriptions and drawings to facilitate the ordering of replacement parts.



1.7 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.

- Upon receipt, the machine must be uncrated and moved into position on a level surface.
- Properly sized power drops with fused disconnects must be installed.
- A pneumatic drop with a manual shutoff valve and regulator for the air connection 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.

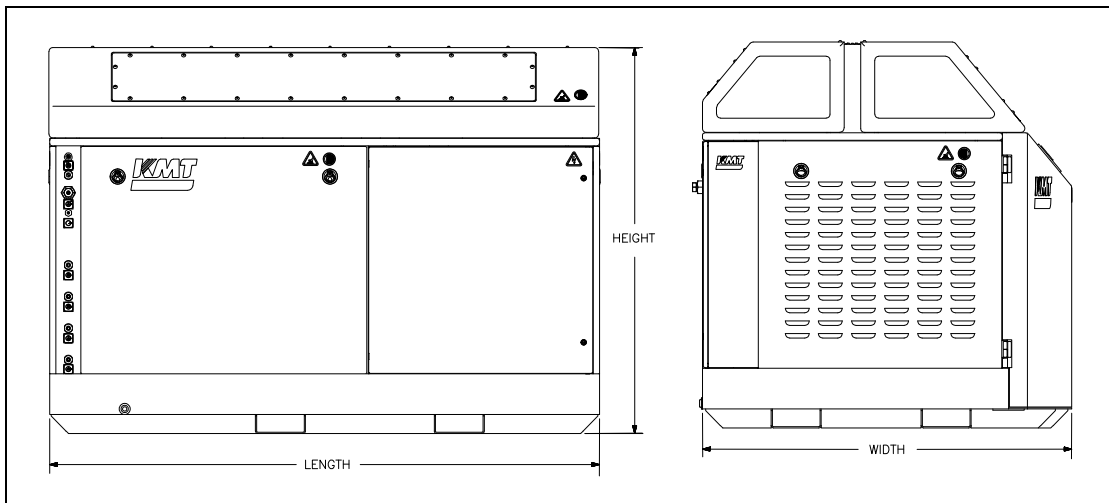
- Drain water plumbing must be suitably located and installed for the proper disposal of wastewater.
- Ultra-high pressure tubing runs from the intensifier to the cutting station must be installed with the appropriate mountings, support brackets and hardware.
- Wiring must be installed and connected between the intensifier and the cutting station control system.
- 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%.

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**

Horsepower Len	gth	Width	Height	Weight
125 HP	88.00" (2,235 mm)	59.09" (1,500 mm)	61.12" (1552 mm)	6,850 lbs (3,107 kg)
With doors open		104.00" (2,641 mm)		

Transporting

The weight of the machine is not evenly distributed from one end to the other, particularly on the larger horsepower models. Do not attempt to lift the machine from either end. Note the warnings stamped on the 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

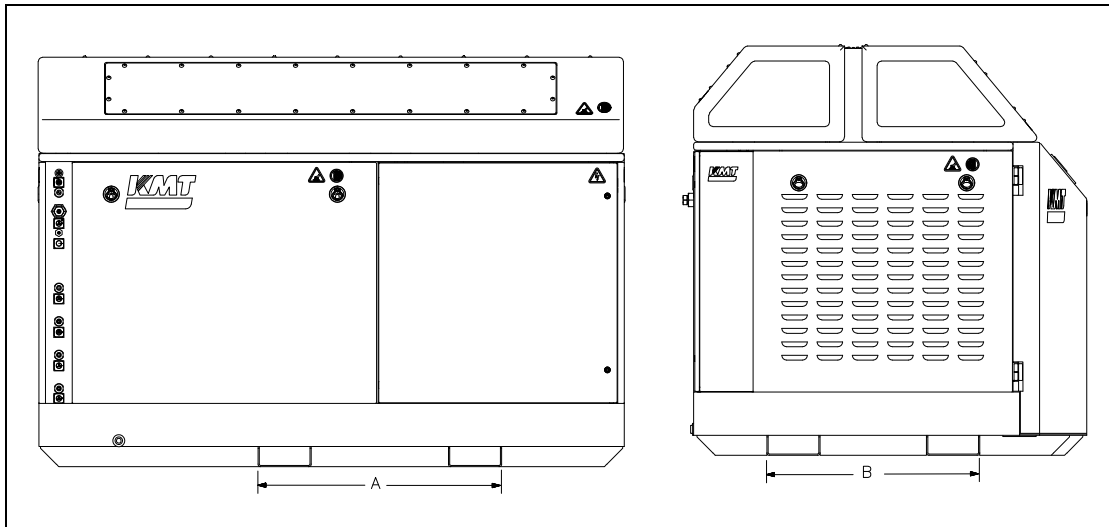


Table 2-2
Fork Pockets

Fork Pocket Dimensions		
Height		3.0" (76 mm)
Width		8.0" (203 mm)
Length, Front Pockets		59.00" (1,499 mm)
Length, Side Pockets		36.62" (930 mm)
A	Distance Between Front Pockets	36.62 (930 mm)
B	Distance Between Side Pockets	32.0" (813 mm)

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 of the specific model. Voltage fluctuations in excess of +/- 10 percent of nominal voltage may damage the machine and void the warranty. Refer to Table 2-3, Ampacity and Power Voltage Requirements.

Table 2-3
Ampacity and Power Voltage Requirements

Power Voltage	Motor Horsepower	Full Load Amps	Circuit Breaker Amps
480/3/50-60	125	137	175

2.5 Service Connections

The intensifier requires two incoming water sources, cooling water and cutting water; two drain lines, cooling water and wastewater; a high pressure discharge line, and an air supply line. All piping must comply with local, regional and national codes.

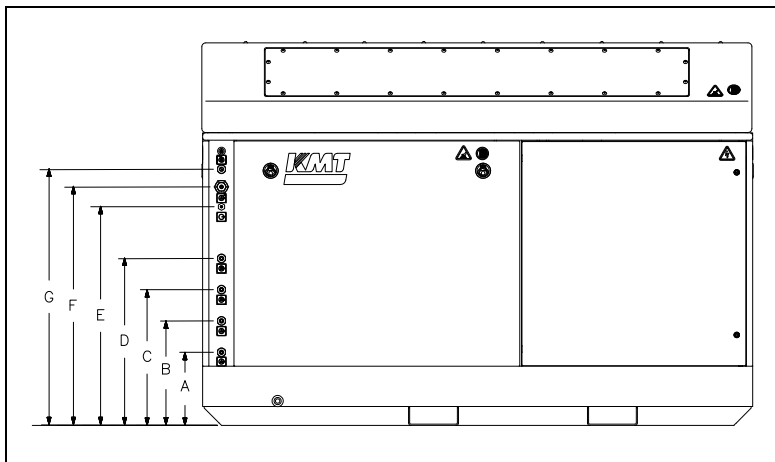


Thoroughly purge all supply plumbing prior to connection to remove any residue that could contaminate the system.

All service connections are made on the rear bulkhead of the machine as shown in Figure 2-3, Service Connections. Table 2-4 lists the fittings required and the height of each interface connection.

With the exception of the wastewater and contaminated waste drain lines, 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.

Figure 2-3: Service Connections



**Table 2-4
Service Connections**

		Connection	Height
A	Drain	1/2" NPT	7.50" (191 mm)
B	Cutting Water In	1/2" NPT	16.68" (424 mm)
C	Cooling Water Out	1/2" NPT	21.68" (551 mm)
D	Cooling Water In	1/2" NPT	26.68" (678 mm)
E	Plant Air In	1/4" NPT	34.93" (887 mm)
F	Cutting Water Out	9/16" UHP	38.12" (968 mm)

Table 2-4
Service Connections

		Connection	Height
G	Contaminated Waste Drain	1/2" NPT	40.93" (1,040 mm)

Cooling Water

Inlet cooling water flows through the oil-to-water heat exchanger in the hydraulic system to control heat build-up 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 specific equipment. If municipal or well water is used for cooling, ensure the supply flow and pressure meet the requirements in Table 2-7, Service Connection 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. Dedicated chilled water systems should be sized according to pump horsepower as illustrated in Table 2-5, Chilled Water Systems.

Table 2-5
Chilled Water Systems
Cooling Requirements at Full Capacity

Horsepower	BTU/HR
125	76,000

Note: Coolant flow to the heat exchanger is regulated by the temperature of the contents in the hydraulic reservoir and will be shut off at times.

Cutting Water

Inlet cutting water is filtered and 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 11, 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 Table 2-7. Only PVC, copper or rubber hoses should be used between the cutting water source and the machine.

The inlet water must be maintained at a minimum pressure of 35 psi (2.4 bar) at all times. If the facility water pressure is below, or can fall below 35 psi (2.4 bar), a water pressure booster pump is required.

NOTE

The machine will not start if inlet cutting water pressure is below 30 psi (2 bar).

Drain

Cutting water released through the safety dump valve when the emergency stop button is initiated 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.

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.

The following table provides specifications for each ISO air quality classification. KMT recommends adherence to Quality Class 4.

**Table 2-6
ISO Air Quality Classifications**

ISO Quality Class	Maximum Particle Size (microns)	Maximum Pressure Dew Point (water @ 100 psi)	Maximum Oil Content (Mg/m ³)
1	0.1	-94° F (-60° C)	0.01
2	1	-40° F (-40° C)	0.1
3	5	-4° F (-20° C)	1
4	15	+38° F (+3° C)	5
5	40	+45° F (+7° C)	25
6	--	+50° F (+10° C)	--

Contaminated Waste Drain

Oil and water that can accumulate on the top pan is disposed of through the contaminated waste drain. This oil and water mixture is considered contaminated and disposal must comply with local, regional and national codes. The volume of waste will be minimal and can be collected in a container of some appropriate type.

Table 2-7
Service Connection Specifications

Cooling Water	
Maximum consumption at 75° F (24° C)	5.0 gpm (18.9 L/min)
Minimum inlet pressure	35 psi (2.4 bar)
Cutting Water	
Maximum consumption	9.2 gpm (34.8 L/min)
Minimum inlet pressure	35 psi (2.4 bar) flowing
Compressed Air	
Minimum air pressure	85 psi (5.9 bar)

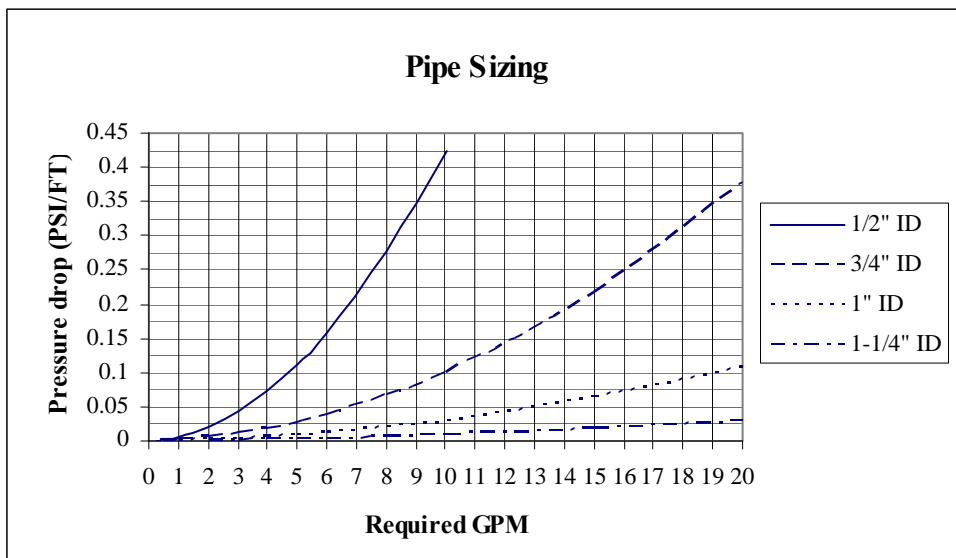
2.6 Flow Requirements

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. **The machine will not start if the inlet cutting water pressure drops below 30 psi (2 bar).**

Figure 2-4: Pressure Drop Values



2.7 Ultra-High Pressure Piping

Ultra-high pressure piping is used to transport high pressure cutting water from the machine to the cutting station. Ultra-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.



Ultra-high pressure tubing and fittings must be rated for 90,000 psi (6,200 bar). Failure to use properly rated components may result in component failure causing equipment damage, personal injury or death.

Ultra-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 2-8.

**Table 2-8
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 2-9. Table 2-10 lists the required cone and thread dimensions illustrated in Figure 2-6.

Figure 2-5: Tube Length

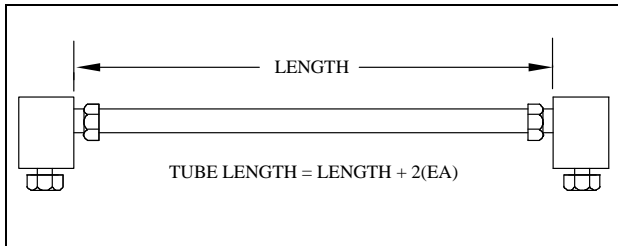


Table 2-9
Engagement Allowance (EA)

1/4" Tubing	0.85" (21.6 mm)
3/8" Tubing	1.09" (27.7 mm)
9/16" Tubing	1.63" (41.4 mm)

Figure 2-6: Cone and Thread Dimensions

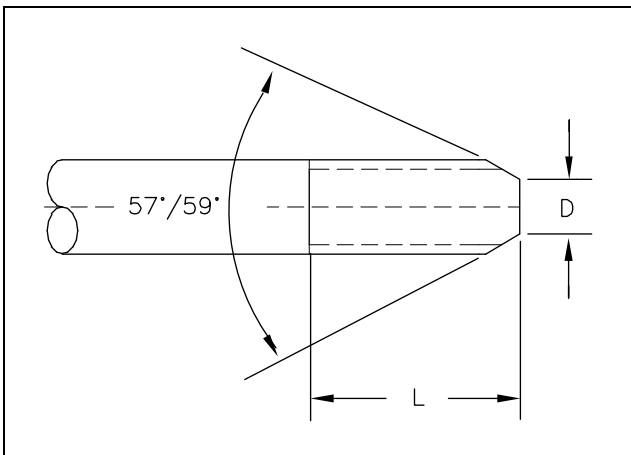
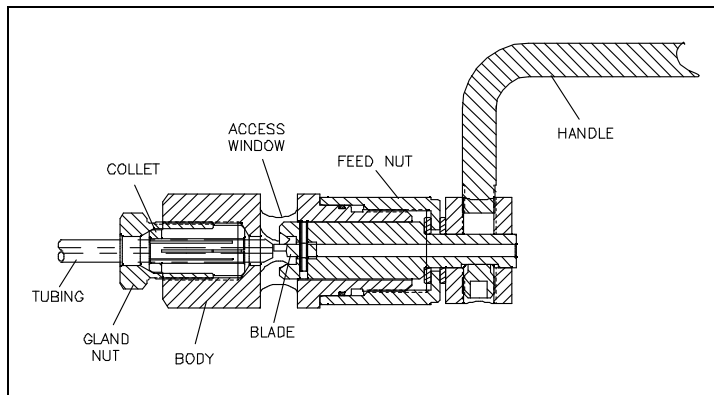


Table 2-10
Cone and Thread Dimensions

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)	0.660" (16.8 mm)	1/4" - 28
3/8" (9.52 mm)	0.125" (3.18 mm)	0.219" (5.6 mm)	0.938" (23.8 mm)	3/8" - 24
9/16" (14.29 mm)	0.188" (4.78 mm)	0.281" (7.1 mm)	1.505" (38.2 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 blade.
2. Turn the feed nut counter-clockwise to retract the cutting blade 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 blade. Loosely tighten the gland nut to slightly grip the tubing.
4. Turn the feed nut counter-clockwise 1/4 turn to retract the cutting blade 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 blade and through the lubrication channel at the cutter handle.
6. Apply cutting oil frequently and liberally throughout the cutting operation. A medium weight cutting oil with high sulfur content is recommended.
7. Turn the feed nut clockwise until the cutting blade contacts the end of the tubing.
8. 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 blade should make light, uninterrupted cuts.

NOTE

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

9. 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.
10. Retract the cutter blade, 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 2-11, 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.
4. Apply cutting oil frequently and liberally throughout the cutting operation. Medium weight cutting oil with high sulfur content is recommended.
5. 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 2-11
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 2-11, Recommended Extension Length.
2. Apply cutting oil to the end of the tube and slide the threading tool on the tubing.
3. Grip the handle 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.
4. Apply cutting oil frequently and liberally throughout the cutting operation. Medium weight cutting oil with high sulfur content is recommended.

5. Continue threading until the proper thread length is achieved; see Table 2-10, 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 2-11, 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.
4. Apply cutting oil frequently and liberally throughout the cutting operation. Medium weight cutting oil with high sulfur content is recommended.
5. Continue threading until the proper thread length is achieved; see Table 2-10, 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 Ultra-High Pressure Connections

When installing ultra-high pressure discharge piping it is essential that all burrs are 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.

Ultra-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.

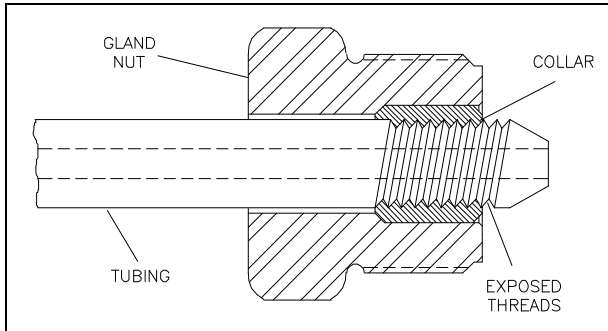


Do not use any other anti-seize compound. Apply Pure Goop **only to stainless steel** components.

Standard Connections

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

Figure 2-8: Standard Ultra-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 2-12.



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

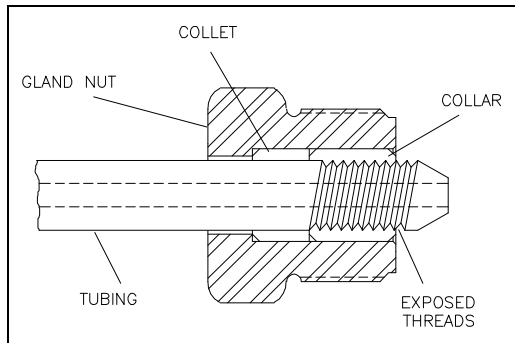
Table 2-12
Torque Specifications
Ultra-High Pressure Connections

1/4" Tubing	35 ft-lb (47 Nm)
3/8" Tubing	75 ft-lb (102 Nm)
9/16" Tubing	160 ft-lb (217 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-Vibrations 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 2-12.

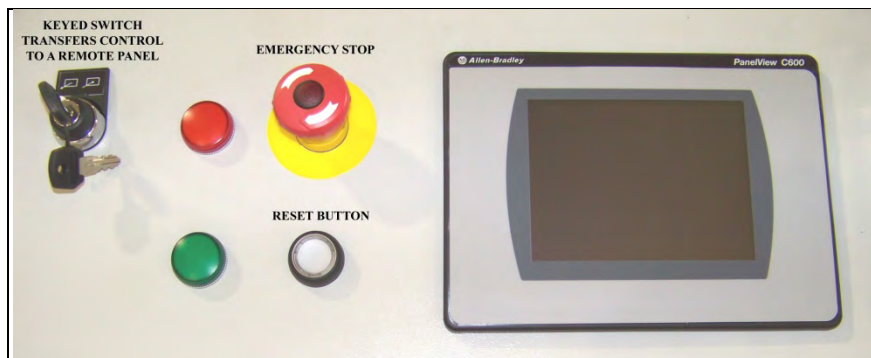
When a flexible whip is used to allow cutting nozzle movement, anti-vibration fittings and proper supports and guides must be provided to prevent failures from non-water related stresses. The whip will only flex in a single plane without being subjected to torsional stress. The use of high pressure swivels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

2.9 Commissioning

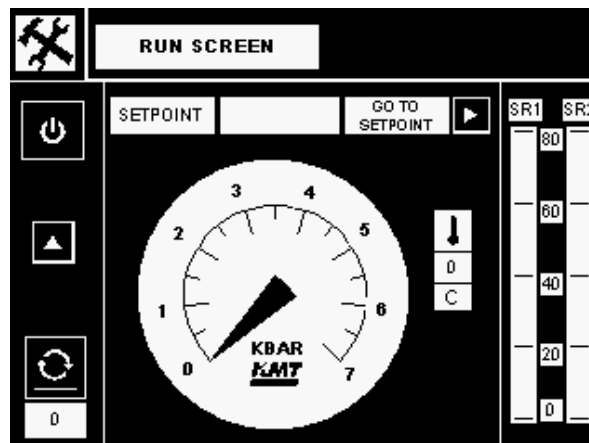
When the machine has been positioned, all service connections installed, and the high pressure plumbing has been installed to the cutting area, the machine is ready to be commissioned.

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 and specifications in Section 6, Recirculation System.
3. Open the shutoff valves on the service connections and check for leaks.
4. Check the connection between the main power disconnect and the disconnect/circuit break on the enclosure door. Verify the proper voltage supply. Close the enclosure door and turn the control power on.
5. To activate the control panel display, pull the EMERGENCY STOP button out and press the RESET button. The control panel will go through a series of diagnostics, and the Run Screen will display. Refer to Section 4, Operation, for additional information regarding control panel functions.



6. On the Run Screen, select the ▼ arrow to select low pressure operation.



7. To avoid a sudden increase in pressure, it is necessary to adjust the high pressure setting. The high pressure adjustment is made from the Run Screen. Refer to Section 4, Operation, for additional information.

Press the SETPOINT numeric field to display the keypad and set the desired operating pressure. The pressure will slowly adjust until it reaches the set pressure. The actual operating pressure will display on the analog gauge.

8. Check the motor rotation. Press the START button on the Run Screen 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, press the STOP button and turn the control power off by pressing the EMERGENCY STOP button.

The electrical power phase must be reversed to any two motor leads. The leads can be reversed at the disconnect/circuit breaker on the enclosure door, 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.

9. Remove the cutting orifice and open the nozzle valve.
10. Activate the control power and press the START/STOP button to start the motor. The dump valve will open for a short time to allow trapped air to bleed from the high pressure cylinders. Run the machine in low pressure mode for approximately five minutes with the orifice removed to purge the system.
11. Check for any leaks in the plumbing, or around the high pressure cylinders. If leaks are detected, stop the machine and correct any problems.
12. Observe the Booster Pressure Gauge on the front of the machine to ensure the inlet cutting water pressure is between 90-120 psi (6-8 bar). If not, the booster pump pressure must be adjusted. Refer to Section 5, Low Pressure Water System, for additional information.
Use a flat blade screwdriver to turn the adjustment screw on the booster pump acorn nut clockwise to increase the pressure or counter-clockwise to decrease the pressure.
13. Check the safety circuits by pushing the EMERGENCY STOP button in and verifying that the power goes off and high pressure water is drained from the system. If applicable, check all remote start and emergency stop functions.
14. Install a large, inexpensive orifice and start the machine.
15. On the Run Screen, select the ▲ arrow to 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.



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

OPERATION

3.1 Overview

The SL Pro² 125 has been designed to fail safely. Systems fail gradually; seals and connections 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.

The comprehensive fault detection and troubleshooting logic built into the programmable logic controller (PLC) monitors crucial pressure, temperature and fluid levels. Warning and shutdown sensors guard against potential injury and equipment damage.

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 and troubleshooting 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 water filter and the oil filter.

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.

Ultra-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 90,000 psi (6,200 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, 1 ounce	Stainless steel threads and metal-to-metal joints	10084440
FML-2 Grease, 14-1/2 ounce	O-rings, backup rings, bearing rings, some seal components	10087385
JL-M Grease, 16 ounce	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.

Check the EMERGENCY STOP button. The normal operating position is pulled out. Turn the power on and activate the emergency stop button by pushing it in to verify the power goes off and the safety dump valve opens to bleed the high pressure from the system.

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.
- Steam or fog inside the top cover is an indication of a high pressure leak. All high pressure leaks must be repaired immediately. Press the EMERGENCY STOP button to turn the control power off and bleed off the high pressure water from the intensifier **before** lifting the cover.
- Never service or maintain any high pressure component, or loosen any high pressure fitting when it is pressurized. Press the EMERGENCY STOP button to 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**.

3.4 Tool Kits

Table 3-2 provides a list of the spare parts and maintenance tools included in standard tool kits for SL Pro series pumps. Components can also be ordered individually.

**Table 3-2
Tool Kits**

Part Number	Description	Tool Kit 72117910	Tool Kit 72117892
20494983	Threadlocker Primer, 1-3/4 ounce	1	1
10148674	HP Seal Installation Tool	1	1
20490232	Cylinder Wrench	1	1
10149029	Emery Cloth, 320 Grit	2	2
10149037	Emery Cloth, 400 Grit	6	6
10149045	Emery Cloth, 600 Grit	6	6
20484961	Vee Block	1	1
20453136	UHP Plug, .38	1	1
20452956	UHP Gland, .38	1	1
10079986	Strap Wrench	1	1
10081370	Spanner Wrench, Adjustable	1	1



Table 3-2
Tool Kits

Part Number	Description	Tool Kit 72117910	Tool Kit 72117892
10084440	Pure Goop, 1 ounce	3	3
10087385	FML-2 Grease, 14-1/2 ounce	1	1
10087609	Crescent Wrench	1	1
05053871	Combination Wrench	1	1
20477460	Plunger Removal Tool	1	1
20470475	Seal Installation Tool Kit, Pneumatic Valves	1	1
80082191	JL-M Grease, 15 milliliter pack	2	2
80079239	End Cap Wrench	1	1
72117884	Torque Wrench, 10-100 ft/lbs	1	1
72117876	Socket Wrench, 7/16, 3/8 Drive	1	1
20487868	Threadlocker 242 Adhesive, .50 milliliter tube	1	1
20473684	Hex Bit Socket, 5/8 x 1/2 Drive	1	1
20476495	Cylinder Clamp	1	1
72121395	Check Valve Rework Kit	1	1
05108832	Coning Tool, .25 Hand		1
05108857	Coning Tool, .38 Hand		1
05108840	Coning Tool, .56 Hand		1
05108865	Threading Tool, .25 Hand		1
05108873	Threading Tool, .38 Hand		1
05108881	Threading Tool, .56 Hand		1



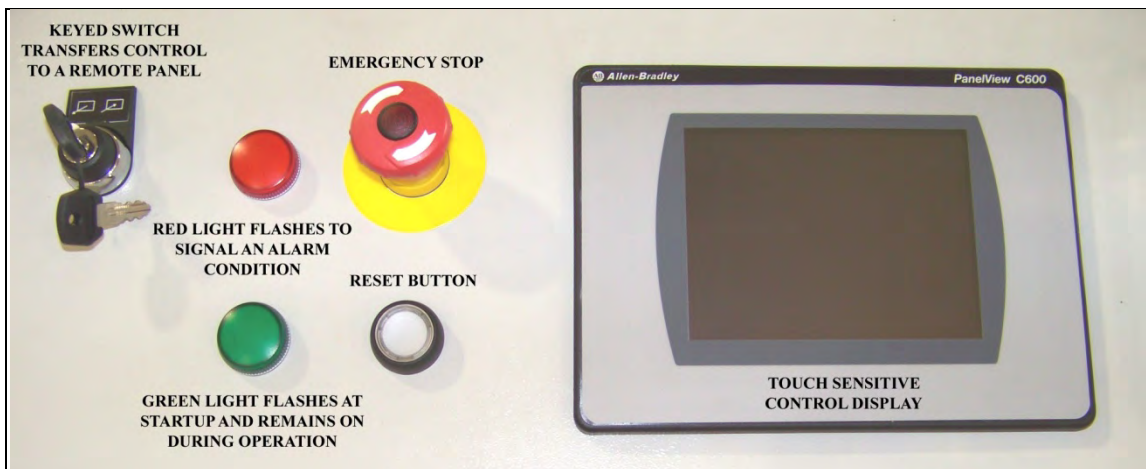
SECTION 4 OPERATION

4.1 Overview

The SL Pro² 125 utilizes a programmable logic controller (PLC) to provide comprehensive fault detection and troubleshooting logic. The operator interface is through a touch sensitive control display where operating parameters are set and monitored. The operator functions and warnings offer a comprehensive view of operating conditions, impending faults, shutdown faults and suggested remedies.

Figure 4-1 identifies the control panel components and functions.

Figure 4-1: Control Panel



4.2 Startup Sequence






After a normal motor stop, the safety dump valve will be closed and high pressure will be present in the system. Press the start button on the Run Screen and the motor will start. The machine will be held in low pressure for 5-60 seconds as determined by the operator, it then goes to high pressure or remains in low pressure, depending on the previous setting.

After an emergency stop, the safety dump valve will be open and high pressure released in the system. The dump valve will close three seconds after the intensifiers begin to stroke.

Pull the EMERGENCY STOP button out and push the RESET button to activate the control display. Press the START button on the Run Screen and the motor will start.

4.3 Display Controls

Table 4-1
Display Controls

Control	Function	Comments
	START/STOP	<p>The START/STOP button starts the pump under normal operating conditions. The START/STOP button stops the motor only, the control power remains on.</p> <p>When started from the Maintenance Screen, the pump will start in maintenance mode. The pump must be started from the Maintenance Screen to access the maintenance functions.</p>
	Return to Main Menu	
	Return to Run Screen	
	ON position for controls on the Setup Screen	Enables function
	OFF position for controls on the Setup Screen	Disables function

4.4 Main Menu

The Main Menu provides a list of available setup and monitoring screens. Press the ▲ or ▼ arrow to highlight the desired screen. Press enter (↵) to display the selected screen.

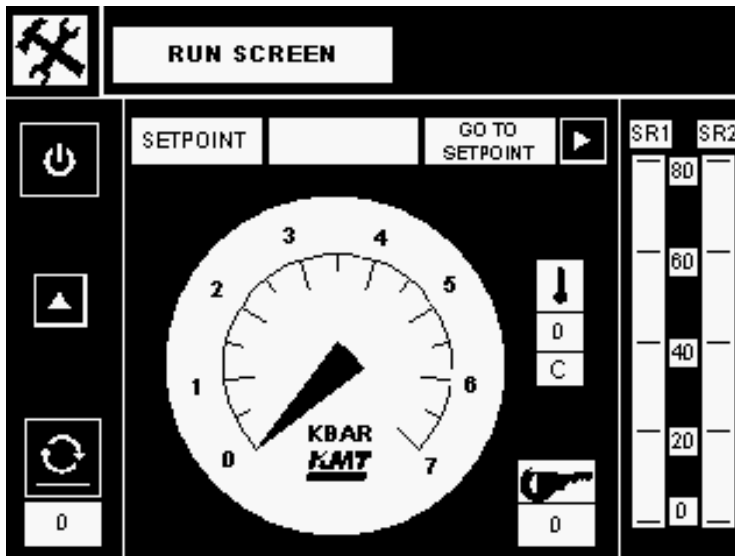
Figure 4-2: Main Menu



4.5 Run Screen

The Run Screen is the only location where the machine can be started to create pressure.

Figure 4-3: Run Screen



The Run Screen displays the following functions:

START/STOP	The START/STOP button starts the machine when all conditions are normal. After the machine has been stopped, there is a five second delay before it can be restarted. The STOP button stops the machine in normal operating mode.
RESET	The inlet water solenoid indicator. The inlet water solenoid valve is automatically closed five minutes after the machine shuts down. When RESET flashes, press the STOP button to reset and open the valve. This function is only visible when the solenoid valve needs to be reset and the function can be disabled on the Setup Screen.
SETPOINT	Press the SETPOINT numeric field to display the keypad in Figure 4-4 and set the desired operating pressure. The pressure will slowly adjust until it reaches the set pressure. The actual operating pressure displays on the analog gauge. Operating pressure is displayed in either psi or bar and the option is selected on the Stroke Rate Screen.
GO TO SETPOINT	Press the ► arrow to rapidly attain the setpoint.
DUAL PRESSURE	In local mode, press the ▲ or ▼ arrow to select high or low pressure. When stopped and restarted the machine will always start in low pressure. After 5-60 seconds, depending on the interval selected by the operator, it will go to high pressure or remain in low pressure, depending on the previous setting. In remote mode, a customer installed switch will toggle between the high and low setting.
RECIRCULATION	Recirculation mode is used for troubleshooting and to cool the hydraulic oil under certain conditions. When activated, it starts the hydraulic system, except for the intensifiers, and circulates oil from the pump to the reservoir in a continuous circuit. Once initiated, it will run for a ten-minute interval and then shut down. The remaining time is displayed in seconds.
ALARM	When a fault is detected the alarm indicator field in the top right-hand corner of the screen flashes and displays the last alarm sensed by the machine. The field is only visible when an alarm condition exists.
TEMPERATURE DISPLAY	The temperature display reads the suction temperature of the hydraulic oil in degrees Fahrenheit or Celsius.
STROKERATE	Graphically displays the total number of strokes for each intensifier since the counter was reset.



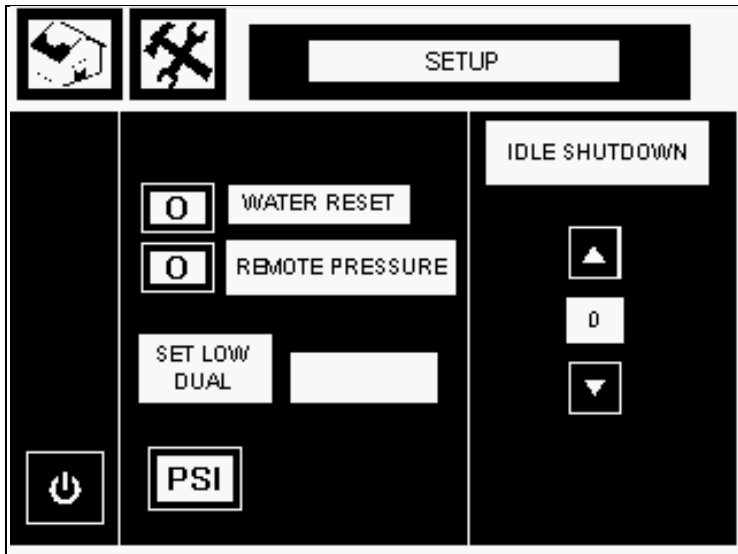
Figure 4-4: Keypad

0		
Enter Value: (0 to 90000)		
7	8	9
4	5	6
1	2	3
•	0	-
←	↵	

4.6 Setup Screen

Functions and options can be enabled or disabled on the Setup Screen.

Figure 4-5: Setup Screen



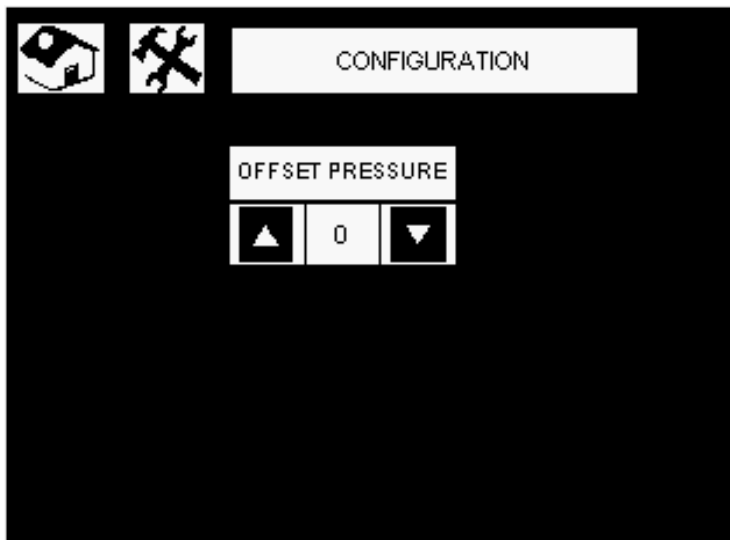
The Setup Screen displays the following functions:

WATER RESET	Automatically shuts the inlet water solenoid valve off five minutes after the machine shuts down; press the control to turn the function ON or OFF.
REMOTE PRESSURE	Allows the output pressure to be set from a remote 0-10V signal; press the control to turn it ON for remote pressure input or OFF to enable default local control features.
SET LOW DUAL	Press the SET LOW DUAL numeric field to display the keypad in Figure 4-4 and set the low operating pressure. If the field is blank, the setting defaults to zero and sets the pump at the lowest compensator setting.
IDLE SHUTDOWN	Automatically stops the motor after a deadhead condition occurs; press the ▲ or ▼ arrow to select an idle time from 5-60 minutes.
PSI/BAR	Press the control to change the pressure readouts to psi or bar.

4.7 Configuration Screen

The Configuration Screen is used to set the offset pressure during initial commissioning. The setting will not require adjustment unless operating conditions change significantly.

Figure 4-6: Configuration Screen



OFFSET PRESSURE

The offset pressure function prevents the operating pressure from overshooting the set pressure at startup. Press the ▲ or ▼ arrow to set the offset pressure from a minimum value of 5 to a maximum value of 20.

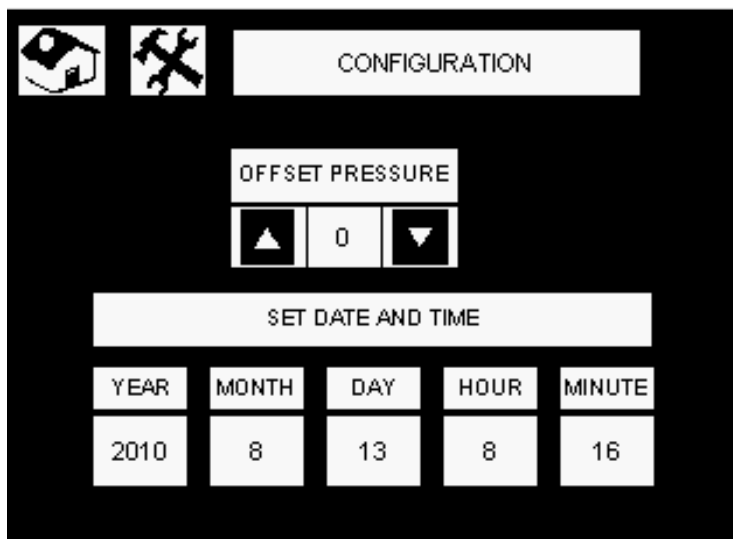
The amount of overshoot depends on the specific operating conditions: the amount of system plumbing, number of cutting heads, and the application.

Changing the Date and Time

The following procedure is used to change the date and time.

1. Navigate to the Configuration Screen.
2. When the prompt displays enter the username KMT and the password 111320 to display the screen shown below.

Figure 4-7: Changing Date and Time

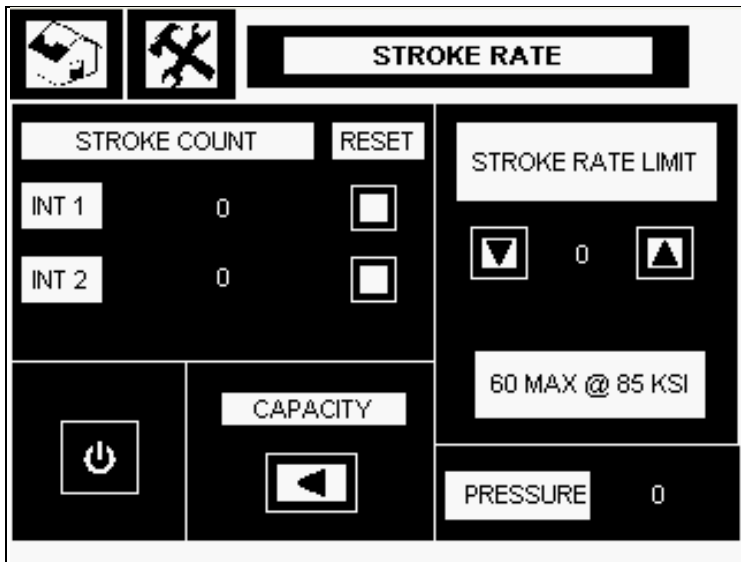


3. Use the buttons to enter the year, month, hour and minutes. The hour value must be entered in the 24 hour format (0-23). The keypad will display to enter each value.
4. When all values have been changed, return to the Run or Main Screen.

4.8 Stroke Rate Screen

The Stroke Rate Screen displays the real time strokes per minute and displays the following functions.

Figure 4-8: Stroke Rate Screen



STROKE RATE LIMIT	Increases or decreases the allowed stroke rate; press the ▲ or ▼ arrow to select the overstroke set point. Stroke rate should be set 4 to 5 strokes higher than the desired operating rate to shutdown the machine quickly in the event of an overstroke condition.
STROKE COUNT	Displays the total number of strokes for each intensifier since the counter was reset. Press the RESET button to reset the stroke counter for one or both intensifiers.
CAPACITY	Press the CAPACITY button to display the Capacity Screen.
PRESSURE	Displays the current operating pressure.

Table 4-2, Overstroke Set Points, illustrates the upper limits for the SL Pro² 125. It also shows the number of strokes per minute above the setting that will result in a warning or shutdown condition.

Before setting the allowed stroke rate, monitor the actual stroke rate during normal operation. The stroke rate allowed should then be set 4 to 5 strokes per minute above that rate.

**Table 4-2
Overstroke Set Points**

Horsepower	Maximum Limit	Strokes Per Minute Added to Stroke Rate Allowed	
	85,000 psi	Warning	Shutdown
125	60	3	6

Example The allowable stroke rate is set at 40 strokes per minute. If the stroke rate reaches 43, an overstroke warning will be issued 15 seconds after detection. The warning will continue until the rate returns to normal, or exceeds the overstroke shutdown point.

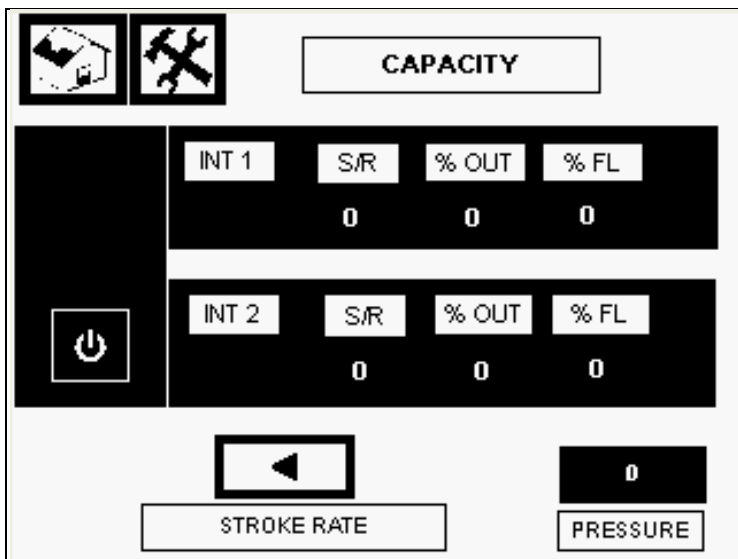
If the stroke rate reaches 46 an overstroke shutdown pending will be issued. If the condition persists for 30 seconds, an automatic shutdown will occur.

4.9 Capacity Screen

The Capacity Screen displays the actual stroke rate, signal to each proportional valve, the percent of full load for each intensifier and the current operating pressure.

The internal balancing system controls the proportional pressure valves and the strokerate. Pressure is maintained at an accuracy of +2,000 psi (+138 bar) to -500 psi (-34 bar). The pressure transducer continually monitors the total system pressure. If the system pressure varies outside this accuracy range, the balancing system automatically adjusts the signal to the proportional valves, increasing or decreasing the demand from each hydraulic pump.

Figure 4-9: Capacity Screen

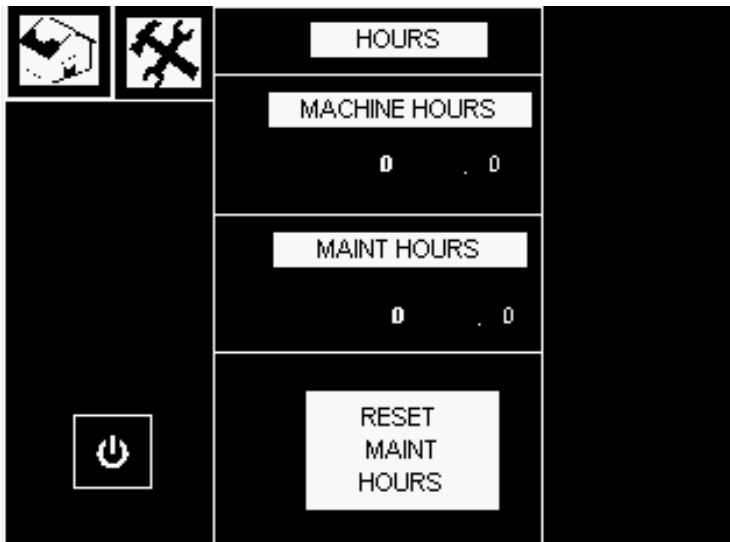


S/R	Displays the actual strokerate for each intensifier. The total number of strokes for both intensifiers represents the total load at any given time.
% OUT	Displays the signal to the proportional pressure valves on each hydraulic pump as a percentage of maximum flow. For example, if the set pressure is 45,000 psi (3,103 bar), a signal is sent to each valve to open 50%.
% FL	Displays the percent of the full load strokes for each intensifier.
PRESSURE	Displays the actual operating pressure, the input signal from the pressure transducer.
STROKE RATE	Press the STROKE RATE button to display the Stroke Rate Screen.

4.10 Hours Screen

The Hours Screen displays total operating hours for the intensifiers and total maintenance hours for the intensifiers. Operating hours cannot be reset. Maintenance hours can be reset by pressing the RESET MAINT HOURS button.

Figure 4-10: Hours Screen



4.11 Run Screen Alarms

In an alarm state, the alarm sensed by the machine is displayed on the Run Screen. If multiple alarm conditions have occurred they can be viewed on the Alarm History Screen. Run Screen alarms are listed in Table 4-3.



Table 4-3
Run Screen Alarms

Alarm	Indication	Comments
Bleed High Pressure Lines	Indicates high pressure is present in the lines when the machine stops.	Intensifier is shut down; high pressure is present in the discharge plumbing and should be bled off to avoid possible injury.
Booster Temperature High	Booster pump water temperature is high, in excess of 128° F (53° C).	Shutdown will occur if condition persists.
High Oil Temperature Warning	High hydraulic oil temperature, in excess of 130° F (54° C).	
High Oil Temperature	High hydraulic oil temperature, in excess of 144° F (62° C).	Shutdown will occur if condition persists.
PLC Low Battery	Battery in the PLC is low. After the alarm occurs, the battery will last for approximately seven days.	Replace with backup/replacement battery.
Low Booster Pressure	Booster pump output pressure is inadequate for proper machine operation, less than 60 psi (4 bar). Shutdown is pending.	Seven seconds after the machine is started, the booster pump output pressure switch is monitored. If the switch opens, a warning is issued. If the condition persists, shutdown will occur after 30 seconds.
Low Inlet Water Pressure	Cutting supply water pressure is inadequate to permit proper machine operation, less than 30 psi (2 bar).	If the inlet cutting water pressure switch is not closed, the machine will not start and a warning is issued. If the switch opens after the machine is started a warning is issued. If the condition persists shutdown occurs after five continuous seconds.
Overstroke Warning		Overstroke warnings, pending shutdowns and shutdowns are issued as left, right or intensifier. An intensifier warning or shutdown indicates the intensifier is shifting too fast in both directions. If the machine is running near full capacity it is possible an intensifier shutdown is actually caused by a left or right fault. This can be diagnosed further by reducing the operating pressure and monitoring all alarm occurrences on the Alarm History Screen.

Table 4-3
Run Screen Alarms

Alarm	Indication	Comments
Overstroke Shutdown Pending	Abnormally high stroke rate caused by an external or internal leak.	Shutdown will occur if condition persists for 30 seconds.
Reset Inlet Water	Inlet water solenoid valve must be reset. RESET will flash and can be reset by pressing the STOP button.	

Installing a New Battery

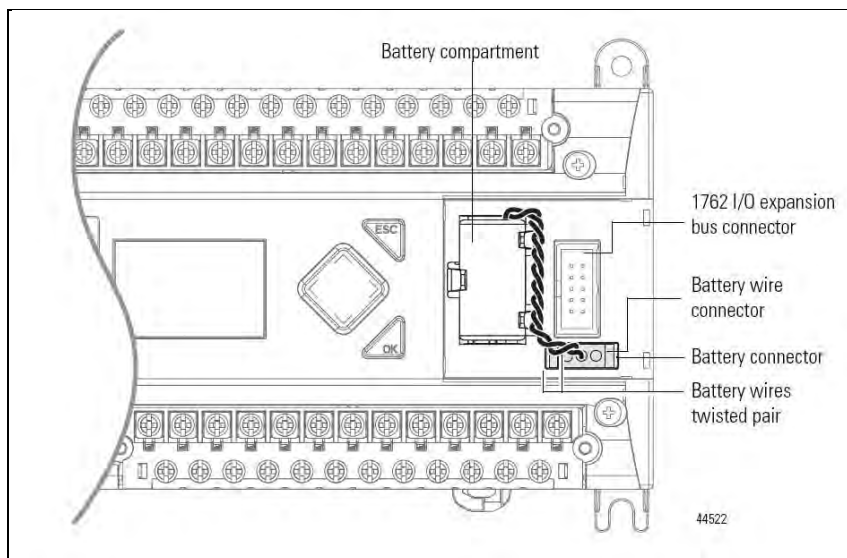
The following procedure is used to change the replacement battery.



Do not attempt to remove the permanent battery.

1. Insert the new battery into the replacement battery pocket with the wires facing up.
2. Insert the wire connector for the replacement battery into the connector port.
3. Secure the battery wires under the wire latch as shown in Figure 4-10, Replacement Battery.
4. All local regulations must be adhered to when disposing of the used battery.

Figure 4-11: Replacement Battery



4.12 Alarm Banners

When a shutdown condition occurs an Alarm Banner will appear over the current screen. The banner displays the type of shutdown and lists possible remedies. Potential remedies are listed in order of most to least probable.

Figure 4-12: Alarm Banner



Pressing the RESET button will clear the alarm banner, but it will not clear the fault. The banner will continue to display until the fault is corrected. Shutdowns will appear on the Alarm History Screen. Alarm banner shutdowns are listed in Table 4-4.

Table 4-4
Alarm Banner Shutdowns

Alarm		Comments	Possible Remedies
1.	Softstart Fault		Check softstart display for error type. <i>Refer to Section 10, Troubleshooting, for details regarding softstart faults and remedies.</i>
2.	Motor Feedback Failure		Check softstarter to verify it is on.
3.	Oil Level Low		Check level gauge.
			Check for hydraulic leaks.
4.	Oil Temperature High	High hydraulic oil temperature, in excess of 144° F (62° C).	Check cooling water.
5.	Low Booster Pressure	Booster pump output pressure is inadequate for proper machine operation, less than 60 psi (4 bar).	Check system relief valve adjustment.
			Check operating condition of booster pump.
6.	Low Inlet Water Pressure	Cutting supply water pressure is inadequate to permit proper machine operation, less than 30 psi (2 bar).	Check water supply.
			Check water filter.
7.	Long Idle Time Shutdown		



Table 4-4
Alarm Banner Shutdowns

Alarm		Comments	Possible Remedies
8.	Left Overstroke Shutdown Int I		Check companion intensifier for fault.
			Check left high pressure seal.
			Check right discharge check valve.
			Check left inlet check valve.
9.	Right Overstroke Shutdown Int I		Check companion intensifier for fault.
			Check right high pressure seal.
			Check left discharge check valve.
			Check right inlet check valve.
10.	T/W Overstroke Shutdown Int I		Check companion intensifier for fault.
			Check plumbing for leaks.
			Check high pressure orifice.
			Check overstroke setting.
11.	T/W Overstroke Shutdown Int II		Check companion intensifier for fault.
			Check plumbing for leaks.
			Check high pressure orifice.
			Check overstroke setting.
12.	Left Overstroke Shutdown Int II		Check companion intensifier for fault.
			Check left high pressure seal.
			Check right discharge check valve.
			Check left inlet check valve.
13.	Right Overstroke Shutdown Int II		Check companion intensifier for fault.
			Check right high pressure seal.
			Check left discharge check valve.
			Check right inlet check valve.

Table 4-4
Alarm Banner Shutdowns

Alarm		Comments	Possible Remedies
14.	Alarm! Pressure Transducer Error	Error must be corrected before normal operation can resume.	Check wiring connection.
15.	Booster Temp High	Booster pump water temperature is high, in excess of 128° F (53° C).	Check incoming water temperature.
			Check for long idle times.

4.13 Alarm History Screen

The Alarm History Screen displays the last 100 shutdown alarms indicating date, time and type of alarm. Use the ▲ or ▼ arrow to view past alarms.

Figure 4-13: Alarm History Screen



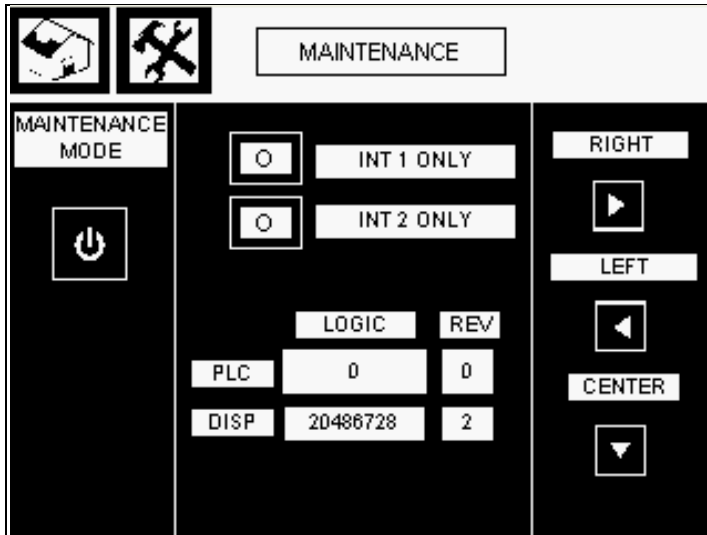
A communication error between the PLC and display will cause the red light on the control panel to come on, but no error message will be displayed. Press the RESET button on the Alarm History Screen to reset all alarms.

4.14 Maintenance Screen

The Maintenance Screen is used to facilitate maintenance procedures and provides the PLC and display logic part and revision number. When started from the Maintenance Screen, the machine starts in maintenance mode and opens the safety dump valve.

The machine must be started from the Maintenance Screen to access the following functions:

Figure 4-14: Maintenance Screen



START/STOP	The START/STOP button will start the machine in maintenance mode and open the safety dump valve. The STOP button will stop the machine.
RIGHT	The RIGHT button will open the dump valve and extend the piston to the right, allowing full exposure to the right plunger when the unit is disassembled. <i>The unit must be completely assembled to use this jog function.</i>
LEFT	The LEFT button will open the dump valve and extend the piston to the left, allowing full exposure to the left plunger when the unit is disassembled. <i>The unit must be completely assembled to use this jog function.</i>
CENTER	The CENTER button will open the dump valve and position the piston in the center of the hydraulic cylinder. <i>The unit must be completely assembled to use this jog function.</i> To center the piston, first press the RIGHT button and then the CENTER button.
INT 1 ONLY INT 2 ONLY	Used to help isolate maintenance issues with a specific intensifier by preventing the companion intensifier from shifting. Do not operate above 50,000 psi (3,447 bar) when this feature is enabled.

4.15 Language Selector Screen

The Language Selector Screen lists the available display languages. Press the ▲ or ▼ arrow to highlight the desired language. Press ENTER (↵) to select.

Figure 4-15: Language Selector Screen



4.16 Contact Information Screen

Consult the Contact Information Screen for technical assistance, available 7 days a week, 24 hours a day.

Figure 4-16: Contact Information Screen





SECTION 5

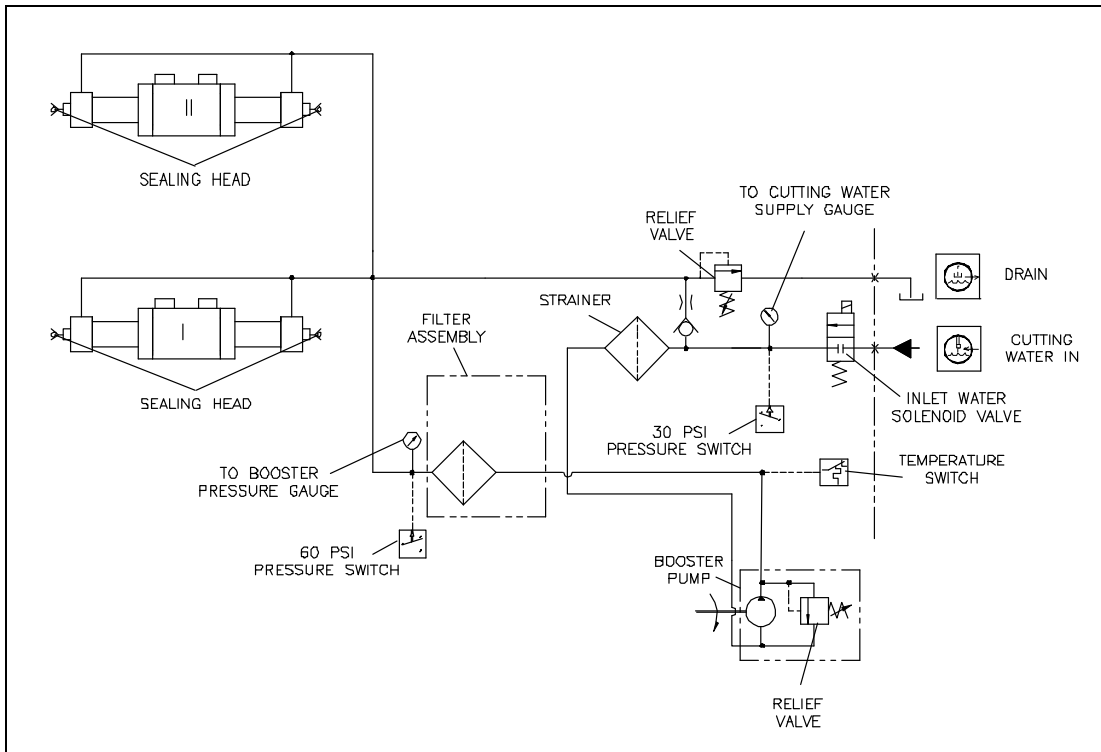
LOW PRESSURE WATER SYSTEM

5.1 Overview

The SL Pro² 125 utilizes two low pressure circuits: cutting water supply and cooling water supply. This section will discuss the cutting water supply circuit. See Section 6, Recirculation System, for a detailed explanation of the cooling water supply circuit.

The cutting water supply circuit supplies the intensifier with the required cutting water flow and pressure. System components include the inlet water solenoid valve, strainer, booster pump, and the low pressure filter assembly. Pressure and temperature switches, connected to the PLC, monitor out of tolerance conditions in the cutting water circuit and provide automatic shutdown protection.

Figure 5-1: Low Pressure Water Circuit



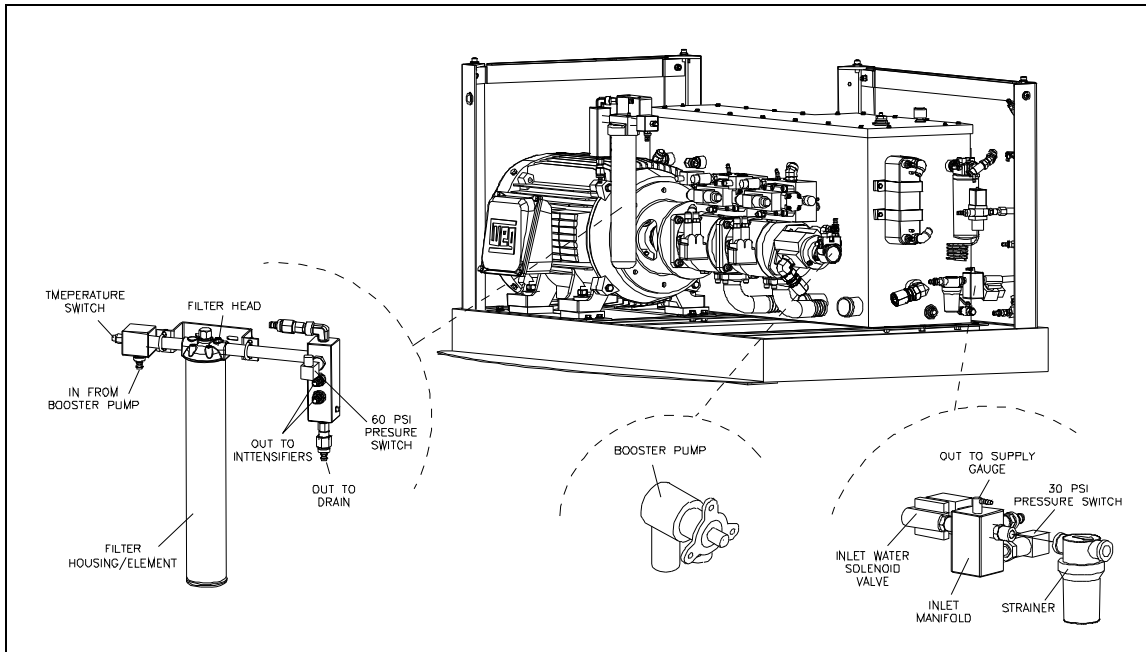
5.2 Cutting Water Supply

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 11, Specifications, for details regarding water quality standards.

5.3 Operation

Cutting water is introduced through the 1/2-inch NPT connection on the rear bulkhead of the machine. Inlet cutting water pressure should be a minimum of 35 psi (2.4 bar) flowing, and can be monitored from the Cutting Water Supply Gauge on the front of the machine.

Figure 5-2: Low Pressure Water System



Cutting water enters 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. The inlet water is monitored by a 30 psi pressure switch mounted on the inlet manifold. If the pressure drops below 30 psi (2 bar) the switch activates an automatic shutdown circuit in the PLC and the machine will not start.

NOTE

The machine will not start if inlet cutting water pressure is below 30 psi (2 bar).

If a shutdown occurs due to an overstroke condition, the inlet solenoid valve automatically closes to prevent water waste due to an external leak. Additionally, when the water reset function is enabled, the valve automatically closes at the idle shutdown interval selected by the operator.

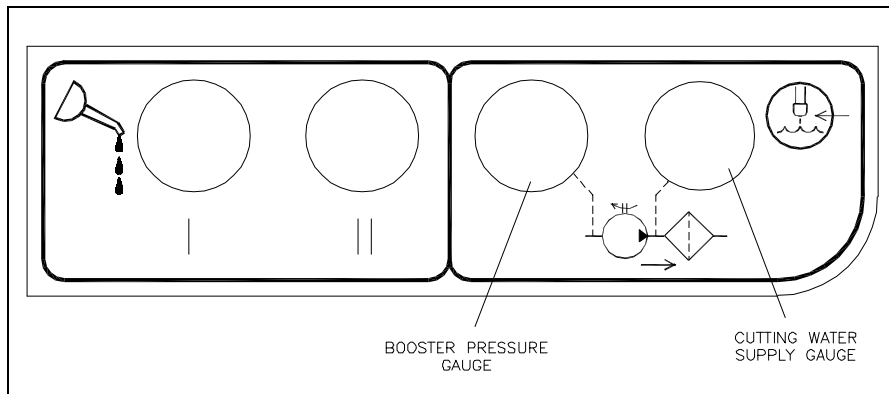
Cutting water then passes through a strainer to remove debris before the water enters the booster pump. The booster pump increases the pressure to the relief valve setting, up to a maximum of 120 psi (8 bar) to ensure proper supply to the intensifier assembly.

Boosted pressure is displayed on the Booster Pressure Gauge on the gauge display. 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.

Figure 5-3: Pressure Gauge Display



Pressurized water is then routed to the filter assembly where debris is removed to prevent contaminants from damaging the check valves and seals in the intensifier. The filter assembly consists of a filter head, housing and a 10 micron absolute filter.

A temperature switch, mounted on the inlet manifold, monitors the discharge temperature. If the temperature exceeds 128° F (53° C), the switch activates an automatic shutdown circuit in the PLC that stops the main motor. The temperature switch prevents booster pump overheating due to lack of water or long deadhead conditions. To reduce overheating during a deadhead condition, water is re-circulated through the orifice and check valve, and routed back through the strainer to the booster pump inlet.

As the water enters the outlet manifold, the discharge pressure is monitored by a 60 psi pressure switch. An automatic shutdown will occur if the pressure is below 60 psi (4 bar).

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

A relief valve built into the filter assembly 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.

From the outlet manifold, cutting water is routed to the inlet check valves in the sealing heads on each end of the intensifiers.

5.4 Service and Maintenance Procedures

To ensure water quality and supply to the high pressure system, the filter element, strainer and booster pump will require routine servicing and maintenance. The procedures for servicing these components are detailed below.

NOTE

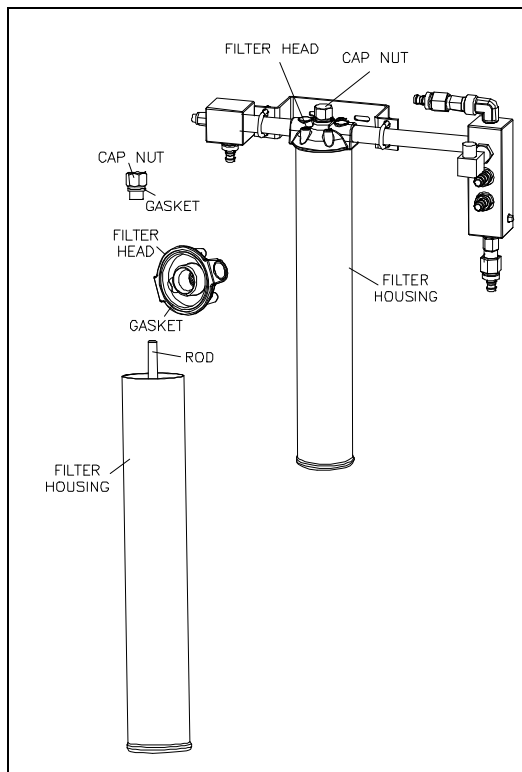
Refer to Section 12, Parts List for a complete listing of replacement parts and part numbers.

Filter Assembly and Strainer 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 Booster Pressure Gauge on the front of the machine. 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. When the filter element is replaced, the strainer should also be cleaned.

The following procedure is used to replace the filter element and clean the strainer.

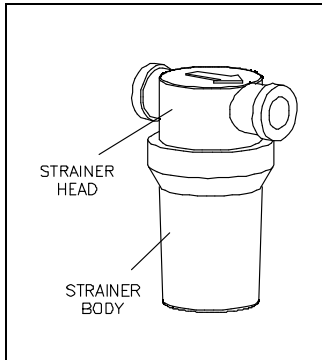
Figure 5-4: Filter Assembly Maintenance



1. Turn the cutting water supply off.
2. Remove the cap nut with the gasket from the filter head.
3. Slide the filter housing away from the head and remove the old filter element.

4. Install the new element over the rod in the center of the housing.
5. Apply FML-2 grease to the gasket in the filter head and to the gasket on the cap nut.
6. Position the housing in the filter head and install the cap nut.

Figure 5-5: Strainer

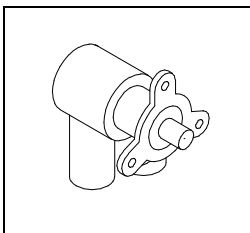


7. Unscrew and remove the strainer body. Remove and clean the mesh liner.
8. Ensure the gasket is properly positioned in the body, install the liner and screw the strainer body into the strainer head, hand tighten.
9. Turn the cutting water supply on.
10. Press the red bleed valve to remove any air inside the housing.
11. Start the machine and verify satisfactory pressure readings.

Booster Pump Adjustment

If the discharge pressure from the booster pump stays below 90 psi (6 bar) while the intensifier is shifting, the relief valve on the booster pump should be adjusted.

Figure 5-6: Booster Pump



1. Turn the cutting water supply on.
2. Start the machine and initiate normal, shifting operation.
3. Observe the discharge pressure from the booster pump. If the pressure stays below 90 psi (6 bar), continue with Step 4.
4. Stop the intensifier.
5. Use a flat screwdriver and turn the adjustment screw on the acorn nut clockwise to increase the discharge pressure or counter-clockwise to decrease the pressure. Adjust the pressure to the highest desired pressure, within 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.

6. Resume normal operation and observe the booster discharge pressure. Peak pressure should be in the range of 90 to 120 psi (6 to 8 bar). If it is not, repeat the adjustment procedure.



SECTION 6

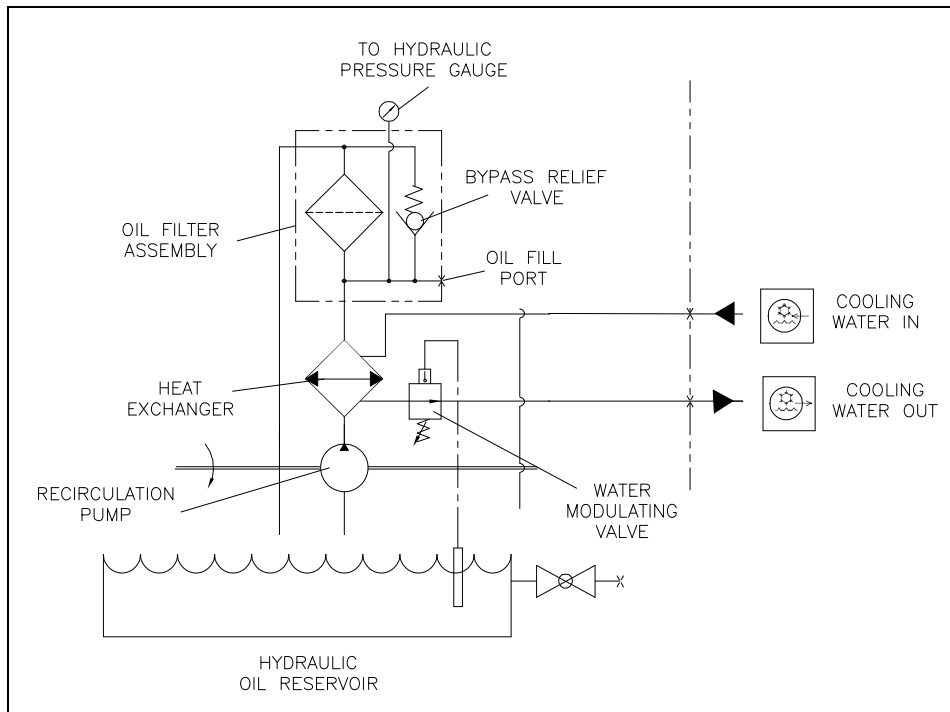
RECIRCULATION SYSTEM

6.1 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 recirculation pump, heat exchanger, oil filter assembly, hydraulic oil reservoir and a water modulating valve. A temperature/low level switch, connected to the PLC, monitors temperature and oil level conditions in the hydraulic oil reservoir and provides automatic shutdown protection.

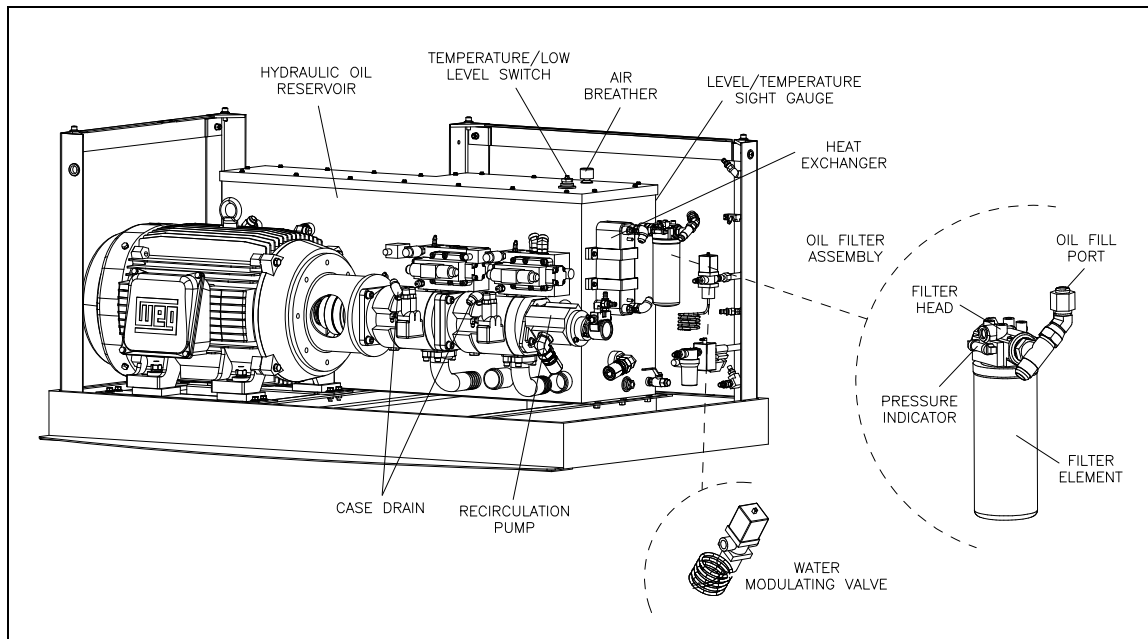
Figure 6-1: Oil Recirculation Circuit



6.2 Operation

Cooling water is introduced through the 1/2-inch NPT connection on the rear bulkhead of the machine. A water modulating valve in the outlet line regulates the cooling flow through 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 or from the Run Screen display.

Figure 6-2: Recirculation System Components



The recirculation pump pulls oil from the reservoir and sends it to the heat exchanger. The 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 rear bulkhead or is routed to a customer supplied water chiller.

The hydraulic oil filter assembly consists of the filter head, and element, pressure gauge indicator, bypass relief valve and the oil fill port. The filter element should be changed when the differential pressure indicator enters the red zone 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 25 psi (1.7 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. An automatic shutdown will occur if the operating oil temperature exceeds 144° F (62° C). An automatic shutdown will also occur if the oil level falls below 75 gal (284 L).

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.

6.3 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 12, Parts List for a complete listing of replacement parts and part numbers.

Hydraulic Oil Maintenance

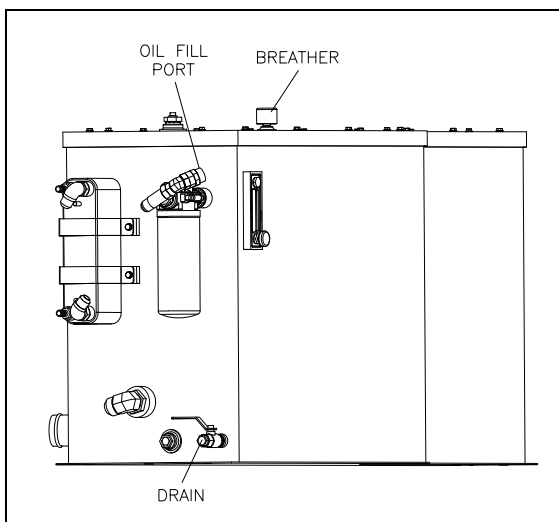
The hydraulic oil should be replaced after 3,000 hours or one year of service, whichever comes first. The oil should be replaced sooner if a fluid sample indicates contamination that cannot be rectified by filtering.

An air breather and filter is located on the top of 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 replaced at the fill port on the filter head.



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 6-3: Hydraulic Reservoir



Before proceeding, disconnect and lockout the main power supply and the electrical enclosure; and ensure that all high pressure water and hydraulic pressure has been bled from the system.



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.

1. Drain the oil reservoir by connecting the inlet hose from an oil transfer pump to the 1/2-inch ORB drain valve on the reservoir.
2. Open the shut off valve on the drain and pump the used oil out to a container.
3. Close the shut off 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.

4. 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.

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

NOTE

If 3/4-inch BSPP threads are required, install the adapter located on the inside of the frame. When filling is complete, remove the adapter and install the fill port cap.

6. Check the oil sight gauge on the reservoir to ensure proper fill level.
7. Remove the hose from the case drain on the hydraulic pumps 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.

8. Disconnect the discharge hose from the fill port and replace the fill port cap.
9. Follow the initial start up sequence in Section 4, Operation, to ensure the system is filled with oil.
10. Check the sight gauge again and follow the same procedure to add additional oil if necessary.

Electric Motor Bump

Bumping is defined as allowing the electric motor to start rotating, but stopping it before the motor gets up to full speed.

Whenever the hydraulic reservoir is emptied or the hydraulic pump has been changed, bumping the electric motor is suggested. This procedure will ensure the hydraulic pump is full of oil and deter cavitation which will cause the hydraulic pump to fail prematurely.

Do not perform this procedure until the correct motor rotation and the presence of hydraulic oil in the hydraulic pump case drain line has been confirmed.

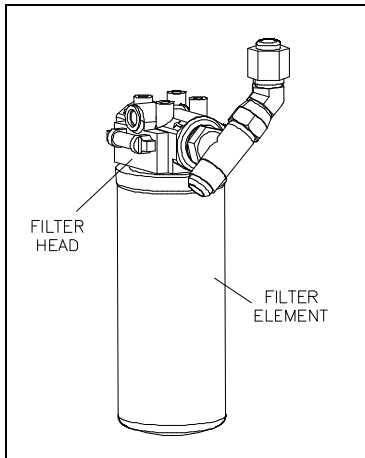
1. Start the pump in recirculation mode, count two seconds and turn the pump off.
2. Repeat this process six times before allowing the hydraulic pump to create pressure.

Oil Filter Maintenance

If the filter element is not properly serviced and fills with debris, the oil will be forced through the relief valve, bypassing the filter. The bypass relief valve opens at 25 psi (1.7 bar). The filter element must be replaced when the pressure indicator is in the yellow zone or entering the red zone during normal operating conditions.

NOTE

Normal operating conditions indicate the machine is running and the oil temperature has reached 115° F (46° C).

Figure 6-4: Oil Filter Assembly

1. Use a filter wrench to unscrew the filter element from the filter head. Make sure the old gasket is removed with the element.
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.

NOTE

If the pressure indicator is in the red zone after the filter is changed, check the operating condition of the indicator. The filter head may require replacement.

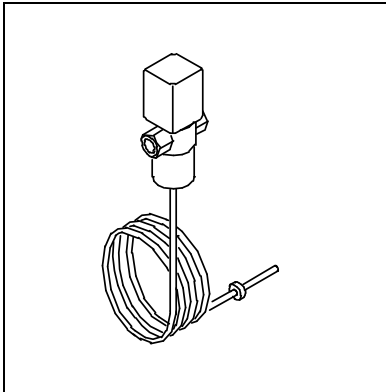
Operating Temperature Adjustment

The cooling water flow through 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). It is adjusted by increasing or decreasing the spring tension on the valve.

NOTE

In most cases, adjustment will be required during commissioning and with seasonal changes to the cooling water temperature.

Figure 6-5: 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 7

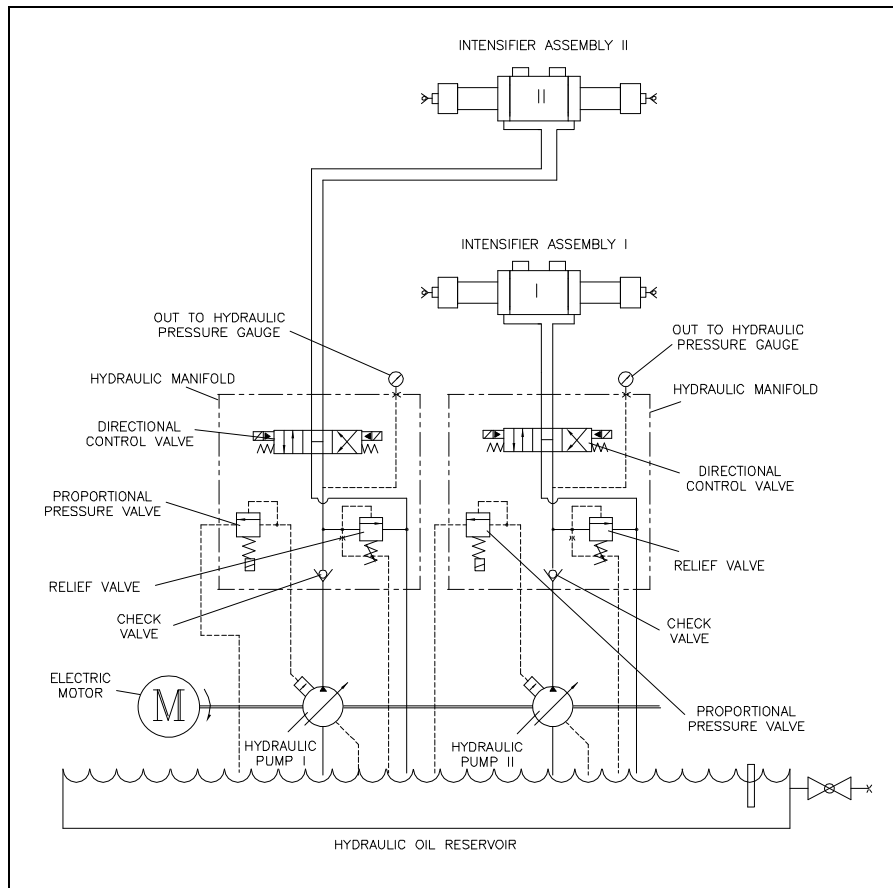
HYDRAULIC SYSTEM

7.1 Overview

The main hydraulic power circuit supplies the intensifier assembly with the hydraulic oil 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, 4-way directional control valves and two hydraulic pumps with hydraulic manifolds. Each manifold houses a proportional pressure control valve and a system relief valve. The system relief valve monitors hydraulic oil pressure and provides system protection by limiting excess pressure.

Figure 7-1: Main Hydraulic Power Circuit

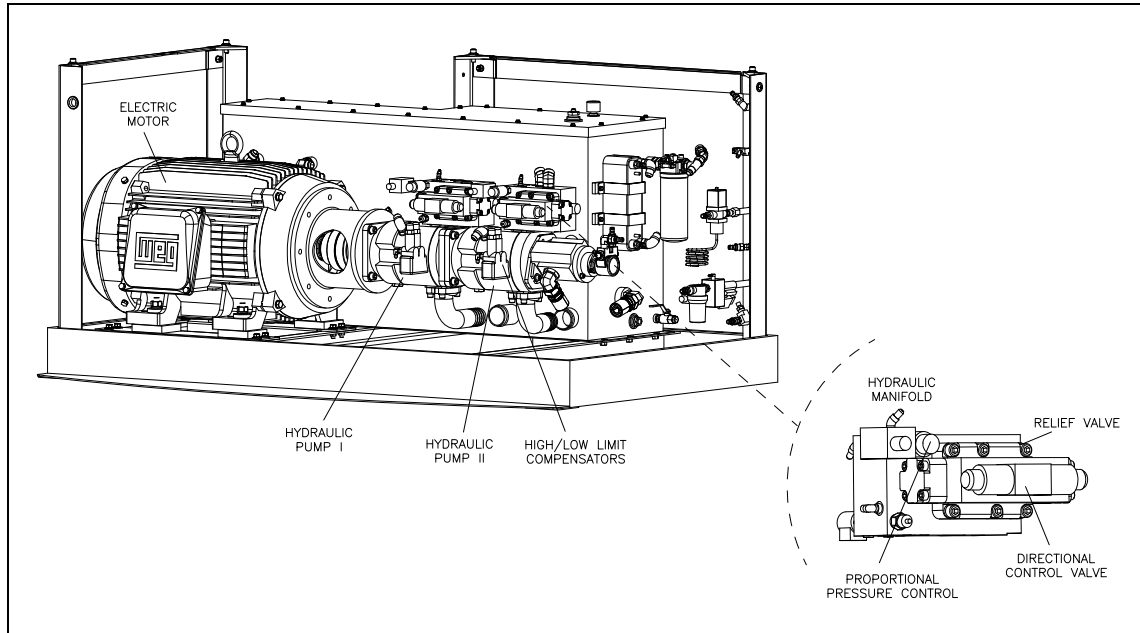


7.2 Operation

The electric motor and the two hydraulic pumps are mounted in tandem. The motor drives the variable displacement; pressure compensated hydraulic pumps by means of a flexible coupling. Hydraulic pump I supplies intensifier I, and pump II supplies intensifier II.

Hydraulic fluid from the reservoir is drawn into the inlet, low pressure side of each hydraulic pump. Oil delivered to the pumps 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 7-2: Hydraulic System Components



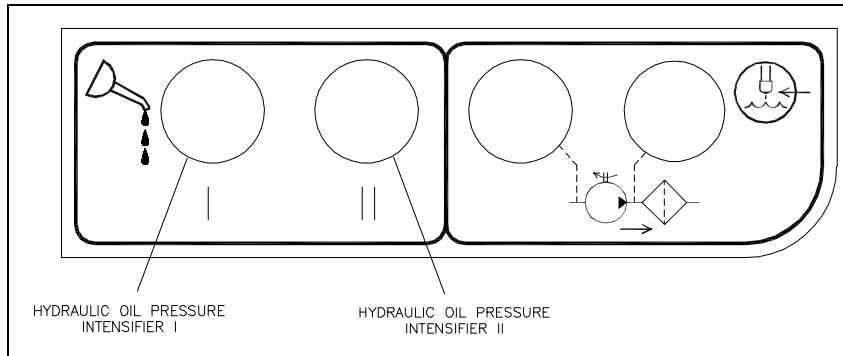
The relief valves provide system protection by monitoring the oil pressure entering each manifold. If the hydraulic pressure to either pump exceeds 2,610 psi (180 bar), the valve opens to limit the pressure. The valve is factory calibrated and is not serviceable. A drain line from the valve prevents oil from collecting behind the relief valve to ensure a constant pressure under all operating conditions.

The high and low limit compensators mounted on each pump regulate the flow of hydraulic fluid to maintain constant operating pressures. The compensators normally do not require any adjustment or maintenance. Operating pressure is set and adjusted from the control panel or a remote console. As the proportional pressure values control the hydraulic oil pressure, they also determine cutting water pressure based on the intensification ratio.



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.

Hydraulic reference gauges display the hydraulic pressure to each intensifier. When the intensifier shifts, it is normal for the pressure display to quickly fall and then rise again.

Figure 7-3: Pressure Gauge Display

The 4-way directional control valves direct pressurized oil to one end the hydraulic cylinder and return 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, energized by the PLC. 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 PLC 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.

7.3 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.

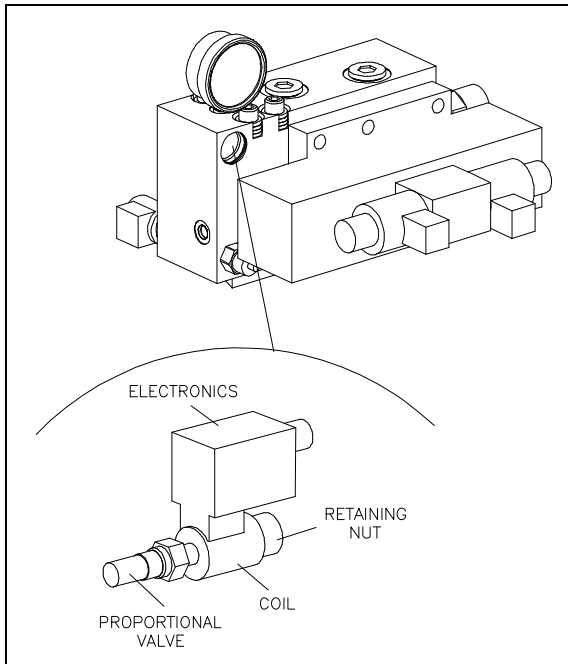
The operating pressure settings must be checked daily, and the electric motor must be inspected at regular intervals. It is also possible for the flexible coupling to fail and require replacement. The procedures for servicing these components are detailed below.

NOTE

Refer to Section 12, Parts List for a complete listing of replacement parts and part numbers.

Proportional Pressure Valve Maintenance

The screen in the proportional valve can become blocked with debris resulting in erratic pressure fluctuations or the inability to reach or maintain the operating pressure.

Figure 7-4: Proportional Valve

1. Unscrew and remove the retaining nut on the proportional pressure valve.
2. Remove the coil and electronics from the valve.
3. Unscrew and remove the valve from the hydraulic manifold.
4. Use air or alcohol to clean the screen inside the valve.

NOTE

A blocked screen will appear black. Clean the screen until it is clear.

5. Screw the cleaned valve into the hydraulic manifold.
6. Replace the coil and electronics.
7. Replace the adjustment knob.

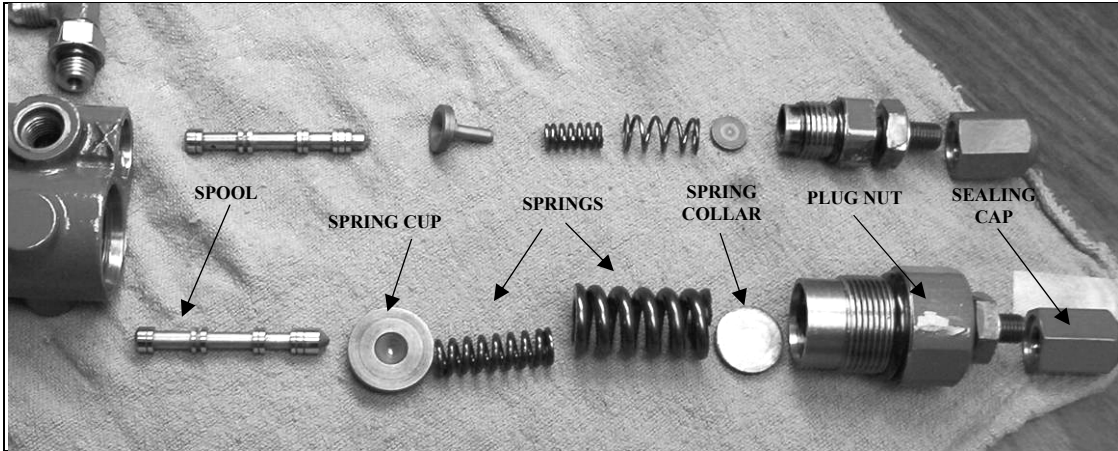
Motor Maintenance

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.

Hydraulic Compensator Maintenance

The high and low limit compensators regulate the flow of hydraulic fluid to the system. The compensators normally do not require maintenance, but they can become blocked with debris resulting in loss of pump control.

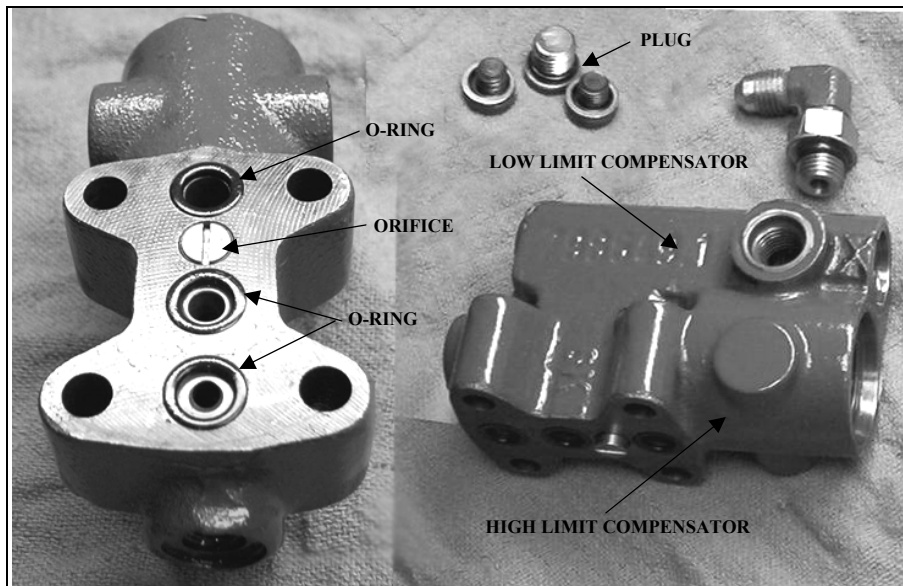
Figure 7-5: Hydraulic Compensator Components



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.

1. Remove the hydraulic hose from the low limit compensator.
2. Remove the four socket screws that attach the compensators to the pump.
3. Remove the compensators and then remove the three plugs and o-rings on the back of the housing.

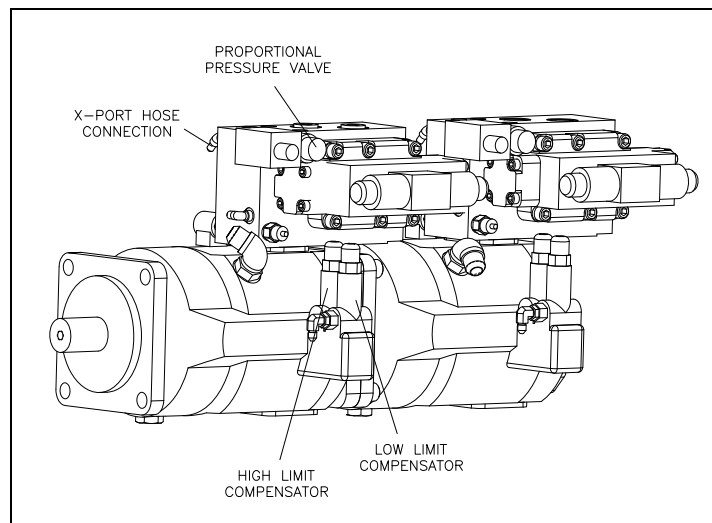


4. Disassemble the compensators one at a time by first removing the hexagon sealing cap.
5. Loosen the lock nut, and then remove the plug nut.
6. Disassemble the plug by removing the spring collar, springs, spring cup and spool.
7. Clean the housing and all components with clean fluid and carefully dry with air.
8. Check and clean the small internal passages in the spools.
9. Check and clean the orifices in both spools.
10. 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.

11. Disconnect one of the 4-way valve solenoid connectors on both pumps.



12. Disconnect the x-port hose from the manifold on the pump being adjusted and place in a suitable receptacle.
13. On the Run Screen, set the operating pressure to 90,000 psi (6,200 bar).
14. Unscrew both the high and low limit compensators three times.
15. Start the unit.
16. Adjust the low limit compensator until the hydraulic pressure reaches 400 psi (28 bar). If the low limit compensator is unscrewed all the way without reaching 400 psi (28 bar), the high limit compensator is unscrewed too far. Screw the high limit compensator in until the hydraulic pressure reaches 600 psi (42 bar) and then unscrew the low limit compensator to 400 psi (28 bar).



17. Lock the low limit compensator in position.
18. Turn the unit off.
19. Reconnect the x-port hose to the manifold.
20. Start the unit.
21. Screw the high limit compensator in until the hydraulic pressure reaches 2,350 psi (162 bar).
22. Turn the unit off and reconnect the 4-way connectors or repeat Steps 12-21 for the other pump.



SECTION 8 ELECTRICAL SYSTEM

8.1 Overview

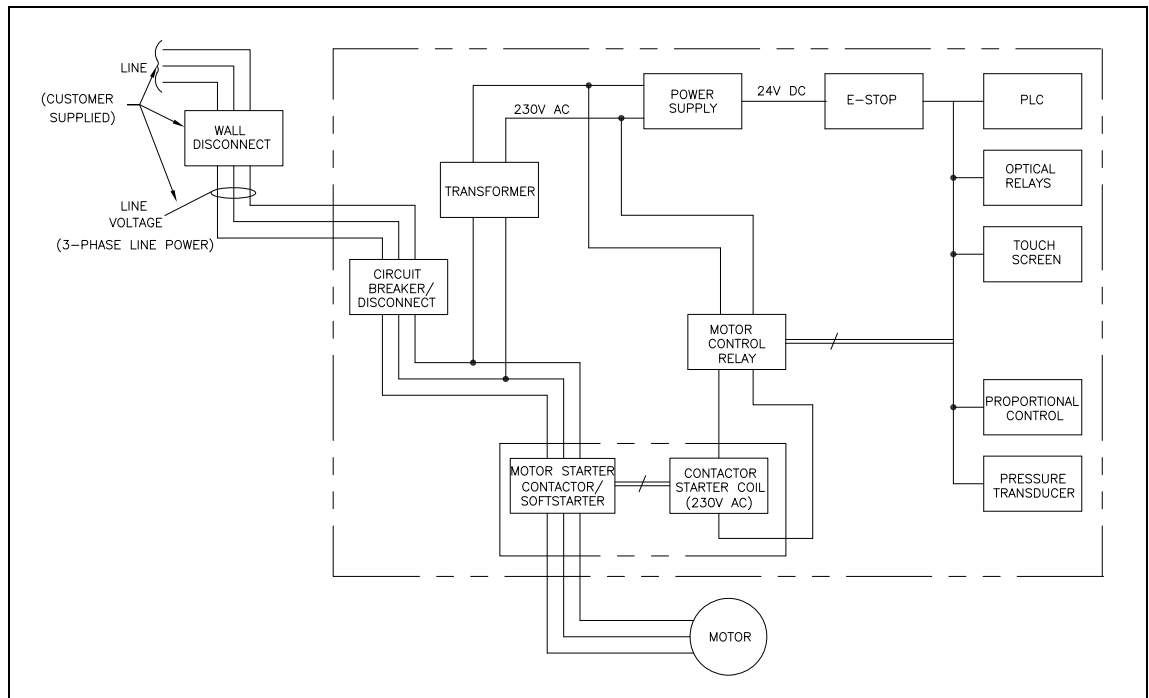
The SL Pro² 125 is equipped with integral motor starter and control circuitry, enclosed in the electrical panel. The operator controls the machine primarily through a touch-screen control panel that communicates with the programmable logic controller (PLC). A series of sensors provide automatic shutdown logic and diagnostics.

Major system components include the electric motor, control panel, high voltage and control components, and the wiring harness that connects the sensors and solenoid valves to the PLC.

8.2 Operation

Electrical power from the utility grid enters the main circuit breaker/disconnect on the electrical enclosure door as 3-phase alternating current. The power is then distributed in two directions. The 3-phase AC, at the voltage provided from the grid, is routed to the motor starter contactor(s) and then to the motor. Single phase AC is routed to the transformer.

Figure 8-1: Electrical Control Power

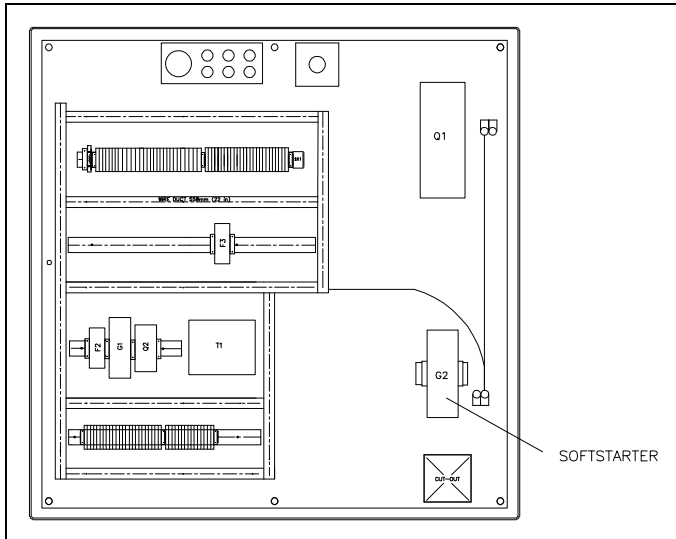


The multi-tap transformer converts the incoming voltage to 230 volt AC that is routed to the power supply. The power supply then provides 24-volt direct current to the control circuits, including the motor starter, emergency stop logic, the Programmable Logic Controller (PLC), optical relays, display screen and the control functions.

The motor is started with a softstarter, operated by 24-volt DC control power. Softstarters combine contactors, overload, timers and internal power/control wiring into a single device. They utilize a current limit starting method to greatly reduce mechanical and electrical shock to the system.

When the START button is pressed on the display panel, an output from the PLC energizes the softstarter, starting the motor. When the STOP button is pressed, the softstarter coil opens, stopping the motor.

Figure 8-2: Softstart Configuration

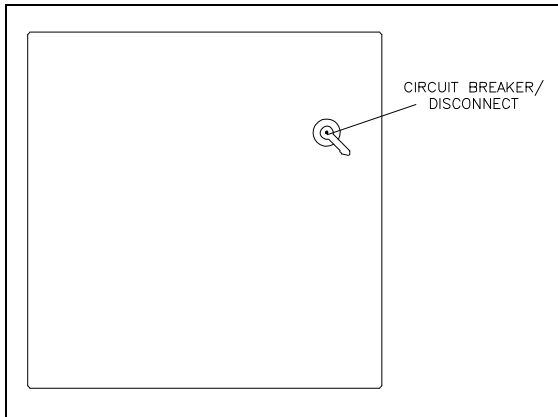


The circuit breaker/door disconnect provides the primary over current protection for the machine. All power is automatically disconnected from the machine when the main disconnect on the enclosure door is opened. However, power is still present on the input side of the circuit breaker/door disconnect. The only way to isolate all power to the machine is to turn the customer installed main power disconnect off.



Hazardous voltage exists in the motor circuit even when the softstart controller is off. Disconnect the main power before servicing the motor controller or associated wiring.

Figure 8-3: Electrical Enclosure Door



NOTE

See Section 2, Installation, regarding specifications for the customer installed main power disconnect.

Sensors and Solenoids

Warning and shutdown sensors monitor operating conditions, and electronically operated solenoids provide basic intensifier shift control. The harness cable connects these sensors and solenoids to the PLC.

Figure 8-4: Sensors and Solenoids

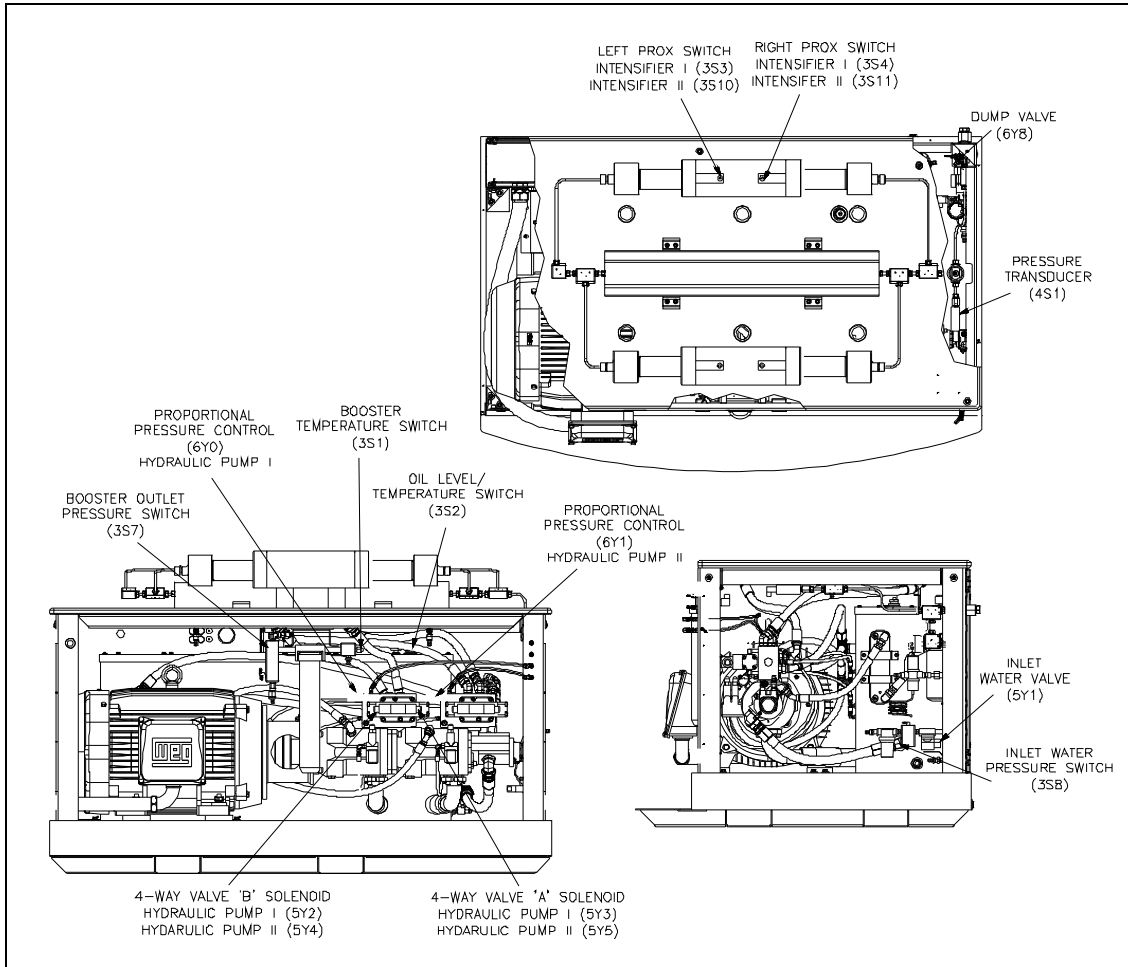


Table 8-1
Sensors and Solenoids

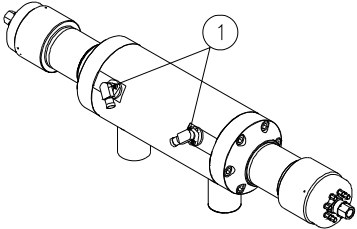
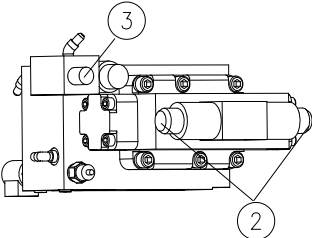
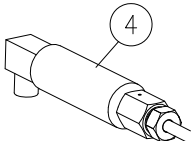
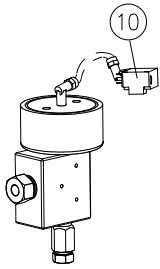
Component	Function
	<p>1 As pressurized hydraulic oil is sent to one side of the hydraulic cylinder, it pushes against the piston, moving it in one direction until it activates the proximity switch at the end of the stroke. The hydraulic flow is then sent to the opposite side of the cylinder, and the 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. Another 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 PLC to change the flow of the directional control valve and reverse direction.</p>
	<p>2 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, energized by the PLC.</p>
	<p>3 When the desired operating pressure is set, a signal is sent to the proportional pressure control valves, mounted on the hydraulic pumps, to open. The control system increases or decreases the signal as needed to maintain the set operating pressure.</p> <p>4 The pressure transducer monitors the output pressure from the attenuator in the high pressure system. If the system pressure is outside the set pressure range, the balancing system automatically adjusts the signal to the proportional valves, increasing or decreasing the demand from the hydraulic pumps.</p>

Table 8-1
Sensors and Solenoids

Component	Function
	<p>5 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. The solenoid valve functions as a safeguard by closing if a leak is detected anywhere in the system, or if the system is idle for an extended period.</p>
	<p>6 The 30 psi pressure switch, mounted on the inlet manifold at the bulkhead, monitors the inlet cutting water. If the pressure drops below 30 psi (2 bar) the switch activates an automatic shutdown circuit, protecting the booster pump from damage due to insufficient water supply pressure.</p> <p>7 A temperature switch monitors the temperature of the cutting water from the booster pump. If the temperature exceeds 128° F (53° C), the switch activates an automatic shutdown circuit in the PLC. The temperature switch prevents booster pump overheating due to lack of water, long deadhead conditions or a blocked orifice.</p> <p>8 To ensure adequate water pressure and supply to the intensifiers, the discharge pressure is monitored by a 60 psi pressure switch located on the low pressure water filter assembly. An automatic shutdown occurs if the pressure is below 60 psi (4 bar).</p>
	<p>9 The temperature/low level/warning 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> <p>A warning is issued if the operating oil temperature reaches 130° F (55° C). If the temperature exceeds 144° F (62° C), an automatic shutdown occurs. An automatic shutdown will also occur if the hydraulic fluid level falls below 75 gal (284 L).</p>

Table 8-1
Sensors and Solenoids

Component	Function
	<p>10 When control power is removed, the 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 from an emergency stop, 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>

8.3 Service and Maintenance Procedures

Electrical components require minimal service. The proximity switches on the hydraulic cylinder and the optical relay switches in the controls subassembly may require replacement, and the proportional valve may require cleaning.

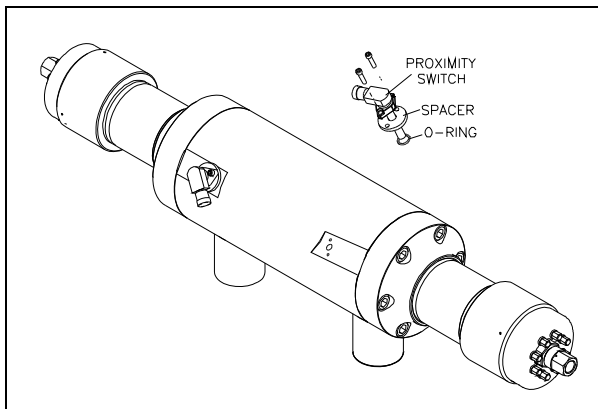
NOTE

Refer to Section 12, 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, if an LED flashes continuously, or if the appropriate input is not noted on the PLC processor annunciator light panel in the electrical enclosure.

Figure 8-5: 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, o-ring and spacer.
4. Apply FML-2 grease to the o-ring and install a new proximity switch by positioning the spacer and the switch. Apply JL-M grease to the threads on the socket head screws and torque 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 on each switch will result in the spray of hydraulic oil.

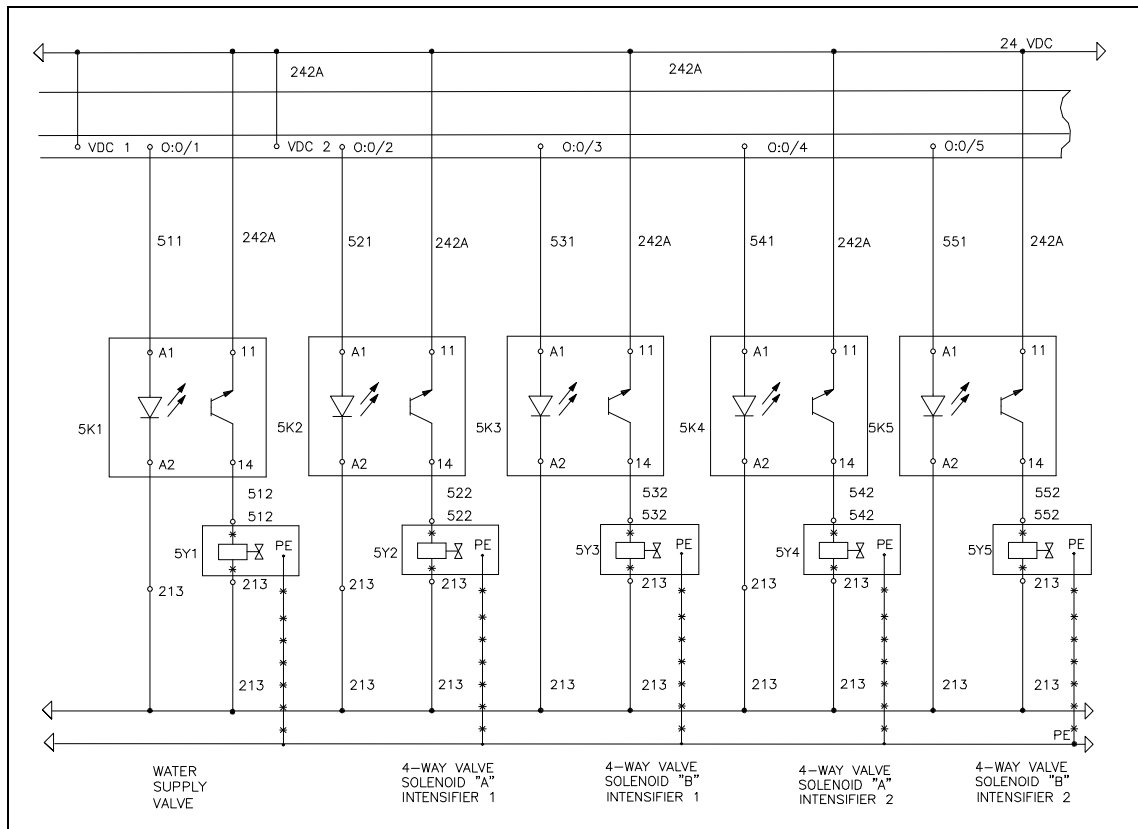
Optical Relay Maintenance

The optical relays identified in Table 8-2 change the state of the associated solenoid valves. If the relay fails, the state will not change. For example, if the relay controlling the water supply valve fails, the valve will not open and close.

Table 8-2
Optical Relays

Label	Component	Function
K4	Directional Control Valve, Solenoid A, Intensifier I	Switches the direction of the hydraulic flow
K5	Directional Control Valve, Solenoid B, Intensifier I	Switches the direction of the hydraulic flow
K6	Directional Control Valve, Solenoid A, Intensifier II	Switches the direction of the hydraulic flow
K7	Directional Control Valve, Solenoid B, Intensifier II	Switches the direction of the hydraulic flow
K3	Water Supply Valve	Opens and closes the inlet water solenoid valve

Figure 8-6: Optical Relays



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. Open the control panel, locate the appropriate optical relay and disconnect its wiring.
3. Remove the relay from the DIN rail by lifting the catch with a small screwdriver.
4. Replace the optical relay and reconnect its wiring.



SECTION 9

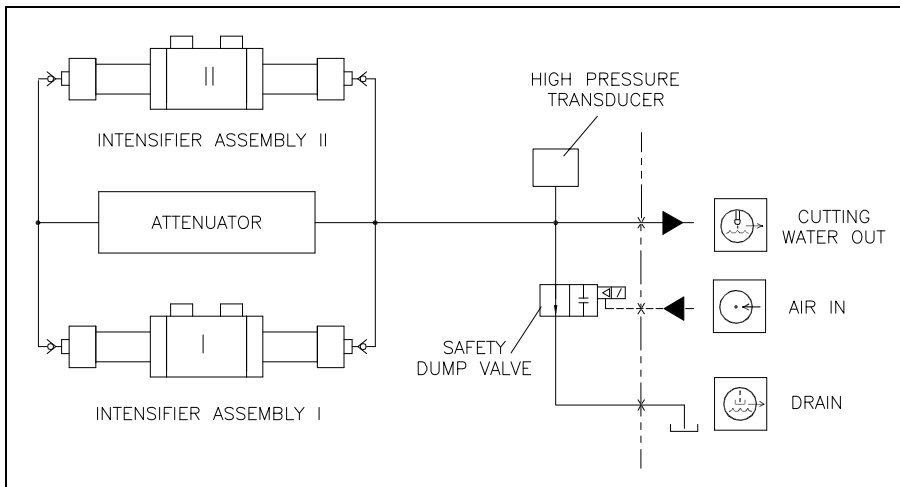
ULTRA-HIGH PRESSURE WATER SYSTEM

9.1 Overview

The ultra-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 a maximum of 90,000 psi (6,200 bar) with the cutting head valve closed or 85,000 psi (5,860 bar) with the cutting head valve open.

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.

Figure 9-1: Ultra-High Pressure Water Circuit

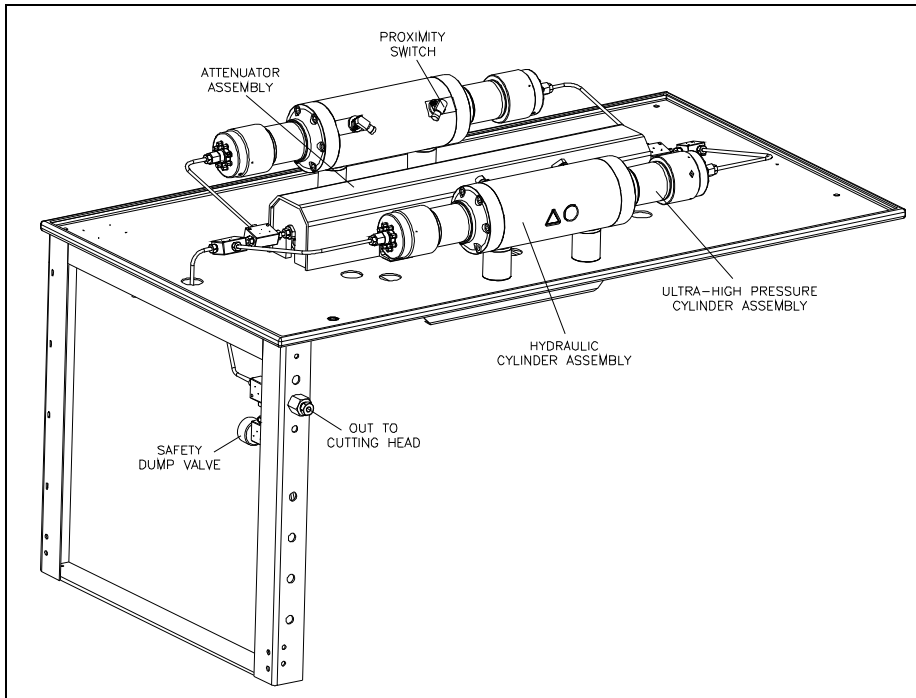


System components include a double-ended hydraulic cylinder; reciprocating piston assembly; two ultra-high pressure cylinders and cylinder sleeves on each end of the hydraulic cylinder; two plungers, sealing heads, a 1.6 liter capacity attenuator and a safety dump valve. Sophisticated check valves and seal assemblies ensure hydraulic oil, and the low pressure and high pressure water travel in the appropriate direction. Warning and shutdown sensors monitor strategic pressure, temperature and fluid levels to safeguard against component damage.

9.2 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.

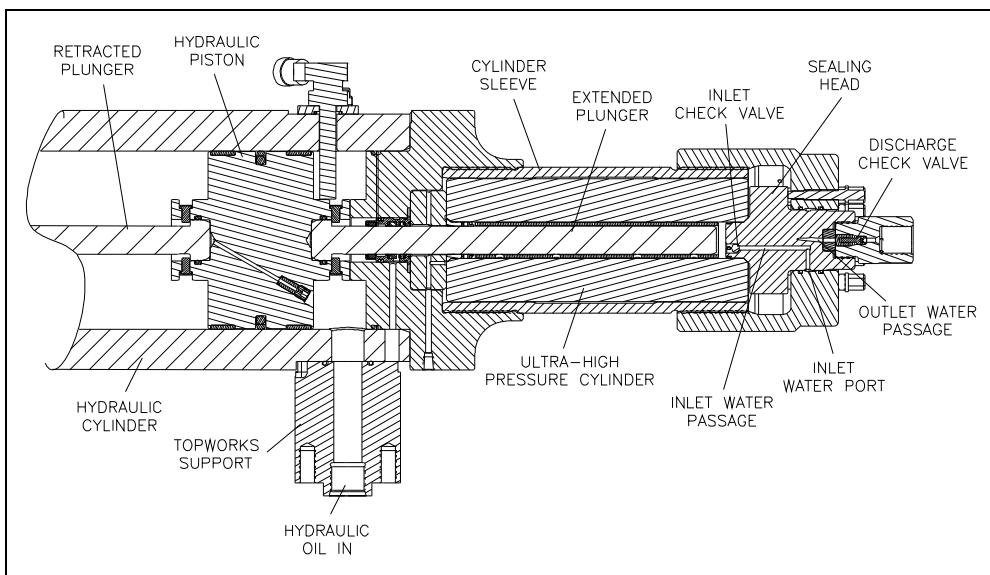
Figure 9-2: Ultra-High Pressure Water System



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, it sends a signal to the PLC to change the flow of the directional control valve and reverse direction.

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 90,000 psi (6,200 bar) with the cutting head valve closed. When the piston reverses direction, the plunger retracts and the plunger in the opposite cylinder extends to deliver the high pressure water.

Figure 9-3: Ultra-High Pressure Cylinder Assembly





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.

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.

The 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 an electrically controlled air valve.

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

9.3 System Components

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

Figure 9-4: Ultra-High Pressure Cylinder Assembly

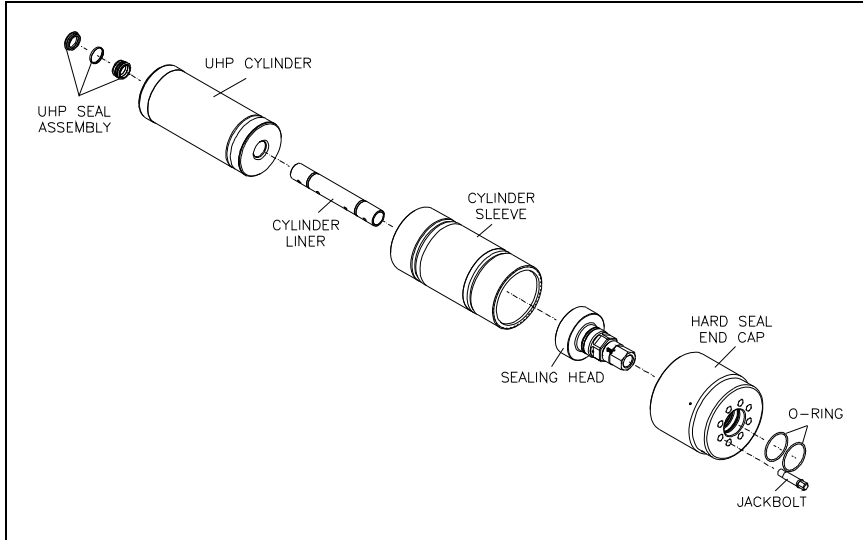


Figure 9-5: Hydraulic Cylinder Assembly

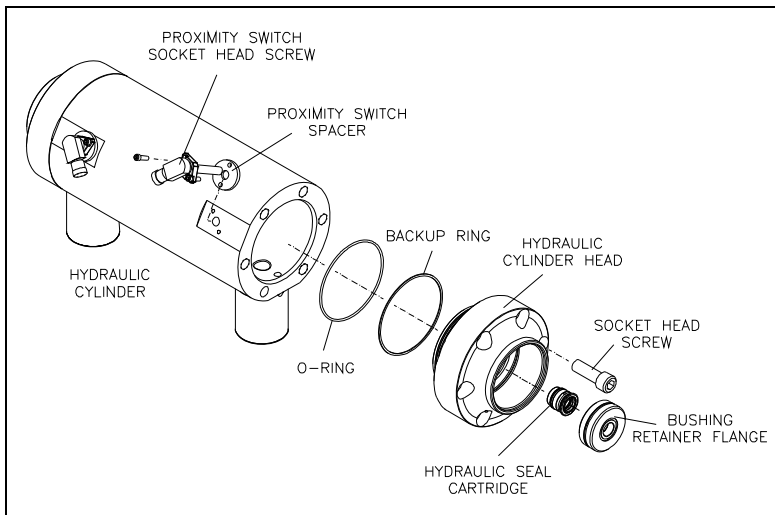
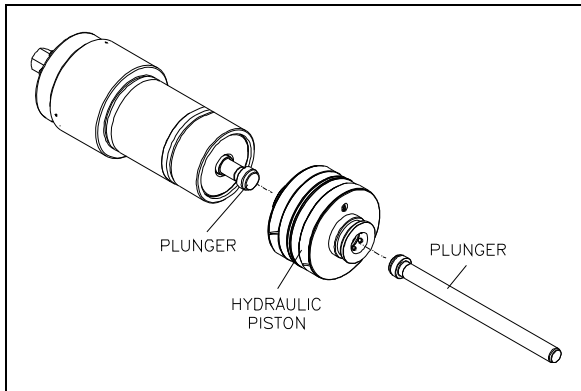


Figure 9-6: Hydraulic Piston

9.4 Service and Maintenance Overview

Never perform any type of maintenance on the high pressure water system while it is pressurized. Always turn the power off and bleed the high pressure water before servicing. Pressing the emergency stop button turns the control power off to the intensifier, and bleeds high pressure water through the dump valve.

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 12, Parts List for a complete listing of replacement parts and part numbers.

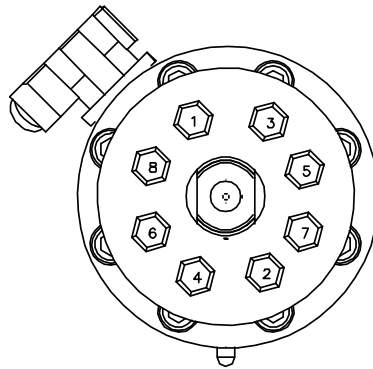
Torque Specifications

Table 9-1, Torque Specifications, details the torque specifications and tightening sequences for the high pressure components and connections.

**Table 9-1
Torque Specifications
Ultra-High Pressure Water System**

Hard Seal End Cap	
Jackbolts	8 (1/2") each
1st Stage	Hand Tight
2nd Stage	20 ft-lbs (27 Nm)* Crossing Pattern
3rd Stage	68-70 ft-lbs (92-95 Nm) Crossing Pattern
4th Stage	68-70 ft-lbs (92-95 Nm) Clockwise Pattern From Bolt 1
Socket Wrench Size	7/16 inch

8-Bolt Crossing Pattern



* **Note:** Crossing Pattern: 1, 2, 3, 4, 5, 6, 7, 8.

** **Note:** A maximum torque of 70 ft-lbs (95 Nm) is etched on the hard seal end cap. This represents the **maximum** allowable torque.

Hydraulic Cylinder Head	
Socket Head Screws	6 (3/4") each
Torque	170-175 ft-lbs (230-237 Nm)
Hex Key	5/8 inch
Proximity Switch	
Socket Head Screws	2 (1") each
Torque	140-160 in-lbs (16-18 Nm)
Hex Key	M5

Table 9-1
Torque Specifications
Ultra-High Pressure Water System

Sealing Head	
Discharge Gland	150 ft-lbs (203 Nm)
Pneumatic Control Valve	
3/8" UHP Gland	75 ft-lbs (102 Nm)
1/4" UHP Gland	35 ft-lbs (47 Nm)
Pneumatic Actuator	5 ft-lbs (7 Nm)
1/4" UHP Adapter	45 ft-lbs (61 Nm)
Ultra-High Pressure Fittings	
1/4" UHP Gland Nut	35 ft-lbs (47 Nm)
3/8" UHP Gland Nut	75 ft-lbs (102 Nm)
9/16" UHP Gland Nut	160 ft-lbs (217 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 9-7, Specialized Maintenance Tools, and part numbers are provided in Table 9-2.

Figure 9-7: Specialized Maintenance Tools

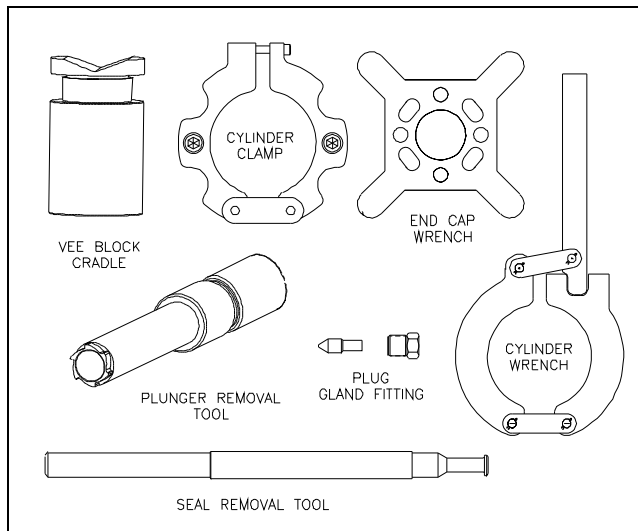


Table 9-2
Specialized Maintenance Tools
High Pressure Water System

	Part Number
Plunger Removal Tool	20477460
Vee Block Cradle	20484961
Seal Removal Tool	10148674
End Cap Wrench	80079239
Cylinder Wrench	20490232
Cylinder Clamp	20476495
UHP Plug, .38	20453136
UHP Gland, .38	20452956

9.5 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 high pressure cylinder
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 flange.
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 9-2.
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.

9.6 Ultra-High Pressure (UHP) Cylinder

The high pressure cylinder and associated components must be removed to service the plunger, ultra-high pressure seals, hydraulic piston and hydraulic cartridge seal.

Ultra-High Pressure Cylinder Removal

Prior to removing electrical power or any high or low pressure piping, start the machine from the Maintenance Screen on the control panel. The machine will start in recirculation mode; the dump valve will open and relieve the high pressure in the system.

Press the RIGHT or LEFT arrow to extend the plunger on the end to be serviced. The plunger will extend in the selected direction, allowing 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.

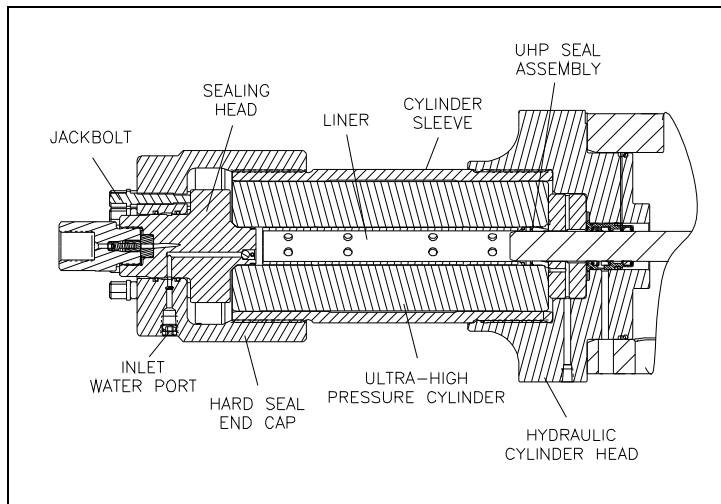
2. Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.
3. Loosen and remove the jackbolts in the hard seal end cap.
4. Unscrew and remove the hard seal end cap (HSEC) from the cylinder sleeve.

NOTE

To facilitate maintenance, the hard seal end cap, cylinder sleeve and hydraulic cylinder head are designed with two-start threads 180 degrees apart. When removing the HSEC, note the position of the inlet water port when the end cap is unscrewed from the sleeve.

5. Remove the sealing head. The sealing head may be removed with the HSEC or after the end cap has been removed.

Figure 9-8: Ultra-High Pressure Cylinder Removal

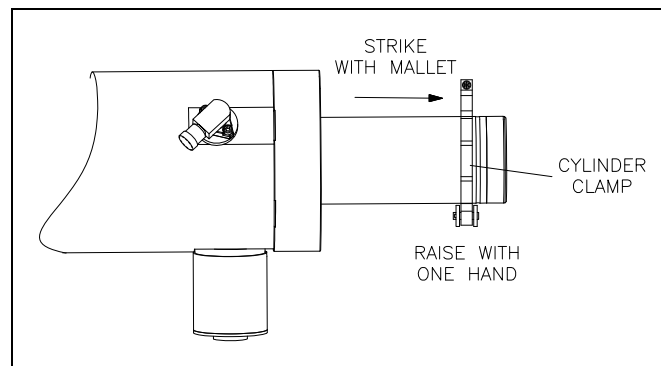


6. Unscrew and remove the cylinder sleeve from the hydraulic cylinder head.
7. Position the vee block cradle under the UHP cylinder to support the weight. Pull and remove the UHP cylinder from the hydraulic cylinder head **using one of the following methods**.
 - a. Rotate the cylinder by hand while simultaneously pulling the cylinder from the hydraulic cylinder head.



During removal, the high pressure cylinder should remain in a parallel position. If removing by hand, roll and pull the cylinder **straight** out of the hydraulic cylinder head.

- b. Position and clamp the cylinder clamp at the sealing head end of the cylinder as shown below. Use one hand to lift the cylinder and strike the clamp with a rubber or plastic mallet to remove the cylinder.



8. Remove the liner and the ultra-high pressure seal assembly, following the procedure, Ultra-High Pressure Seal Assembly.

Ultra-High Pressure Cylinder Installation

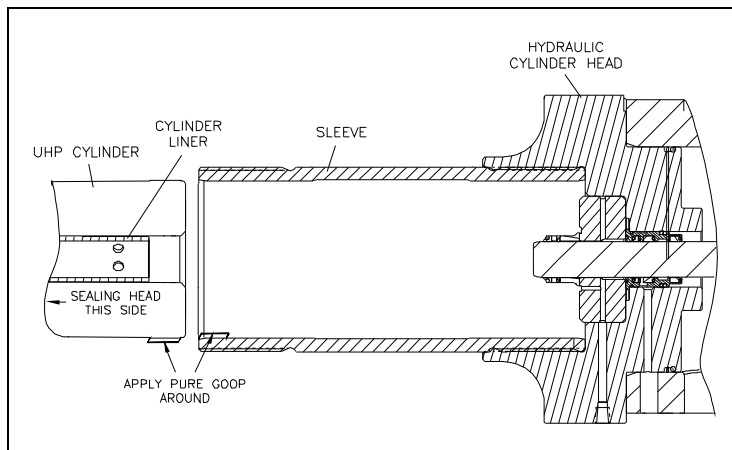
1. Carefully inspect the UHP seal assembly for wear or damage. Depending on the condition of the seals, the assembly can be reused. Install or replace the seal assembly, following the procedure, Ultra-High Pressure Seal Assembly.
2. Apply Pure Goop to the threads on the cylinder sleeve and to the internal threads in the hydraulic cylinder head. Thread the sleeve into the hydraulic cylinder head.
3. Verify the UHP cylinder bore has been adequately cleaned with alcohol and is free of lint and dust.
4. Insert the liner into the UHP cylinder through the end facing the UHP seal assembly.

NOTE

The ends of the UHP cylinder are **not interchangeable**. The cylinder is marked indicating which end must be positioned against the sealing head.

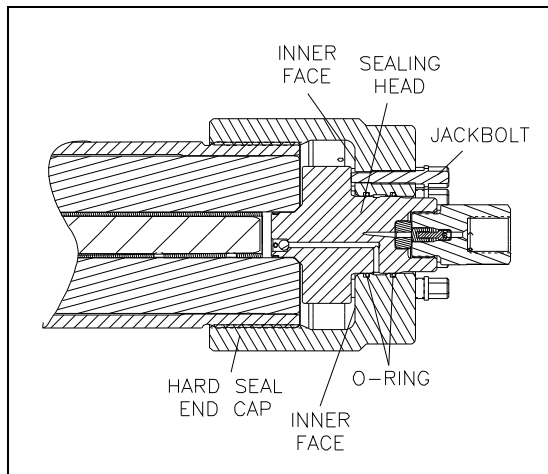
5. Apply Pure Goop on the inside diameter of the sleeve and the appropriate outer diameter of the UHP cylinder as illustrated below.

Figure 9-9: Ultra-High Pressure Cylinder Installation



6. Slide the UHP cylinder into the sleeve until contact is made with the UHP seal assembly. Using your hand or a soft mallet, push the cylinder until the cylinder face is approximately flush with the end face of the sleeve.
7. Before installing the end cap, apply FML-2 grease to the two o-rings and verify they are properly installed in the inside diameter grooves of the HSEC.

Figure 9-10: Hard Seal End Cap Installation



8. Apply Pure Goop to the coned sealing surface on the sealing head and the chamfer on the exposed end of the UHP cylinder. Apply Pure Goop to the internal threads in the end cap, place the sealing head in the end cap and push into position.
9. Apply JL-M grease to the full length of the threads and to the ends of the jackbolts. Apply JL-M grease to the internal threads in the hard seal end cap. Install the jackbolts, ensuring they are slightly less than flush with the inner face of the end cap.



Make sure the JL-M lube is well mixed and not dried up due to age.

10. Apply Pure Goop to the threads on the cylinder sleeve. Position the end cap on the cylinder sleeve, ensuring the orientation of the inlet water port matches the orientation at removal. Fully engage the threads on the end cap with the cylinder sleeve. The cone seal on the sealing head should be in contact with the cylinder.
11. If necessary, 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 1/2 turn.**

NOTE

If the inlet water port does not align properly, remove and rotate the end cap 180 degrees and rethread the end cap onto the sleeve.

12. Hand-tighten the jackbolts until they make contact with the sealing head.
13. Tighten the jackbolts following the tightening sequence and torque specifications in Table 9-1.

NOTE

If the specified jackbolt torque is unable to pressure seal a new sealing head, completely remove and clean the jackbolts with alcohol. Inspect the threads, re-apply JL-M grease, install and re-torque the jackbolts.

14. Connect the high and low pressure water piping and turn the low pressure water supply on.
15. 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 start up procedure.

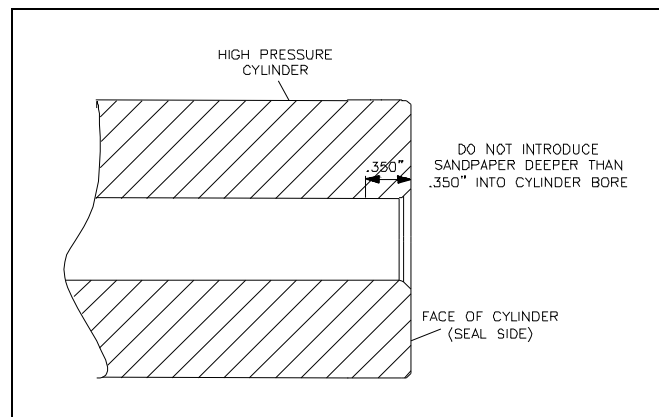
Ultra-High Pressure Cylinder Maintenance

The 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 wedge ring and packing follower are located 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** exceed a maximum depth of .350 inch (8.9 mm) from the face of the cylinder. **Do not** polish or drag the sandpaper along the length of the cylinder. **Do not** use sandpaper in the o-ring seating area.



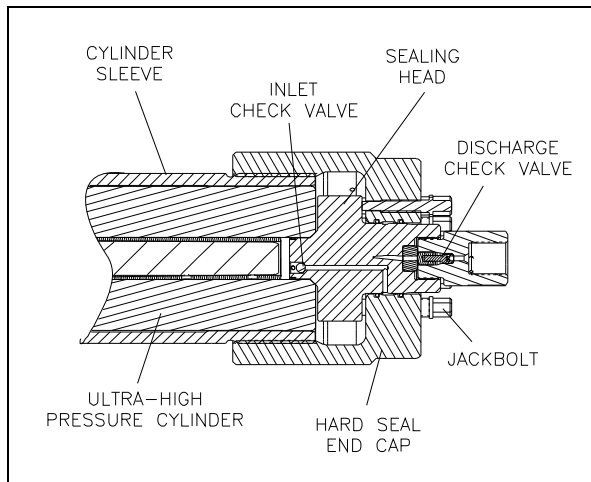
3. Clean the residue from the inside diameter of the cylinder and re-inspect for surface defects. The bore should be dust and lint free.

9.7 Sealing Head

The sealing head is sealed to the outboard end of the high pressure cylinder by a 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.

Figure 9-11: Sealing Head



High Pressure Discharge Check Valve

The high pressure 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.

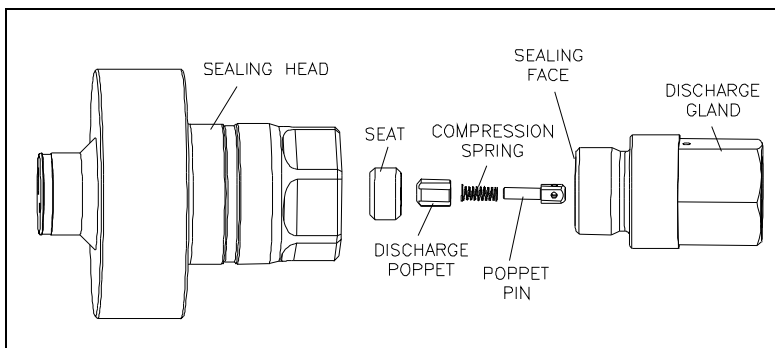
2. Disconnect the high pressure water piping, following the procedure, High and Low Pressure Water Piping.
3. Use two wrenches to remove the discharge gland. The poppet pin, spring and discharge poppet valve will normally remain in the gland nut when it is removed. Remove the components from the gland.
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.

- 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 9-12: High Pressure Discharge Check Valve

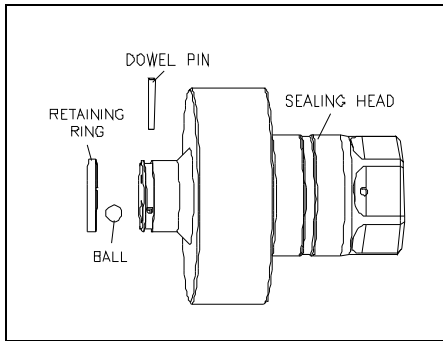


- Apply a thin film of Pure Goop only to the seat face facing the sealing head and install the seat into the sealing head. **Do not** apply Pure Goop to the seat face facing the discharge poppet.
If the existing seat is reused, flip the seat so the surface previously facing the sealing head now faces the discharge poppet.
- Install the poppet pin and the spring, and then install the poppet valve into the discharge gland. Make sure the large end of the spring is against the poppet.
- Apply a small amount of Pure Goop to the sealing face on the discharge gland. Apply a thin film of Pure Goop to the threads on the gland and thread the gland into the sealing head. Hand-tighten until there is a 0.20 inch (5 mm) gap between the gland 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.
- Use a crowfoot/torque wrench combination and tighten the discharge gland to the torque specifications in Table 9-1.

Low Pressure Inlet Check Valve

The low pressure inlet check valves should be inspected or refinished on a regular schedule. Inspection is recommended every 500 hours. The hard seal end cap must be removed to inspect and service the inlet check valve.

Follow the applicable steps in the procedure, Ultra-High Pressure Cylinder. When the end cap has been removed, proceed with Step 1 below.

Figure 9-13: Low Pressure Inlet Check Valve

1. Remove the retaining ring, dowel pin and ball.
2. Inspect the sealing head for scratches or wear on the contact surface and the ball seating surface. If defects are detected on the sealing head contact surface, the surface must be refinished. See the procedure, Sealing Head Maintenance.
3. If defects are detected on the ball, replace the ball. If defects are detected on the ball seating surface it may be possible to refinish the surface, depending on the severity of the defects. See the procedure, Sealing Head Maintenance.

If the surface cannot be properly refinished the sealing head must be replaced.

NOTE

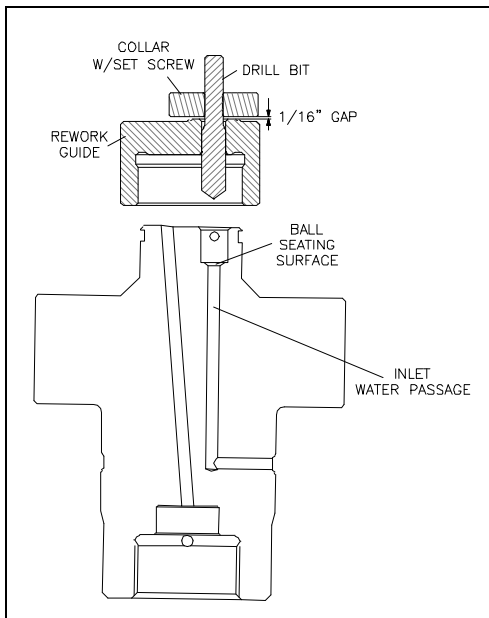
Refinishing the surface on a regular schedule, prior to the detection of defects, will prolong the life of the sealing head.

4. If no defects are detected on the ball or seating surface, replace the ball and the dowel pin.
5. Install the retaining ring.
6. Inspect the assembled unit to ensure the ball moves freely.

Sealing Head Maintenance

The sealing head should be inspected for scratches, excessive sealing damage or erosion marking on the high pressure cylinder contact surface, and on the ball seating surface. If defects are detected on the contact surface, the surface must be refinished. If defects are detected on the ball seating surface, the sealing head can be refinished.

1. Clean the 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 edges of the inlet water passage in the ball seating surface. The passage should be cylindrical with smooth edges. Over time the edges become jagged. It may be possible to refinish the surface, depending on the severity of the defects.

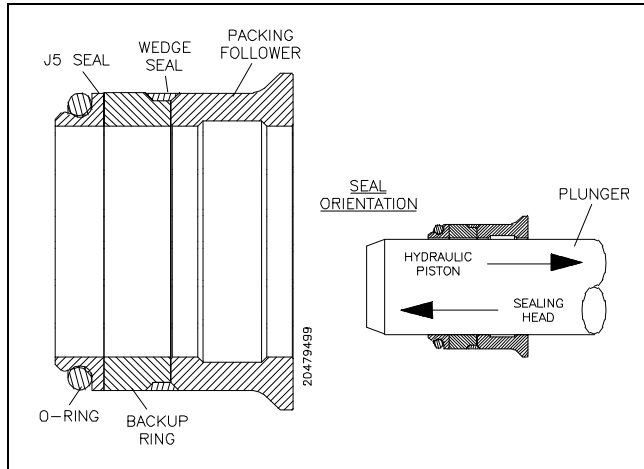
Figure 9-14: Ball Seating Surface Rework

3. Position the drill bit in the bore until it bottoms out against the seating surface.
4. Slide the rework guide over the bit and push it down over the end of the seating head.
5. Position the collar on the drill bit until there is a 1/16" gap between the collar and the guide. Tighten the set screw.
6. Use a power drill and carefully drill the bore.
7. Remove the guide with the drill bit and clean the bore with dry air and alcohol. Use a plastic or brass bristle brush to deburr the bore. No not use a steel or wire brush.
8. If additional refinishing is required, repeat the process.

9.8 Ultra-High Pressure Seal Assembly

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

Figure 9-15: Ultra-High Pressure Seal Assembly



Prior to removing electrical power or any high or low pressure piping, start the machine from the Maintenance Screen on the control panel. The machine will start in recirculation mode, the dump valve will open and relieve the high pressure in the system.

Press the RIGHT or LEFT arrow to extend the plunger on the end to be serviced. The plunger will extend in the selected direction, allowing 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.

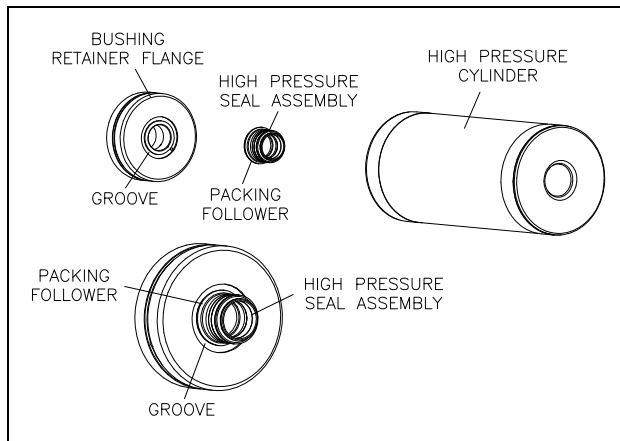
2. Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.
3. Remove the high pressure cylinder, following the procedure, Ultra-High Pressure Cylinder Removal.
4. Use a magnet to remove the bushing retainer flange from the hydraulic cylinder head.
5. Remove the cylinder liner from the bore of the ultra-high pressure cylinder and inspect for possible heat or wear damage. If cracks or brittleness are detected on the tabs on the ends of the liner, the liner must be replaced.
6. Slide the seal removal tool through the sealing head end of the UHP cylinder and use a mallet to remove the ultra-high pressure seal assembly.

7. Clean and inspect the UHP cylinder for unusual wear, cracks or pitting. Feel approximately one inch into the cylinder bore for obvious ridges or grooves. If seal debris is present, follow the procedure, Ultra-High Pressure Cylinder Maintenance.
8. 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.
9. Thoroughly clean the surfaces on the bushing retainer flange, the weep holes and the internal and external grooves. Install the flange in the hydraulic cylinder head with the surface groove facing the UHP cylinder. Ensure proper orientation as illustrated below.
10. Install the new seal components on the plunger until contact is made with the bushing retainer flange. **Do not apply any grease to the seal components.** Ensure the proper orientation of the packing follower and wedge ring seals as illustrated in Figures 9-15 and 9-16.



Proper orientation of the bushing retainer flange and the high pressure seal is critical.

Figure 9-16: Bushing Retainer Flange and Ultra-High Pressure Seal Orientation

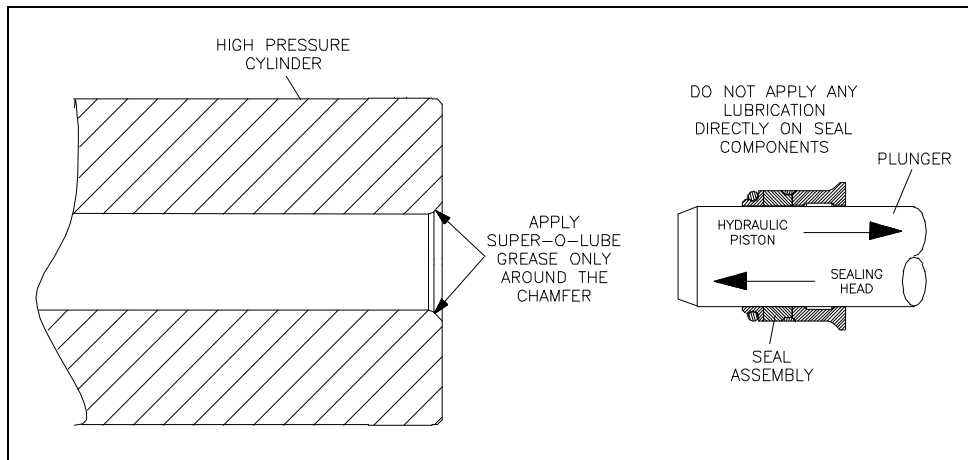


11. Apply a very light film of super-o-lube grease (P/N 20479328) at the inlet chamfer of the UHP cylinder facing the seal components. **Do not** apply any grease for food grade applications.



Do not apply any grease directly on the seal components.

Figure 9-17: UHP Seal Assembly Lubrication



12. Slide the cylinder liner over the plunger.
13. Install the ultra-high pressure cylinder and associated components, following the procedure, Ultra-High Pressure Cylinder Installation.
14. Reconnect the high and low pressure water piping and turn the low pressure water supply on.

9.9 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 from the Maintenance Screen on the control panel. The machine will start in recirculation mode, the dump valve will open and relieve the high pressure in the system.

Press the RIGHT or LEFT arrow to extend the plunger on the end to be serviced. The plunger will extend in the selected direction, allowing 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. This will allow the hydraulic oil to drain back to the reservoir, minimizing oil spillage. It will take approximately five minutes for the oil to drain.

4. Remove the UHP cylinder and associated components, following the procedure, Ultra-High Pressure Cylinder Removal.
5. Remove the bushing retainer flange and clean the surfaces, weep holes and grooves. Check the retainer flange for cracks.
6. Apply FML-2 grease to the o-ring and replace the proximity switch by positioning the spacer and the switch. Apply JL-M grease to the threads on the socket head screws and tighten, following the torque specifications in Table 9-1.

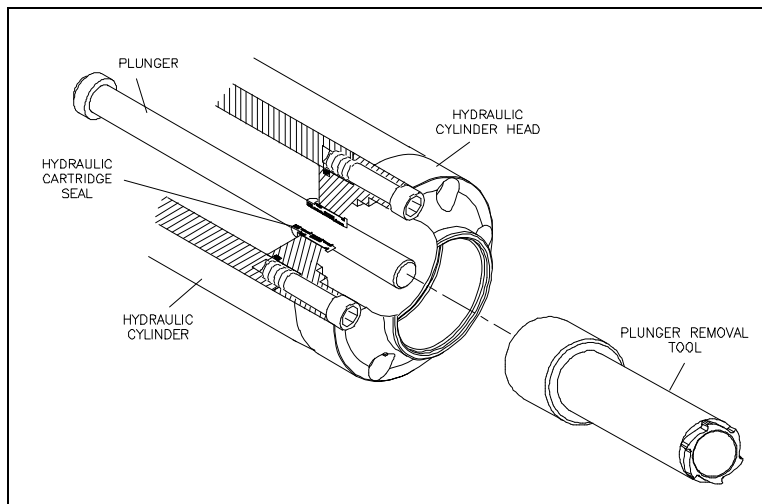


It is recommended that the proximity switch be reinstalled as soon as practical. Removal of the switch presents the potential of an oil spray hazard.

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

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

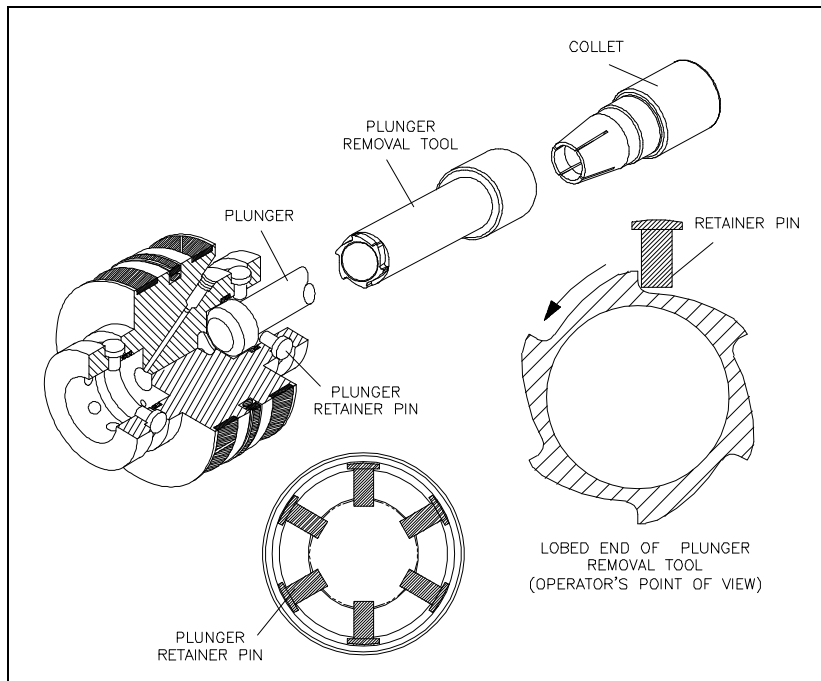
Figure 9-18: Hydraulic Cartridge Seal Removal



8. 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.

Clean the plunger and the ID of the collet with alcohol or a similar solvent. Partially thread the collet into the plunger removal tool and slide the removal tool over the plunger with the lobed end toward the plunger button. Note the orientation of the retainer pins on the plunger button. Align the lobes on the tool with the retainer pins as shown below. Tighten the collet. Rotate the tool counter-clockwise and pull to retract the pins, releasing the plunger from the hydraulic piston. Remove the plunger from the piston.

Figure 9-19: Plunger Retainer Pins

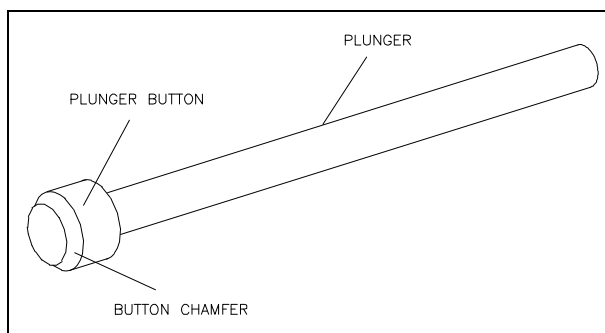


Plunger Maintenance

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 circumferential direction with wet 600-grit sandpaper. However, plunger surface flaws usually cannot be repaired on site. The plunger can be returned to KMT Waterjet for reconditioning.

Figure 9-20: Plunger



Plunger Installation

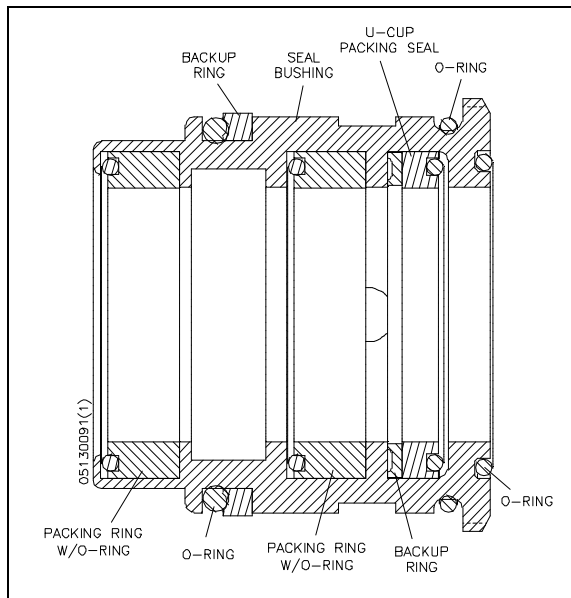
To install the plunger, slide the plunger removal tool over the plunger with the lobed end toward the plunger button to help center the plunger in the hydraulic cylinder head. Position the plunger in the button socket of the piston and force the plunger into place by hand. Use a flashlight to verify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

Hydraulic Cartridge Seal Installation

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 9-21: Hydraulic Cartridge Seal



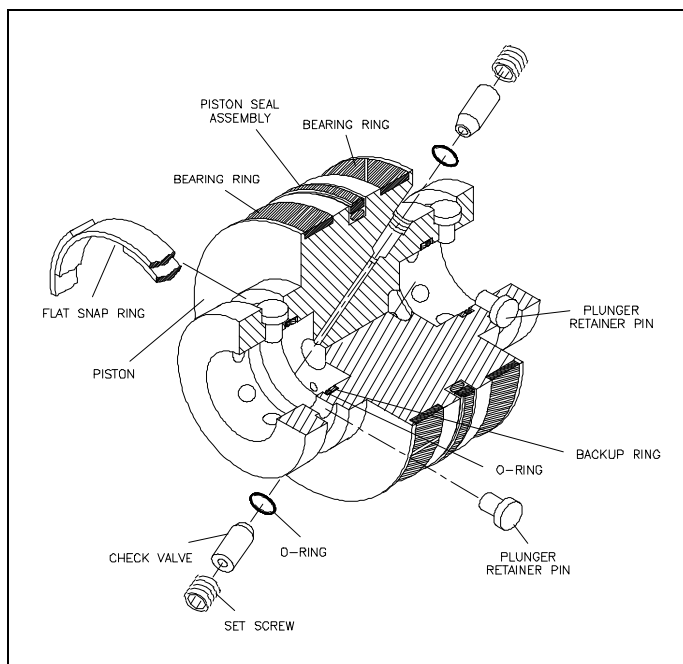
1. Carefully remove the worn seals and o-rings from the cartridge by pushing them with a plastic or wooden dowel, or similar object. Remove the seals closest to the open ends first, and work toward the center.
2. Inspect the seals for unusual wear, deformation or cuts. Note any unusual buildup of solid 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 9-21 for the proper orientation.
6. 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.
7. Thoroughly clean the bushing retainer flange, including the cross-drilled weep holes and internal and external grooves. Install the retainer ensuring the horizontal bore is in the 6 o'clock position.

8. Install the UHP cylinder and associated components, following the procedure, Ultra-High Pressure Cylinder Installation.
9. Connect the high and low pressure water piping and turn the low pressure water supply on.

9.10 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 9-22: 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.

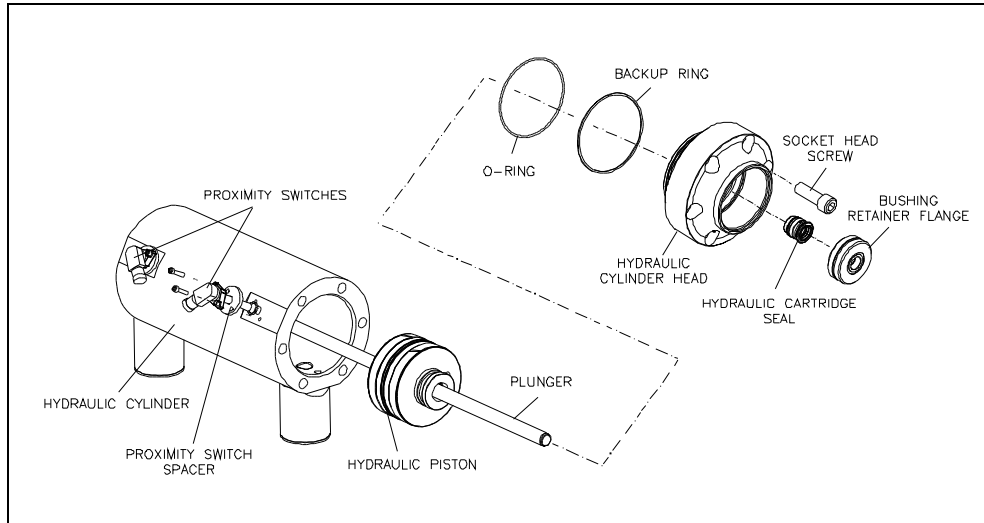


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before proceeding.

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 UHP cylinder and associated components on each end of the intensifier, following the procedure, Ultra-High Pressure Cylinder Removal.

Figure 9-23: Hydraulic Piston Removal



4. Remove both of the proximity switches to prevent interference and to allow the hydraulic oil to drain back to the reservoir, minimizing oil spillage. It will take approximately five minutes for the oil to drain.
5. Remove the 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
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 from brass or similar soft metal material to remove the two bearing rings and the seal assembly.

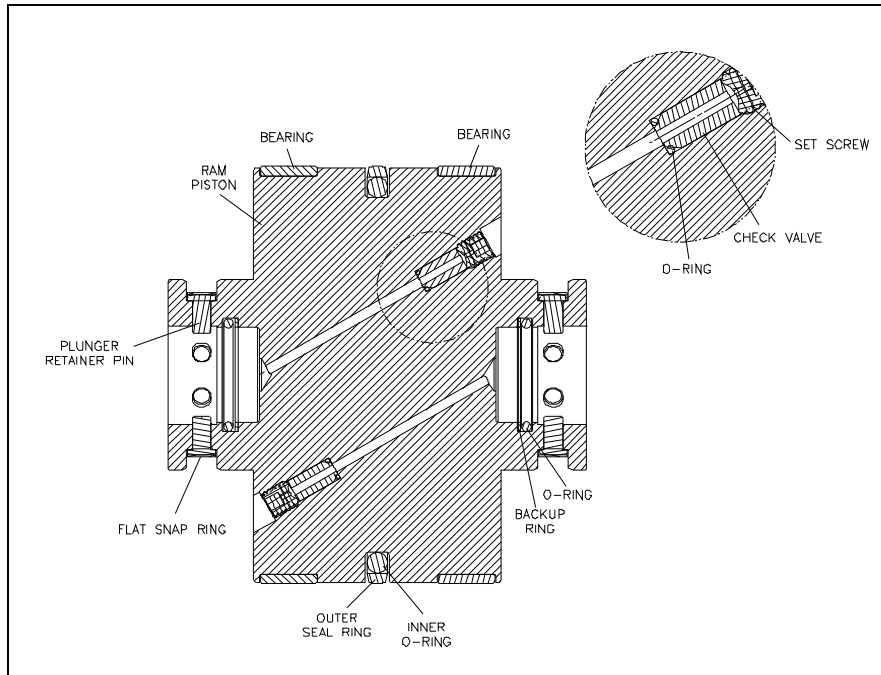
NOTE

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.

- The piston seal assembly consists of an inner o-ring and an outer seal ring. Apply FML-2 grease to both rings. Use the smooth, dull-edged blade to install the inner o-ring, ensuring the o-ring is not twisted after installation. Slide the outer seal ring over the metal edges and ease it into position over the o-ring.

Figure 9-24: Hydraulic Piston



Plunger Button Sockets, Seals and Retainer Pins

- Remove the flat snap rings and plunger retainer pins on both ends of the piston.
- 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.
- Remove the plunger button o-ring and backup ring from each plunger socket. Take care not to scratch or damage the seal groove surfaces.
- Clean and inspect the seal grooves for residue buildup or surface marks that could cause seal leaks.
- 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.

- 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 ring 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 9-23, 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.

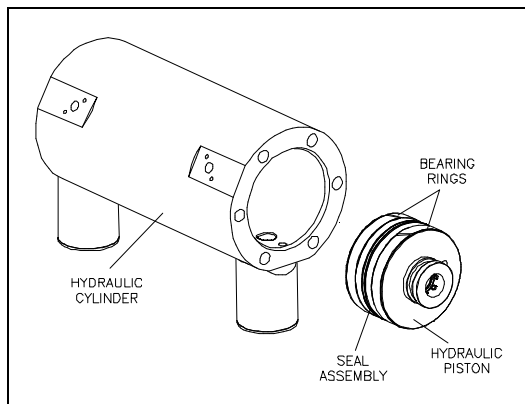
NOTE

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.

Figure 9-25: Hydraulic Piston Installation



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.

NOTE

If the studs have not been removed, they should be removed to facilitate the installation of the hydraulic cylinder heads.

6. Use a pipe wrench or a pair of pliers to loosen the studs and then remove.
7. Position the hydraulic 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 9-1.
8. Replace the hydraulic cartridge seal and bushing retainer flange in both hydraulic cylinder heads.
9. Apply FML-2 grease to the o-ring and replace the proximity switches by positioning the spacers and the switches. Apply JL-M grease to the threads on the socket head screws and tighten, following the torque specifications in Table 9-1.



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.

10. Apply Pure Goop to the threads on the studs, install the studs in the hydraulic cylinder head and hand-tighten.
11. Install the high pressure cylinders and associated components, following the procedure, High Pressure Cylinder Installation.
12. Connect the high and low pressure water piping. And turn the low pressure water supply on.

9.11 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.

9.12 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.

9.13 Ultra-High Pressure Dump Valve

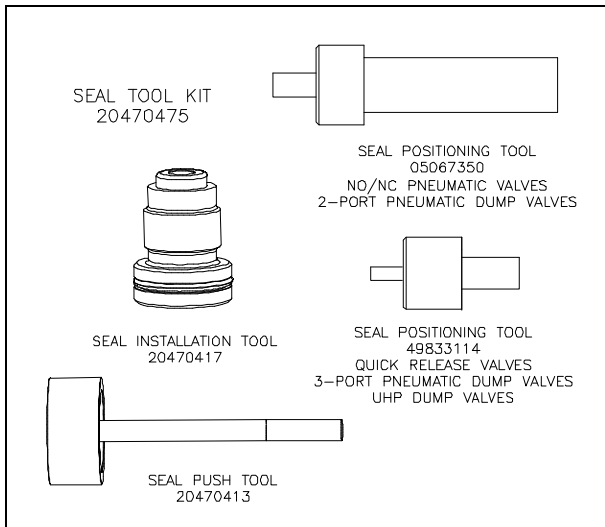
The ultra-high pressure pneumatic dump valve assembly includes a normally open ultra-high pressure (UHP) water valve and a solenoid operated air valve. The following procedure is recommended for servicing the UHP dump valve. Failure to follow this procedure will cause damage to the stem, valve seat,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



The ultra-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 9-26, Pneumatic Valve Seal Tools, illustrates the specialized seal tools recommended for this procedure.

Figure 9-26: Pneumatic Valve Seal Tools



Pneumatic Control Dump Valve

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

Before proceeding, disconnect and lockout the main power supply and the electrical enclosure; and ensure that all high pressure water and hydraulic pressure has been bled from the system.

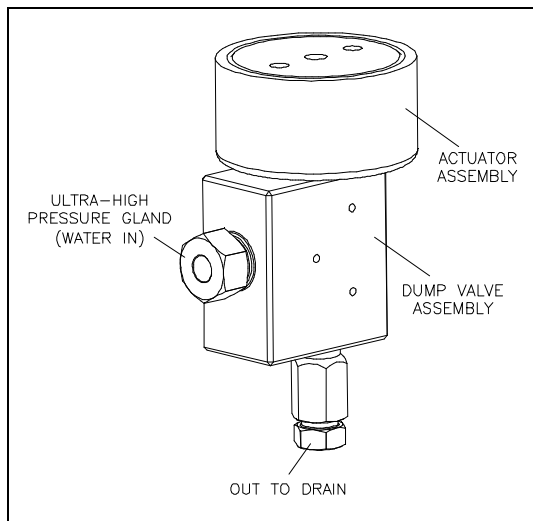


Severe injury can result if the machine is not properly locked out. Observe electrical Lock Out/Tag Out procedures before proceeding.

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

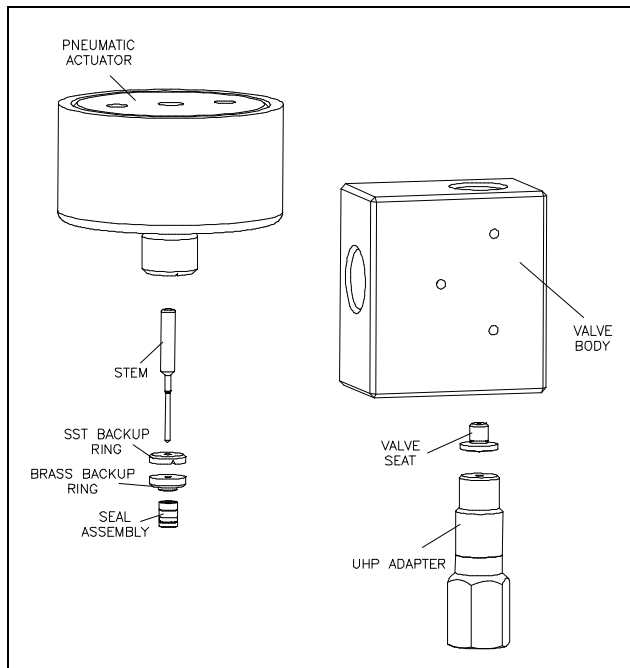
1. Turn the air supply off.
2. Remove the air supply hose, and the electrical connection to the solenoid valve.

Figure 9-27: Ultra-High Pressure Dump Valve



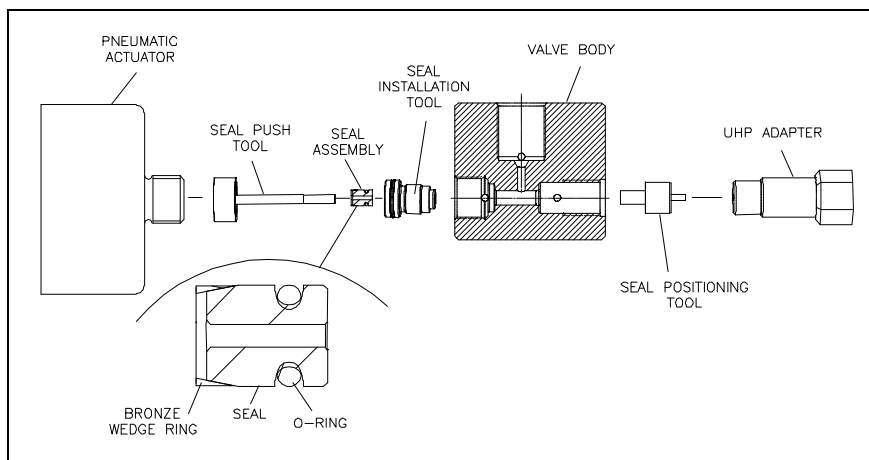
3. Loosen and remove the high pressure gland connection and the drain connection.
4. Remove the valve and actuator assembly from the machine.

Figure 9-28: Dump 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 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 the seal push tool (P/N 20470413). The assembly must be pushed out through the actuator port in the top of the valve body.
9. Discard the stem, brass backup ring, seal assembly and valve seat.
10. Clean and inspect the valve body, being careful not to damage or scratch the bore.

Figure 9-29: Valve Seal Installation

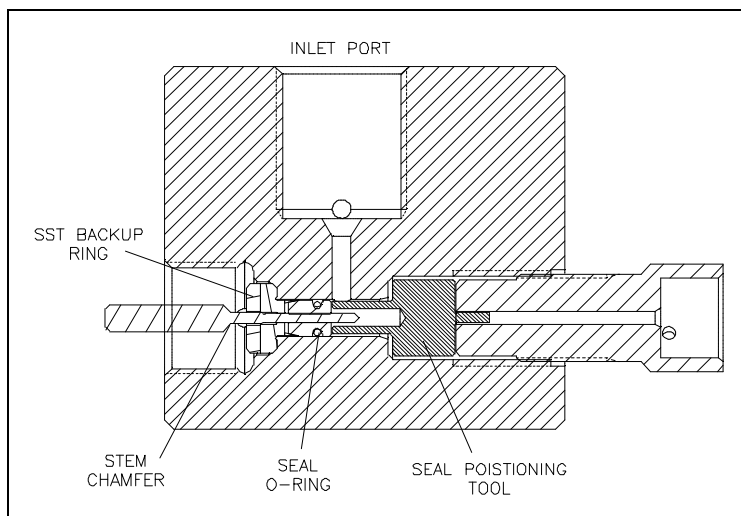


11. Place the seal positioning tool into the end of the valve body as shown above. Thread the high pressure adapter into the valve body until light contact is made with the positioning tool. Tighten finger-tight only. See Figure 9-29, Valve Seal Installation.
12. Apply Pure Goop anti-seize compound to the threads on the seal installation tool. Screw the seal installation tool into the threads of the valve body. Tighten finger-tight only. See Figure 9-29, Valve Seal Installation.
13. Lubricate the seal and the o-ring with FML-2 food grade grease. Insert the seal and o-ring, with the bronze wedge ring, into the seal installation tool. Insert the o-ring end of the seal first so the tapered end of the seal (wedge ring end) faces the actuator. The tapered end of the seal must face the actuator. See Figure 9-29, Valve Seal Installation.
14. Use the seal push tool to push the seal assembly into the bore of the valve body until the seal makes light contact with the positioning tool.
15. Remove the push tool and the installation tool from the valve body.
16. Install the existing SST backup ring and a new brass backup ring on a new stem. The vee groove on the SST backup ring must face toward the brass backup ring. The small OD of the brass backup ring must face toward the seal assembly.
17. Apply FML-2 grease to the tip of the stem and insert the stem with the backup rings into the top of the valve body so the stem enters the ID of the seal assembly. **Insert the stem until the chamfer on the stem is seated against the SST backup ring. See Figure 9-30, Valve Stem Placement.**



Do not push the o-ring on the seal assembly past the inlet port on the valve body. This will damage the seal o-ring.

Figure 9-30: Valve Stem Placement



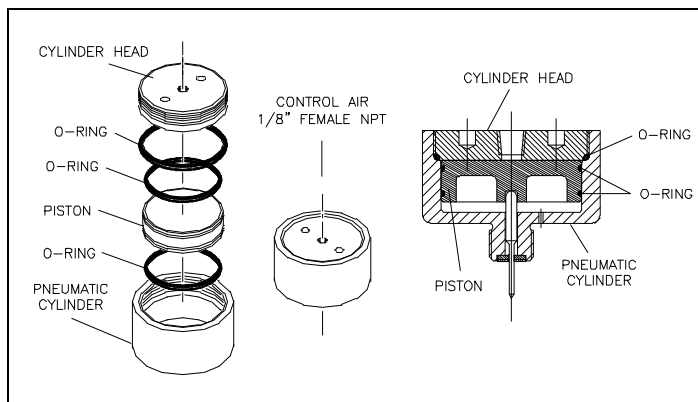
18. Remove the high pressure adapter and the seal positioning tool.

19. Apply Pure Goop 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).
20. Apply Pure Goop anti-seize compound to all surfaces, except the ID, of a new valve seat. Install the seat into the opposite end of the valve body, inserting the small OD first.
21. Apply anti-seize compound to the threads on the high pressure adapter. Install the adapter and torque to 35 ft-lbs (47 Nm).
22. Replace the 1/4-inch gland nut and collar and torque to 35 ft-lbs (47 Nm).
23. 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 75 ft-lbs (102 Nm).
24. 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 9-31: Pneumatic Actuator



1. Unscrew and remove the cylinder head using a strap wrench and a pin spanner. Remove the piston from the cylinder.



Do not install the pneumatic cylinder in a vise to remove the cylinder head. This may distort the body and seize the piston, preventing proper operation.

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.

9.14 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 9-3 lists the location of the weep hole, the possible source of the leak and the corrective action required.

Table 9-3
Weep Holes
Ultra-High Pressure Water System

Location	Indication	Comments
Hydraulic Cylinder Head		
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 ultra-high pressure seal assembly	Replace the ultra-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.
	Seal material buildup on plunger	Polish the plunger surface following the procedure, Plunger Maintenance.
	Damaged UHP cylinder	
Check the inside diameter of the cylinder for expansion where the ultra-high pressure seal assembly is located. If detected, replace the cylinder.		



**Table 9-3
Weep Holes
Ultra-High Pressure Water System**

Location	Indication	Comments
Sealing Head		
Water leaking from the weep hole in the sealing head	Seat in the discharge check valve is not sealing properly	Make sure the discharge gland is tightened to the proper torque specification. Inspect the seat, sealing head and discharge gland for 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 discharge gland	Tighten the gland to the proper torque specification.
	Erosion or scratches on the contact surface of the sealing head, or on the gland where the seat makes contact	Polish the surfaces following the procedure, Sealing Head Maintenance.
	High pressure piping gland is not tight and is not sealing properly	Tighten the gland to the proper torque specification.
Water leaking from the weep hole in the discharge gland	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 for deformation of the threads.
Damaged sealing head gland	Check the gland for cracks due to fatigue. If cracks are detected, replace the gland.	



Table 9-3
Weep Holes
Ultra-High Pressure Water System

Location	Indication	Comments
Hard Seal End Cap		
Water leaking from the weep holes in the hard seal end cap	Damaged ultra-high pressure cylinder	Check for scratches or grooves on the cone seal surface. If detected, polish to remove following the procedure, Ultra-High Pressure Cylinder Maintenance.
	External crack in sealing head	Replace the sealing head.
	Damaged sealing head	Check for scratches or grooves on the cone seal surface of the sealing head. If detected, polish the surface following the procedure, Sealing Head Maintenance.
	Improper torque on jackbolts	Re-torque the jackbolts to the proper torque specification.
	Damaged o-ring on end cap	Inspect the o-rings for cuts or nicks and replace if necessary.



SECTION 10

TROUBLESHOOTING

10.1 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 boosted water temperature
2. Booster pump pressure drop is greater than 30 psi (2 bar) during stroke condition
3. Outlet booster pump pressure is falling below 60 psi (4 bar)
4. Inlet water flow is poor and the filter housing is not filling completely
5. Water is leaking around the cap nut on the filter head
6. High oil temperature resulting in shutdown
7. Low oil level resulting in shutdown
8. Restricted or no cooling flow
9. Hydraulic pressure but no high pressure water pressure
10. Erratic fluctuations in the operating pressure, or inability to reach or maintain set pressure
11. No hydraulic oil pressure
12. Pump shaft will not turn
13. Pump will not start
14. Console display and lights do not illuminate
15. Pump quits running
16. No control power
17. Red light on operator's console is flashing
18. Abnormal fluctuations in high pressure water signal
19. Hot surfaces on the high pressure cylinder components
20. Low cutting water supply pressure
21. Low cutting water pressure
22. Hydraulic oil leaking from the weep hole in the hydraulic cylinder head
23. Water leaking from the weep hole on the hydraulic cylinder head flange
24. Water leaking from the weep hole in the sealing head
25. Water leaking from the weep hole in the sealing head discharge gland
26. Water leaking from the weep holes in the hard seal end cap



10.2 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.

Pro² 125 Troubleshooting Guide

Malfunction		Indication	Comments
1.	High boosted water temperature	Orifice is blocked with debris	
		Long deadhead condition	
		Insufficient water supply	
		Booster pump temperature switch malfunction	
2.	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	
3.	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	
4.	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.
5.	Water is leaking around the cap nut on the filter head	Gasket that closes the passage has deteriorated	A gasket under the cap nut can deteriorate causing the passage to remain open. The gasket can be replaced by removing the cap nut.



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
6.	High oil temperature resulting in shutdown	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.
7.	Low oil level resulting in shutdown		Check the level gauge.
			Check for hydraulic leaks.
			Check the level switch.
8.	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.



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
9.	Hydraulic pressure but no high pressure water pressure	Proximity switch failure	From the Maintenance Screen on the control panel, jog the intensifier left and right and verify that the red light comes on at both proximity switches.
		I/O relay failure	From the Maintenance Screen on the control panel, jog the intensifier left and right and verify that the green light comes on at both directional valve solenoids.
		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.
		PLC failure	If there are inputs from the proximity switches, but no outputs, contact the KMT Customer Service Department for a logic review and verification of PLC failure.
10.	Erratic fluctuations in the operating pressure, or inability to reach or maintain set pressure	The screen in the proportional pressure valve is blocked with debris	Remove the valve and clean the screen following the maintenance procedure in Section 7, Hydraulic System.
11.	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.
		Incorrect motor rotation	Check the motor rotation.
12.	Pump shaft will not turn	The flexible coupling has failed	Replace the flexible coupling.
		The hydraulic pump has seized	Replace the hydraulic pump.



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments	
13.	Pump will not start	Emergency stop button is depressed	Pull the e-stop button out.	
			Check all remote e-stop buttons.	
		Main power is disconnected	Check the main power and verify that the main power disconnect is on.	
			Control power has been interrupted	Check the power supply circuit for a tripped breaker.
				Check the input and output of the 24 volt DC power supply.
		A protection fault has been activated	Check the 2K1 relay.	
			Check the display panel for fault messages.	
Motor overload relay has been tripped	Identify the source of the overload and remedy the problem. Reset the overload relay.			
Inlet water valve is turned off	Press the reset button on the Run Screen to reset the water valve.			
14.	Console display and lights do not illuminate	Emergency stop button is depressed	Pull the e-stop button out.	
			Check all remote e-stop buttons.	
		Main power is disconnected	Check the main power and verify that the main power disconnect is on.	
			Control power is not available	Check the power supply circuit for a tripped breaker.
				Check the input and output of the 24 volt DC power supply.
		Check the 2K1 relay.		

Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
15.	Pump quits running	Unsafe operation has been detected	Check the display panel for fault messages.
		Electrical power has been interrupted	Check the power supply circuit for a tripped breaker.
			Check the input and output of the 24 volt DC power supply.
			Verify that power is available at the main power source.
			Check the 2K1 relay coil.
		Check the 4K0 relay.	
Motor overload relay has been tripped	Identify the source of the overload and remedy the problem. Reset the overload relay.		
16.	No control power	Circuit breaker has been tripped	Check the input and output of all circuit breakers.
		Power supply fault	Check the input and output voltages at the power supply.
		Emergency stop button is depressed	Pull the e-stop button out.
			Check all remote e-stop buttons.
		Master control relay is not energized	Verify that the contactor coil is pulling in on the master control relay.
Contact set failure on the master control relay	Verify that the contact sets on the master control relay are changing states when the relay is energized.		



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
17.	Red light on operator's console is flashing	An alarm condition has occurred	<p>Check the display panel for fault messages.</p> <p><i>Refer to Section 4, Operation, for additional information regarding warning and alarm conditions and recovery procedures.</i></p>
18.	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.		

Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
19.	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, if applicable, 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.
20.	Low cutting water supply pressure	Restricted water supply	Check cutting water supply flow and pressure.
		Clogged water filter	Check the condition of the low pressure water filter and replace the filter element if necessary.
		Trapped air	Bleed the air from the cutting water plumbing.
21.	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.
		Collapsed element in the high pressure line filter	Check the element in the high pressure line filter.
22.	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.



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
23.	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 9, Ultra-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 9, Ultra-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.

Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
24.	Water leaking from the weep hole in the sealing head	Seat in the discharge check valve is not sealing properly	Make sure the discharge gland is tightened to the proper torque specification. Inspect the seat, sealing head and gland for scratches, erosion or cracks.
		Improper torque on gland	Tighten the gland to the proper torque specification.
		Internal crack in sealing head	Replace the sealing head. <i>A cracked sealing head can result in water leaking from the high pressure outlet passages to the low pressure inlet passages.</i> <i>The sealing head body can become extremely hot.</i>
		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 9, Ultra-High Pressure Water System.
25.	Water leaking from the weep hole in the sealing head discharge gland	High pressure piping gland is not tight and is not sealing properly	Tighten the gland 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 for deformation of the threads.
Damaged sealing head gland	Check the gland for cracks due to fatigue. If cracks are detected, replace the gland.		



Pro² 125 Troubleshooting Guide

	Malfunction	Indication	Comments
26.	Water leaking from the weep holes in the hard seal end cap	Damaged high pressure cylinder	Check for scratches or grooves on the cone seal surface. If detected, polish to remove following the procedure, Ultra-High Pressure Cylinder Maintenance, detailed in Section 9, Ultra-High Pressure Water System.
		Replace the UHP cylinder.	
		External crack in sealing head	Replace the sealing head.
		Damaged sealing head	Check for scratches or grooves on the cone seal surface of the sealing head. If detected, polish the surface following the procedure, Sealing Head Maintenance, detailed in Section 9, Ultra-High Pressure Water System.
		Improper torque on jackbolts	Re-torque the jackbolts to the proper torque specification.
Damaged o-ring on end cap	Inspect the o-rings for cuts or nicks and replace if necessary.		



10.3 Softstarter

A flashing red LED indicates a fault, either internal to the softstarter, or with the incoming power or motor. The number of flashes in sequence indicates the fault.

Softstarter Troubleshooting Guide

1.	Pre-start Motor fails to start or Motor attempts to start, but aborts before up-to-speed or Motor stops inadvertently	LED off	Check control power connections and the power source to the softstarter.
		LED on	Check presence of line power.
		LED flashing one time; overload	Identify the source of the overload and remedy. Reset the softstarter.
		LED flashing two times; over temperature	Allow time for unit to cool.
		LED flashing three times; phase reversal	Motor turning wrong direction. Reverse two incoming lines.
		LED flashing four times; phase loss/open load	Check line and load connections to the softstarter, contactors and motor.
			Confirm that 3-phase is present.
		LED flashing five times; phase imbalance	Check the line current present in each phase. <i>The unit will trip if imbalance is >50%.</i>
LED flashing six times; shorted SCR	Perform continuity check across the power poles L1-T1, L2-T2, L3-T3. <i>Remove line power and load connections before taking measurements. Measurements should exceed 10k for good power pole.</i>		



SECTION 11 SPECIFICATIONS

11.1 Overview

Comprehensive lists of specifications for the SL Pro² 125 are provided in this section.

**Table 11-1
SL Pro² 125**

Model	Motor Horsepower Rating	
	HP	Kw
SL Pro ² 125	125	93

11.2 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.

Sound Level

Sound level [dB(A)]	82.0
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Equipment Dimensions and Weight

Horsepower	Length	Width	Height	Weight
125 HP	88.00" (2,235 mm)	59.09" (1,500 mm)	61.12" (1,552 mm)	6,850 lbs (3,107 kg)
With doors open		104.00" (2,641 mm)		

Service Connections

	Connection	Height
Drain	1/2" NPT	11.68" (297 mm)
Cutting Water In	1/2" NPT	16.68" (424 mm)
Cooling Water Out	1/2" NPT	21.68" (551 mm)
Cooling Water In	1/2" NPT	26.68" (678 mm)
Plant Air In	1/4" NPT	34.93" (887 mm)
Cutting Water Out	9/16" UHP	38.12" (968 mm)
Contaminated Waste Drain	1/2" NPT	40.93" (1,040 mm)

All service connections are made on the rear bulkhead of the machine. The intensifier requires two incoming water sources, cooling water and cutting water; two drain lines, cooling water and wastewater; an ultra-high pressure discharge line, and an air supply line.

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.

The following table provides specifications for each ISO air quality classification. KMT recommends adherence to Quality Class 4.

Table 11-2
ISO Air Quality Classifications

ISO Quality Class	Maximum Particle Size (microns)	Maximum Pressure Dew Point (water @ 100 psi)	Maximum Oil Content (Mg/m ³)
1	0.1	-94° F (-60° C)	0.01
2	1	-40° F (-40° C)	0.1
3	5	-4° F (-20° C)	1
4	15	+38° F (+3° C)	5
5	40	+45° F (+7° C)	25
6	--	+50° F (+10° C)	--



11.3 Water Specifications

Cutting Water Supply (Low Pressure Water System)

Maximum consumption	9.2 gpm (34.8 L/min)
Minimum inlet water pressure	35 psi (2.4 bar) flowing
Maximum inlet water pressure	80 psi (5.5 bar)
Maximum 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)
Low inlet water pressure	30 psi (2 bar)
Low booster pressure	60 psi (4 bar)
Booster pump overheat	128° F (53° C)

Cooling Water Supply (Recirculation System)

Reservoir capacity	110 gal (416 L)
Low oil level shutdown	75 gal (284 L)
Maximum consumption at 75° F (24° C)	5.0 gpm (18.9 L/min)
Total heat rejection	75,000 BTU/hr
Minimum operating oil temperature	60° F (15° C)
Optimum operating oil temperature	115° F (46° C)
Hot oil shutdown (maximum operating oil temperature)	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)



Cooling Water Supply (Recirculation System)

Recommended oil type	
General service	Mobil DTE 26, Grade 68 Conoco Hydroclear™ multi-purpose R&O
Food service	Fuchs/Geralyn AW68

* **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 11-3
Water Quality Standards

Constituent (mg/l or ppm)	Minimum Requirement	Best
Alkalinity	25	10
Calcium	5	0.5
Chloride	15	1
Free Chlorine	1	0.05
Iron	0.1	0.01
Magnesium as Mg	0.1	0.1
Manganese as Mn	0.1	0.1
Nitrate	25	10
Silica	10	1
Sodium	10	1
Sulfate	25	1
TDS*	100	35**
Total Hardness	10	1
pH	6.5-8.5	6.5-8.5
Turbidity (NTU)	5	1

* **Note:** Total dissolved solids

****Note:** Do not reduce the TDS beyond this amount or the water will be too aggressive.

Table 11-4
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.
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.
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.



11.4 Electrical Specifications

Electrical System

Motor type	TEFC (Totally Enclosed Fan Cooled)
Controls	
Voltage	24 volts DC
Power supply	10 amps DC

Ampacity and Power Voltage Requirements

Power Voltage	Motor Horsepower	Full Load Amps	Circuit Breaker Amps
480/3/50-60	125	137	175

11.5 Hydraulic and Ultra-High Pressure Water System Specifications

Hydraulic System

Maximum continuous operating pressure	2,400 psi (165 bar)
Main system relief valve	2,610 psi (180 bar)



Ultra-High Pressure Water System

Plunger diameter	0.875" (22 mm)
Piston diameter	5.50" (139.7 mm)
Intensification ratio	38.5:1
Maximum flow rate	
60,000 psi (4,137 bar)	2.30 gpm (8.71 L/min)
85,000 psi (5,860 bar)	1.53 gpm (5.79 L/min)
Minimum outlet pressure	16,000 psi (1,103 bar)
Maximum outlet pressure with cutting head valve open	85,000 psi (5,860 bar)
Maximum outlet pressure with cutting head valve closed	90,000 psi (6,200 bar)
Pneumatic Control Valve	
Maximum water pressure	90,000 psi (6,200 bar)
Minimum air pressure	85 psi (5.9 bar)
Maximum air pressure	100 psi (6.9 bar)
Maximum 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 11-5
Single Orifice Diameter**

Model	Motor Horsepower Rating		Maximum Operating Pressure	Maximum Single Orifice Diameter (at full pressure)
	HP	Kw		
SL Pro ² 125	125	93	85,000 psi (5,860 bar)*	0.015 inch (0.381 mm)

***Note:** Maximum pressure with cutting head valve open is 85,000 psi (5,860 bar).



**Table 11-6
Horsepower Requirements**

Orifice Size inches (mm)	60,000 psi (4,137 bar)	75,000 psi (5,171 bar)	85,000 psi (5,860 bar)
0.003 (0.076)	2.6	3.6	4.3
0.004 (0.102)	4.6	6.4	7.7
0.005 (0.127)	7.1	9.9	12.0
0.006 (0.152)	10.2	14.3	17.3
0.007 (0.178)	13.9	19.5	23.6
0.008 (0.203)	18.2	25.5	30.8
0.009 (0.229)	23.0	32.2	39.0
0.010 (0.254)	28.5	39.8	48.1
0.011 (0.279)	34.4	48.1	58.2
0.012 (0.305)	41.0	57.3	69.3
0.013 (0.330)	48.1	67.2	81.3
0.014 (0.356)	55.8	77.9	94.3
0.015 (0.381)	64.0	89.5	108.3

The horsepower requirements for operating multiple orifices are determined by adding the requirements in Table 11-6 for each orifice. Examples are shown below.

Orifice Size inches (mm)	Number of Orifices	Operating Pressure	Calculation	Total Horsepower
0.005 (0.127)	3	85,000	3 x 12.0	36.0
0.013 (0.381)	1	60,000	48.1 + 28.5	76.6
0.010 (0.254)	1			

11.6 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.

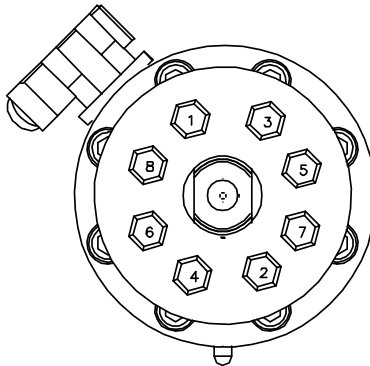


Excessive torque can cause component damage or failure, resulting in potential hazards to equipment and personnel.

Torque Specifications

Hard Seal End Cap	
Jackbolts	8 (1/2") each
1st Stage	Hand Tight
2nd Stage	20 ft-lbs (27 Nm)* Crossing Pattern
3rd Stage	68-70 ft-lbs (92-95 Nm) Crossing Pattern
4th Stage	68-70 ft-lbs (92-95 Nm) Clockwise Pattern From Bolt 1
Socket Wrench Size	7/16 inch

8-Bolt Crossing Pattern



* **Note:** Crossing Pattern: 1, 2, 3, 4, 5, 6, 7, 8.

** **Note:** A maximum torque of 70 ft-lbs (95 Nm) is etched on the hard seal end cap. This represents the maximum allowable torque.



Torque Specifications

Hydraulic Cylinder Head

Socket Head Screws	6 (3/4") each
Torque	170-175 ft-lbs (230-237 Nm)
Hex Key	5/8 inch

Proximity Switch

Socket Head Screws	2 (1") each
Torque	140-160 in-lbs (16-18 Nm)
Hex Key	M5

Sealing Head

Discharge Gland	150 ft-lbs (203 Nm)
-----------------	---------------------

Pneumatic Control Valve

3/8" UHP Gland	75 ft-lbs (102 Nm)
1/4" UHP Gland	35 ft-lbs (47 Nm)
Pneumatic Actuator	5 ft-lbs (7 Nm)
1/4" UHP Adapter	45 ft-lbs (61 Nm)

Ultra-High Pressure Fittings

1/4" UHP Gland Nut	35 ft-lbs (47 Nm)
3/8" UHP Gland Nut	75 ft-lbs (102 Nm)
9/16" UHP Gland Nut	160 ft-lbs (217 Nm)



SECTION 12 PARTS LIST

12.1 Overview

This section contains a comprehensive list of all standard and optional parts for the Streamline Pro² 125. To facilitate the ordering of replacements parts, item numbers in each table correspond to the identifying numbers in the accompanying figures.

Use the following information to contact the Customer Service Department at KMT Waterjet Systems.

USA

Customer Service Department
KMT Waterjet Systems
PO Box 231
635 West 12th Street
Baxter Springs, KS 66713-0231
USA

Phone (800) 826-9274
Fax (620) 856-2242
Email wj.service@kmtwaterjet.com
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



12.2 Index

Parts are arranged in the following sequence:

Parts List Index

Table	Description	Part Number	Page	Table	Description	Part Number	Page
12-1	Pro ² 125 Intensifier Unit		12-3	12-12	Hydraulic Hose Connections	20481885	12-23
12-2	Intensifier Assembly	72122361	12-5	12-13	Reservoir Assembly	20476737	12-25
12-3	Hydraulic Cartridge Seal	05130091	12-7	12-14	Bulkhead Pipe Assembly	72121957	12-27
12-4	Sealing Head Assembly	20480087	12-8	12-15	Electrical Assembly	20489149	12-31
12-5	Pneumatic Valve/Actuator Assembly	20468634	12-9	12-16	Controls Subassembly	20490305	12-33
12-6	Hydraulic Piston Assembly	72101190	12-11	12-17	Control Panel Configuration	20492462	12-36
12-7	Ultra-High Pressure Piping	72119297	12-13				
12-8	Low Pressure Water Filter Assembly	80087976	12-15				
12-9	Hydraulic Power Package	20481767	12-17				
12-10	Pump/Manifold Assembly	20484787	12-19				
12-11	Hydraulic Manifold Assembly	72112043	12-21				



Table 12-1
Streamline Pro² 125 Intensifier Unit

Item	Part Number	Description	Quantity
1	72119297	UHP Water Assembly	1
2	72121957	Bulkhead Pipe Assembly	1
3	20480527	Frame Assembly	1
4	20476737	Reservoir Assembly	1
5	20486812	Cover Assembly	1
6	10097657	Button Head Screw, 1/4-20 x 3/4	4
7	95838314	Lock Washer, .25	4
8	95391322	Flat Washer, .25	4
9	20481767	Hydraulic Power Package	1
10	20481885	Hydraulic Hose Connections	1
11	72119602	Decal Package	1

Figure 12-1: Streamline Pro² 125 Intensifier Unit

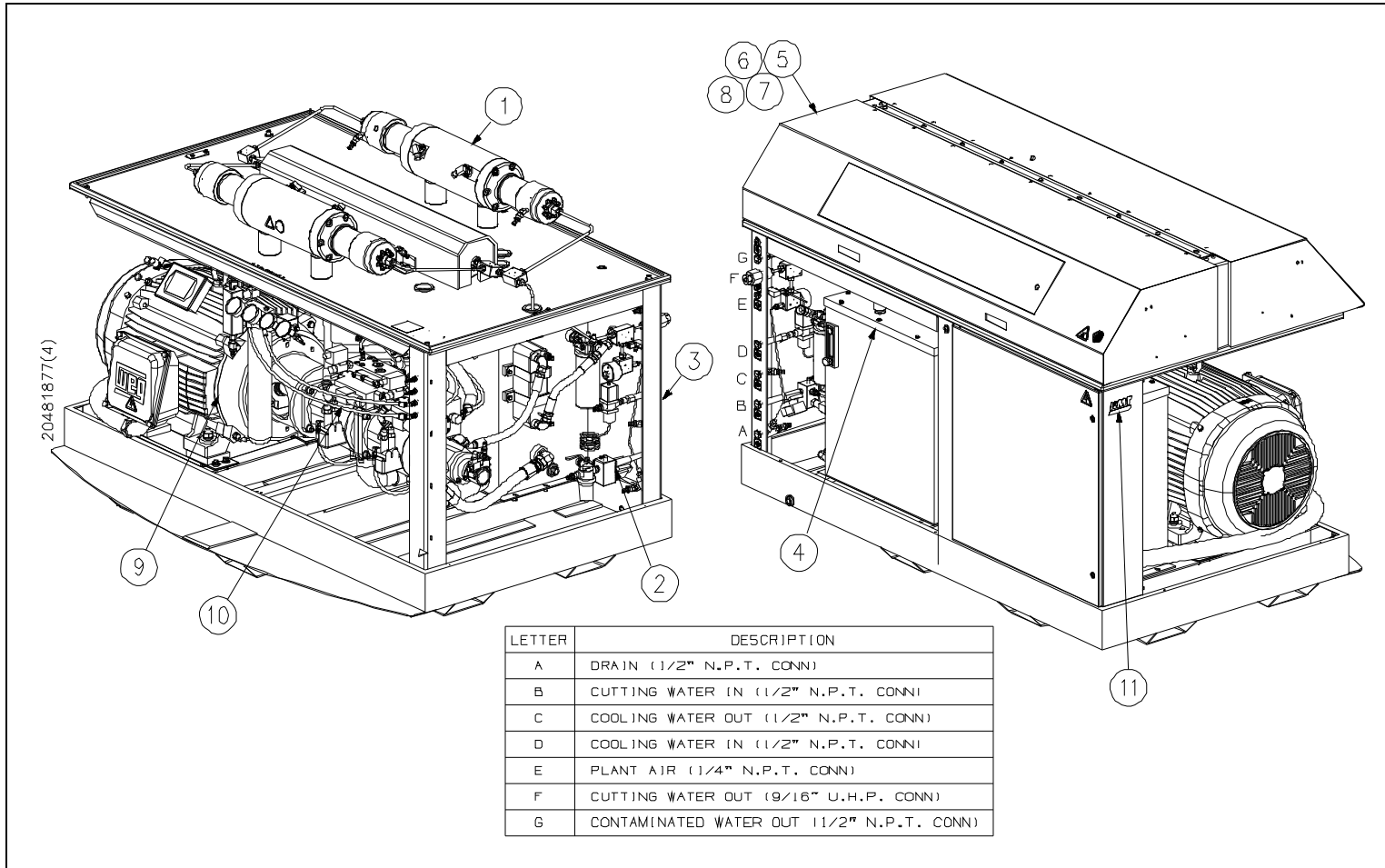




Table 12-2
Intensifier Assembly
72122361

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	72121858	UHP Cylinder	2	14	05144183	Spacer, Proximity Switch	2
2	05119151	Plunger	2		05144191	O-Ring, .69 x .88 x .09	
3	72101156	UHP Sleeve	2	15	95119004	Socket Head Screw, 1/4-20 x 7/8	4
4	72101172	Hydraulic Cylinder Head	2	16	05144191	O-Ring, .69 x .88 x .09	2
5	20480087	Sealing Head Assembly	2	17	05097886	Socket Head Screw, 3/4-16 x 2-1/4	12
6	20497850	Jackbolt, 1/2-20 x 2.37	16	18	20476377	Support, Topworks	2
7	05130091	Hydraulic Cartridge Seal Assembly	2	19	10118206	O-Ring, 1.31 x 1.56 x .13	2
8	10074771	O-Ring, 5.25 x 5.50 x .13	2	20	05146592	Gasket, Topworks Support	2
9	05120092	Backup Ring	2	21	05098991	Socket Head Screw, 3/8-16 x 3-3/4	8
10	20478400	Bushing Retainer Flange	2	22	95688743	Lock Washer, .38	8
11	05144514	Hydraulic Cylinder	1	23	20474333	Liner, UHP Cylinder	2
12	72101190	Piston Assembly	1	24	20479499	UHP Seal Assembly	2
13	20453925	Kit, Proximity Switch	2	25	72101164	Cylinder Nut	2
	05130224	Proximity Switch		26	05069919	O-Ring, 1.88 x 2.06 x .09	4
	95119012	Socket Head Screw, 1/4-20 x 1		27	05111406	Adapter, JIC/Pipe, .50 x .25	2

Figure 12-2: Intensifier Assembly

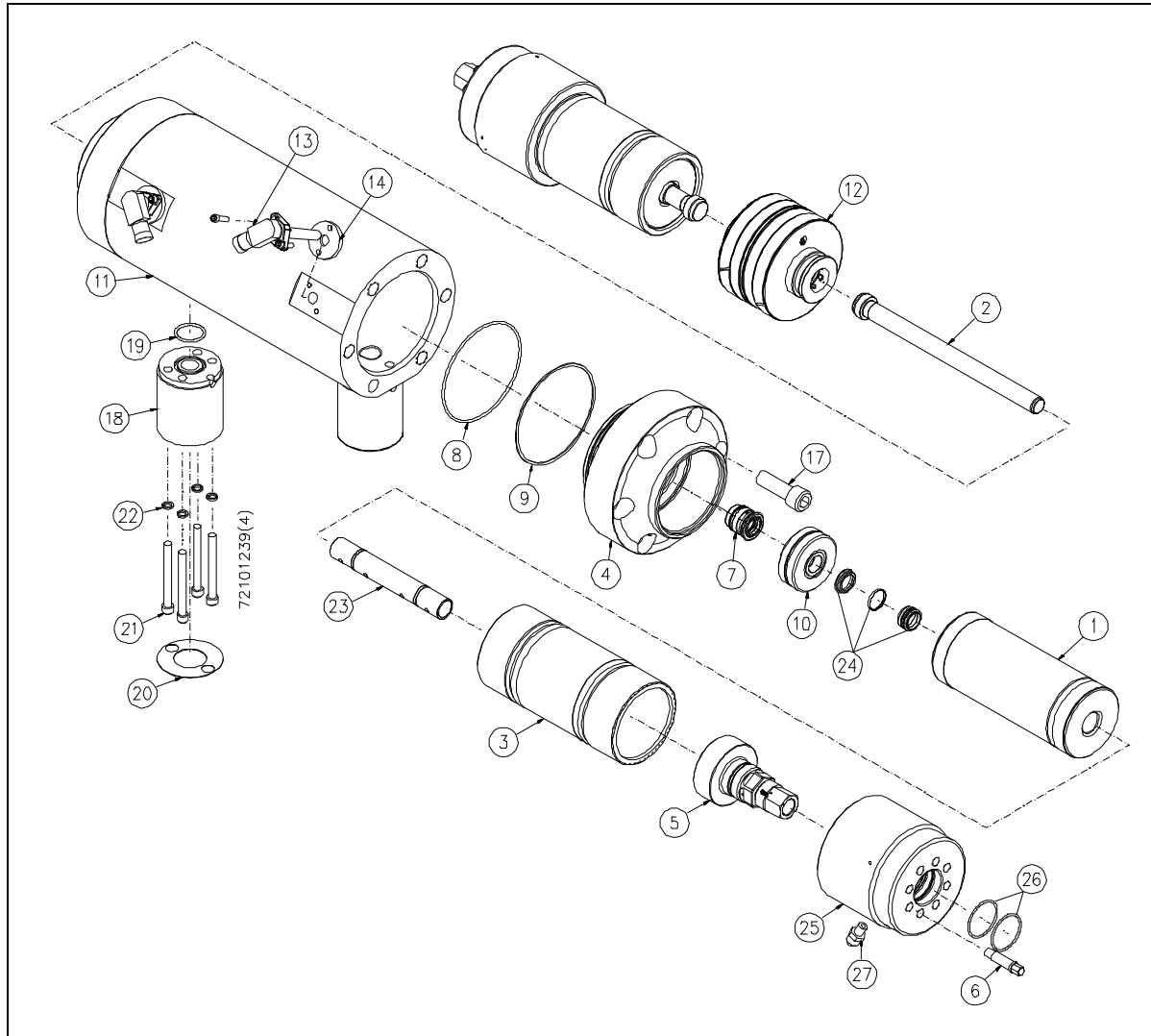


Table 12-3
Hydraulic Cartridge Seal
05130091

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05130109	Seal Bushing	1	5	05129481	O-Ring, 1.0 x 1.13 x .06	1
2	05015060	Packing Ring	2	6	05013024	O-Ring, 1.25 x 1.38 x .06	1
3	10193522	O-Ring, 1.19 x 1.38 x .09	1	7	05129515	Backup Ring	1
4	05050760	Backup Ring	1	8	05027255	Packing Seal	1

Figure 12-3: Hydraulic Cartridge Seal

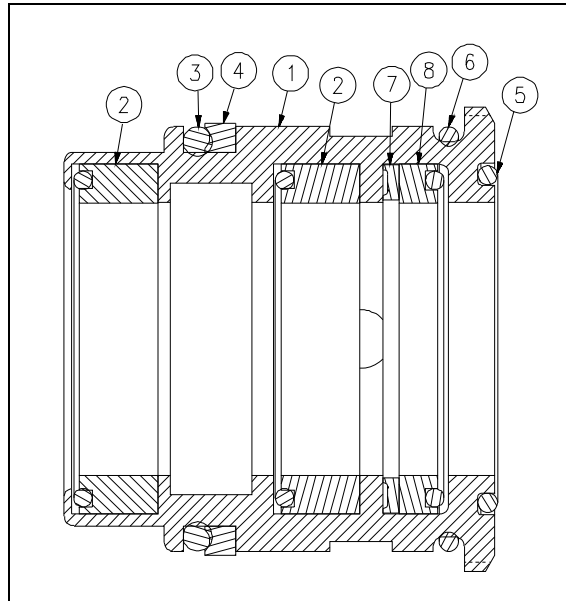


Table 12-4
Sealing Head Assembly
20480087

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	72113373	Sealing Head	1	6	05116561	Discharge Poppet	1
2	20481660	Gland, Sealing Head	1	7	05116751	Poppet Pin	1
3	20492123	Retaining Ring	1	8	05147863	Compression Spring	1
4	10085371	Ball, .25	1	9	20492131	Dowel Pin	1
5	72101570	Seat	1				

Figure 12-4: Sealing Head Assembly

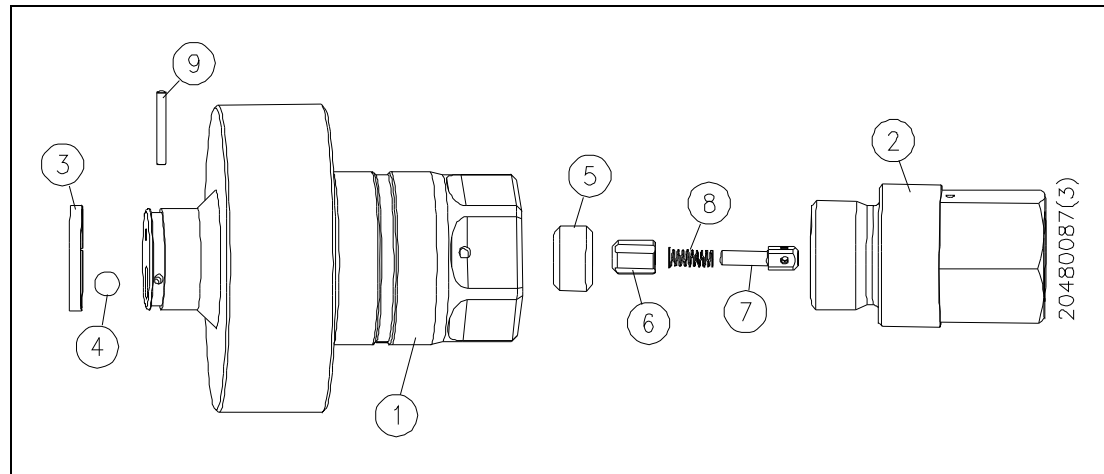




Table 12-5
Pneumatic Valve/Actuator Assembly, Normally Open
20468634

Item	Part Number	Description	Quantity
1	20468617	Valve Body	1
2	10178697	Valve Seat	1
3	20451557	UHP Adapter	1
4	72112069	Seal Assembly	1
5	20475874	Backup Ring, Bronze	1
6	20475878	Valve Stem	1
7	20468601	Pneumatic Cylinder	1
8	BV601184	Cylinder Head	1
9	10074714	O-Ring, 2.44 x 2.63 x .09	1
10	10074565	O-Ring, 2.25 x 2.38 x .06	2
11	BV501184	Piston	1
12	20452965	UHP Collar, .38	1
13	20452956	UHP Gland, .38	1
14	20452959	UHP Collar, .25	1
15	20452962	UHP Gland, .25	1
16	20475882	Backup Ring, SST	1



Figure 12-5: Pneumatic Valve/Actuator Assembly

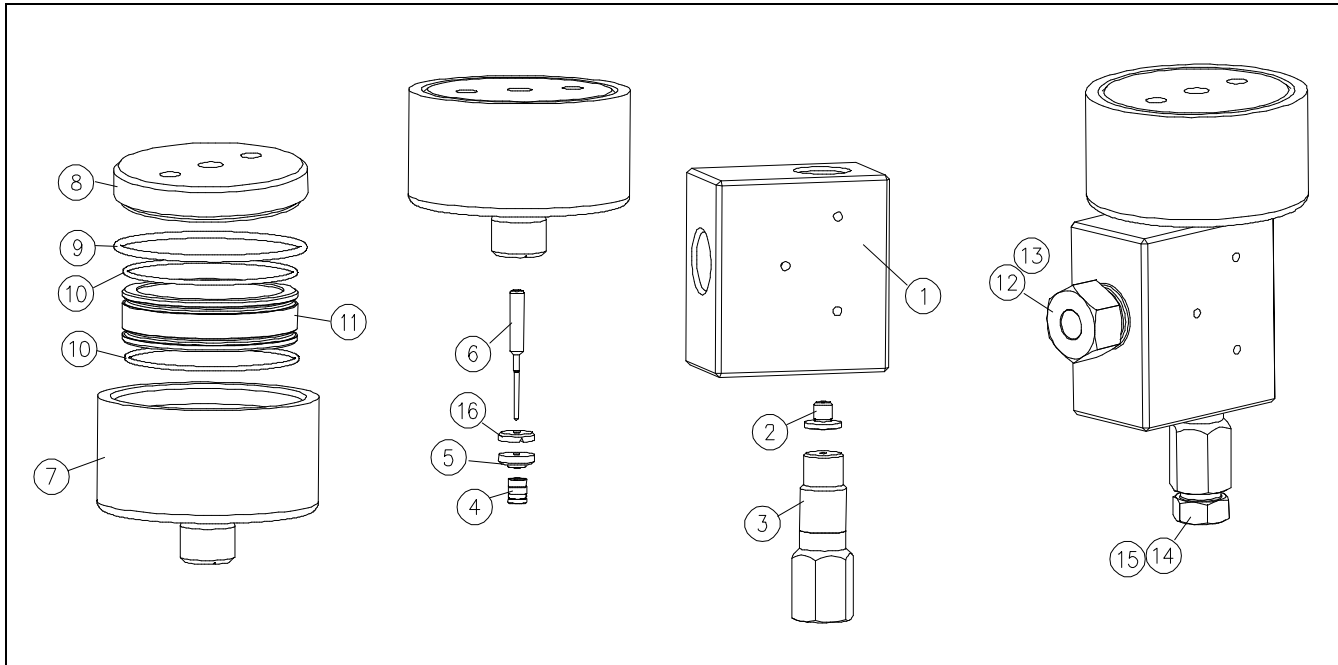




Table 12-6
Hydraulic Piston Assembly
72101190

Item	Part Number	Description	Quantity
1	72101205	Piston	1
2	05074380	Clevis Pin	12
3	05049887	Setscrew	2
4	10148757	Check Valve	2
5	49877509	Threadlocker Adhesive	0.001
6	05088364	Retaining Ring	2
7	05049994	Backup Ring	2
8	05087713	O-Ring, 1.25 x 1.50 x .13	2
9	05120118	Seal Assembly	1
10	05120100	Bearing	2

Figure 12-6: Hydraulic Piston Assembly

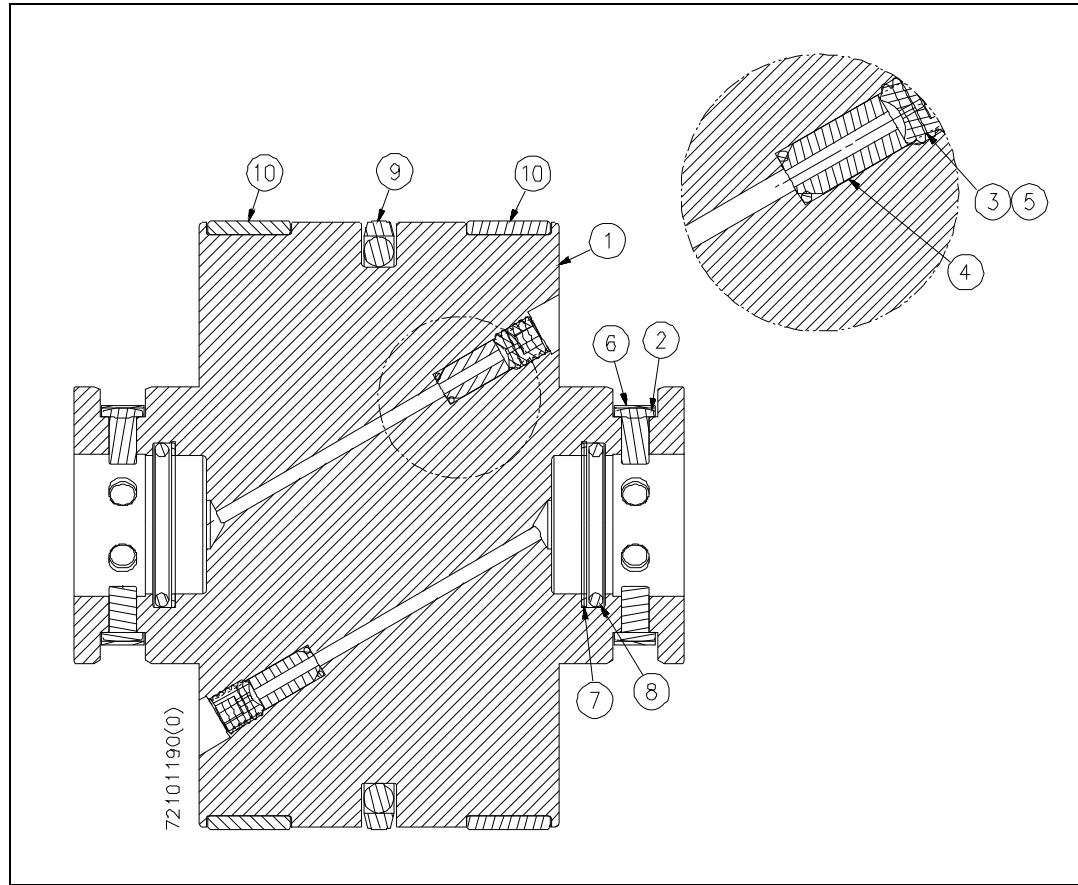




Table 12-7
Ultra-High Pressure Piping
72119297

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	72122361	Intensifier Topworks	2	14	95383790	Socket Head Screw, 1/2-13 x 1	8
2	20455809	Elbow Assembly, UHP, .38 x .38	1	15	95413696	Lock Washer, .50	8
3	72118404	UHP Tube, Bent, .38	2	16	20484084	UHP Tube, Bent, .38	1
4	72118412	UHP Tube, Bent, .38	2	17	20481140	Pressure Transducer, 0-100,000 psi	1
5	20455812	Tee Assembly, UHP, .38	5	18	20481124	Bushing Assembly, UHP, .38 x .25	1
6	20484506	UHP Tube, Bent, .25	1	19	20468830	UHP Tube, .38 x 4.81	3
7	20478834	Attenuator Assembly	1	20	20468634	Pneumatic Valve/Actuator Assembly	1
8	95660957	Flat Washer, .38	8	21	20484076	UHP Tube, Bent, .38	1
9	95670972	Lock Washer, .38	8	22	20453271	Coupling Assembly, Bulkhead, .56 x .38	1
10	95375473	Socket Head Screw, 3/8-16 x 1	8	23	05144837	Spacer, Attenuator Bracket	4
11	20452956	UHP Gland, .38	6	24	20480175	Attenuator Housing	1
12	20452965	UHP Collar, .38	6	25	10112662	Neoprene	45.50"
13	20478649	UHP Tube, .38 x 4.0	4				

Figure 12-7: Ultra-High Pressure Piping

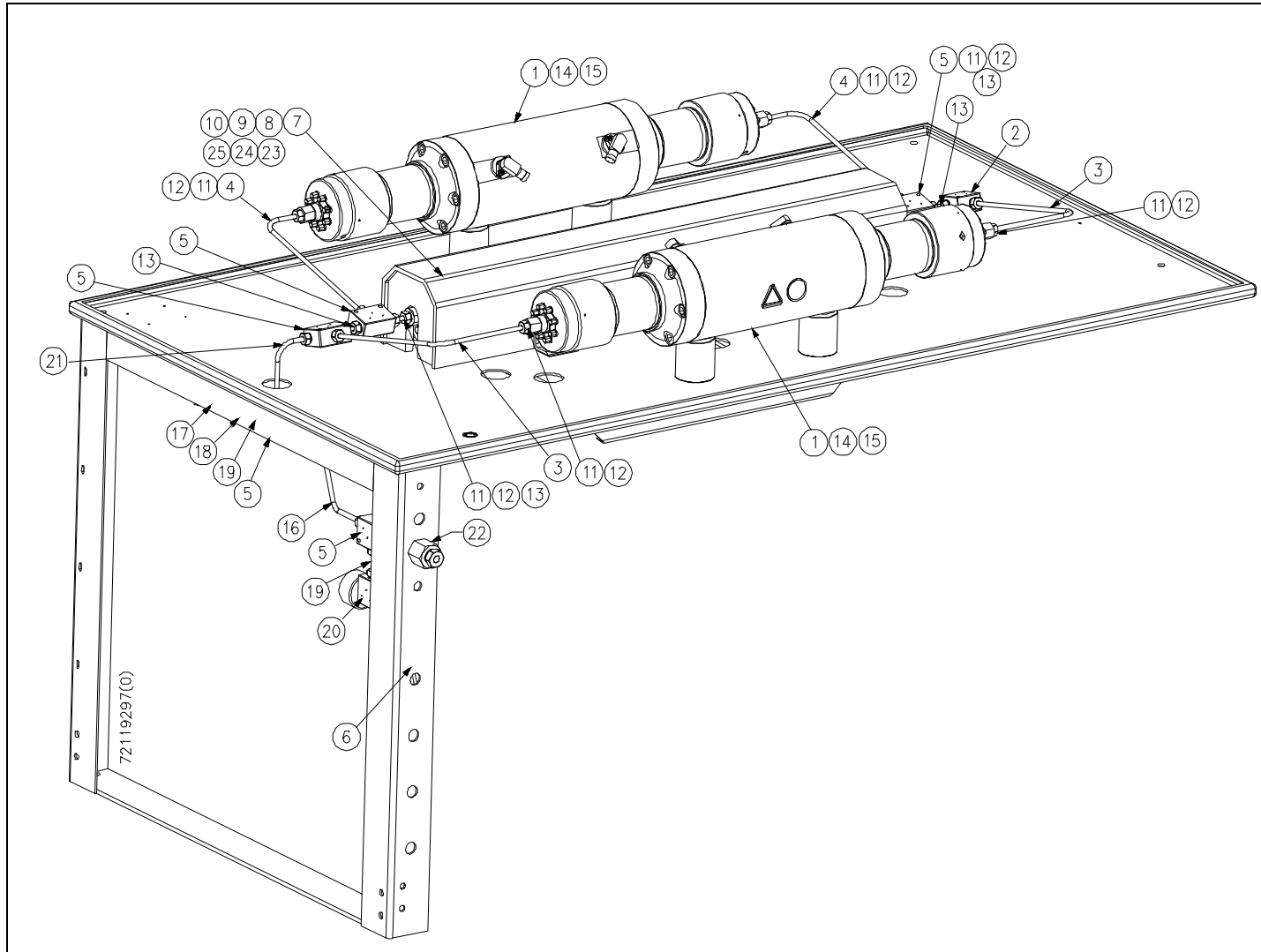




Table 12-8
Low Pressure Water Filter Assembly
80087976

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05070982	Relief Valve	1	8	05135652	Check Valve	1
2	49838386	Pipe Nipple, .75 x 4.0	2	9	49833882	Adapter, Hose/ORB, .50 x .50	3
3	10119253	Elbow, Pipe, .50 x .50	1	10	95838314	Lock Washer, .25	4
4	20413848	Manifold, Outlet	1	11	49834716	Filter Element, 10 Micron	1
5	49833924	Manifold, Left	1	12	95391322	Flat Washer, .25	4
6	49835804	Adapter, Hose/Pipe, .50 x .50	2	13	10083384	U-Bolt, .75	2
7	72118339	Filter Housing Assembly	1	Ref 1	05073630	Bracket, Filter Mounting	0
	72121304	Cap Nut Gasket					
	72121296	Filter Head Gasket					



Figure 12-8: Low Pressure Water Filter Assembly

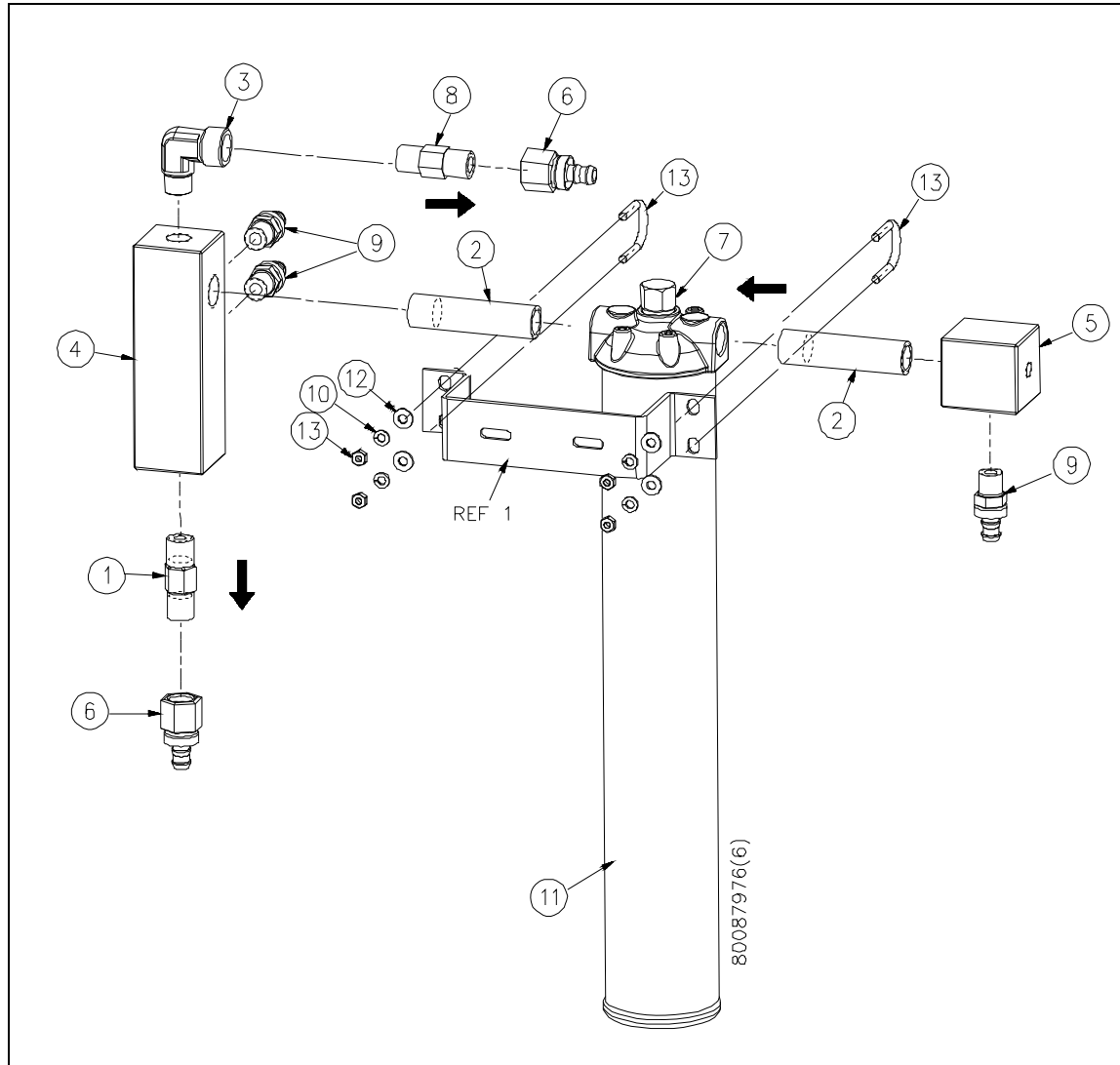




Table 12-9
Hydraulic Power Package
20481767

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	20473124	Electric Motor, 125HP	1	17	10151470	Adapter, ORB/JIC, 1.0 x .75	1
2	20476316	Adapter, Motor/Pump	1	18	10192961	Socket Head Screw, M12 x 1.75 x 30MM	2
3	20476307	Coupling, Flexible Drive	1	19	10069763	Flat Washer, .50	2
4	20469936	Relief Valve	2	20	20484771	Pad, Motor Mount	4
5	20427442	Adapter, JIC/ORB, 1.25 x 1.0	2	21	05040977	Socket Head Screw, 3/4-10 x 5	4
6	95045555	Hex Head Screw, 3/4-10 x 2-1/4	4	22	61125370	Flat Washer, .75	8
7	72111845	Pilot Manifold	2	23	20484779	Washer, Motor Mount	4
8	20484787	Pump/Manifold Assembly	1	24	95688735	Lock Washer, .75	8
9	05091301	Gear Pump	1	25	05103411	Adapter, Water Pump	1
10	05041033	Socket Head Screw, 3/8-16 x 1-1/4	2	26	05103429	Spline Shaft	1
11	95750394	Lock Washer, .38	2	27	05103395	Shaft Coupling	1
12	49836778	Vane Pump	1	28	95069985	Hex Nut, 3/4-10	4
13	95572897	Hex Head Screw, 1/4-20 x 5/8	3	29	80071087	Proportional Pressure Control Valve	2
14	95838314	Lock Washer, .25	3	30	10069581	Lock Washer	4
15	10091510	Arrow Decal	1	31	10144376	Socket Head Screw, 1/4-20 x 1-1/4	4
16	10099760	Adapter, JIC/ORB, 1.25 x 1.25	1	32	10144749	Adapter, JIC/ORB, .25 x .25	2
				33	10142644	Adapter, JIC/ORB, .25 x .25	2
				34	05055017	Plug, ORB, .13	2

Figure 12-9: Hydraulic Power Package

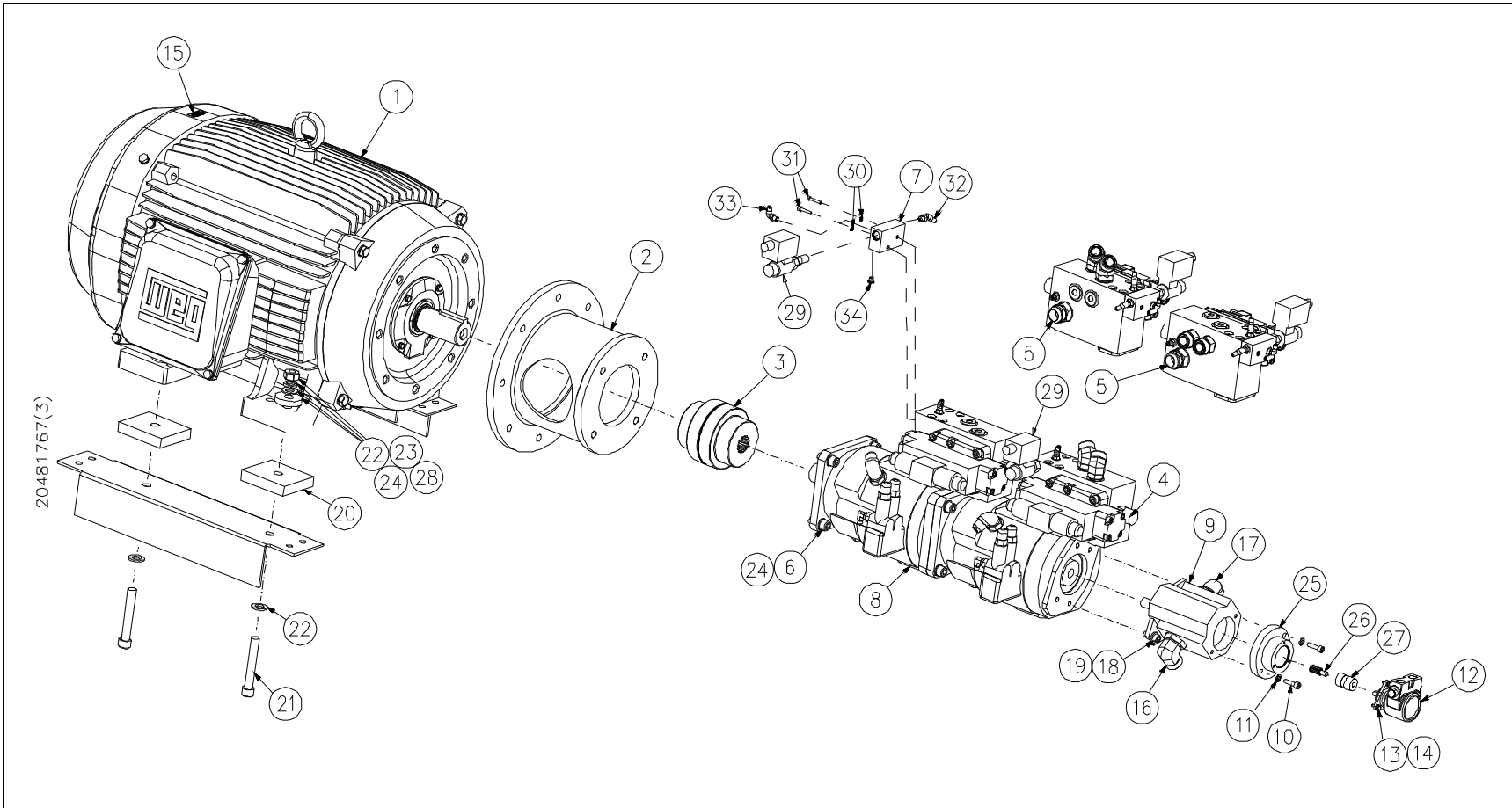




Table 12-10
Pump/Manifold Assembly
20484787

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	72112043	Manifold Assembly	2	11	05071055	Plug, ORB, .75	2
2	20437206	Directional Control Valve	2	12	05103247	Socket Head Screw, 1/2-13 x 6	8
3	95688750	Lock Washer, .50	20	13	20431563	Socket Head Screw, M16 x 2 x 35MM	4
4	95055059	Socket Head Screw, 1/2-13 x 2-1/2	12	14	49892359	Lock Washer, M16	4
5	05103239	Hydraulic Pump	1	16	80079684	Adapter, FSOR/ORB, 1.0 x .75	2
6	20421355	Hydraulic Pump	1	17	80079809	Adapter, FSOR/ORB, 1.0 x .75	2
7	20432620	Coupling, Pump Shaft	1	18	49882087	O-Ring, 1.88 x 2.13 x .13	2
8	10074896	O-Ring, 6.0 x 6.25 x .13	1	19	20484795	Adapter, ISO/ORB, M14 x .38	2
9	05085758	Adapter, ORB/JIC, .38 x .25	2	20	10144749	Adapter, JIC/ORB, .25 x .25	2
10	10091163	Adapter, JIC/ORB, .75 x .75	1	21	05107024	Adapter, ORB/Tube, .75 x .75	1

Figure 12-10: Pump/Manifold Assembly

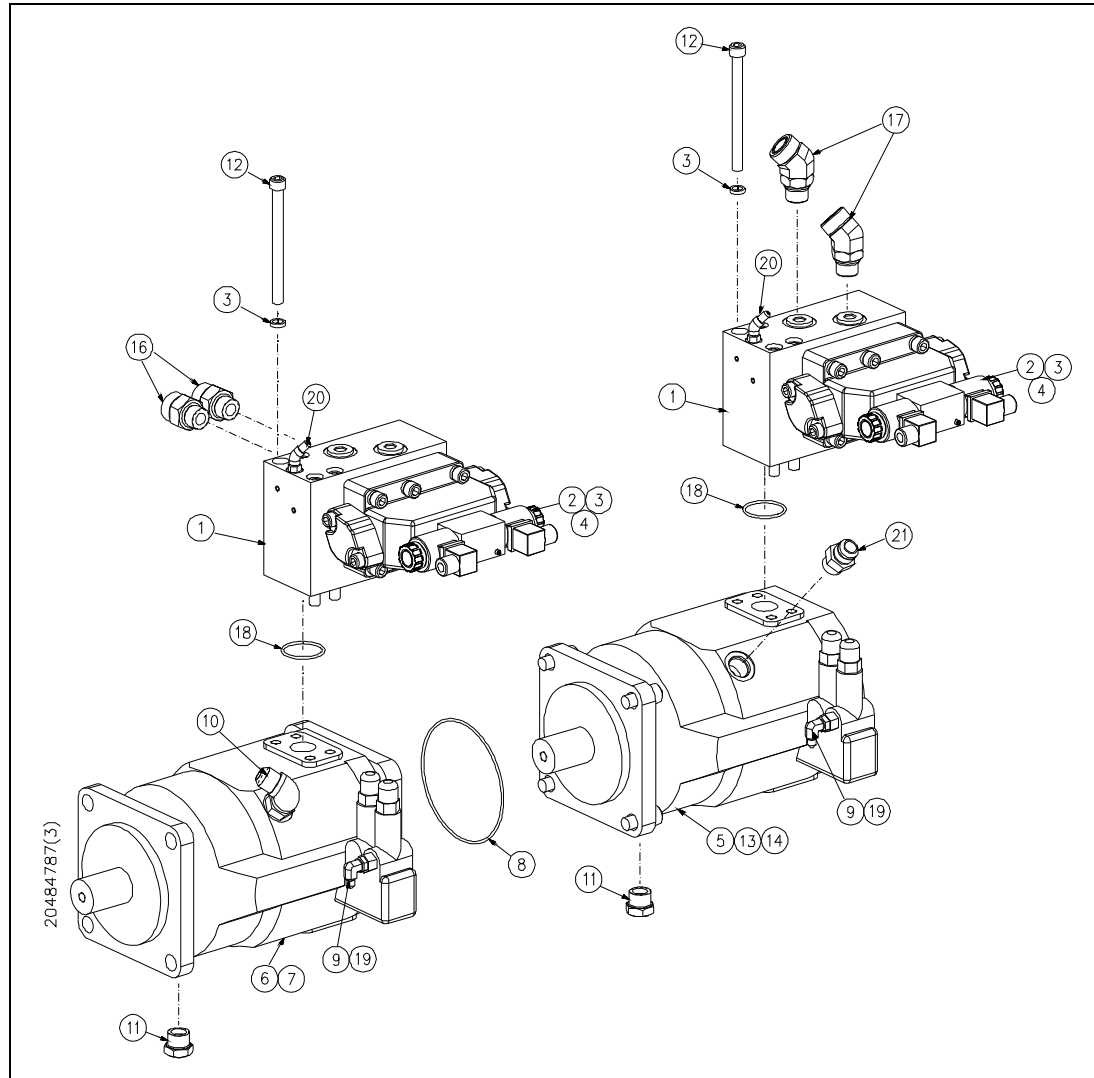




Table 12-11
Hydraulic Manifold Assembly
72112043

Item	Part Number	Description	Quantity
1	72112035	Hydraulic Manifold	1
2	10187417	O-Ring, 1.50 x 1.69 x .09	1
3	05071055	Plug, ORB, .75	3
4	05103189	Check Valve	1
5	49876089	Adapter, JIC/ORB, .25 x .25	1
6	49889769	Plug, ORB, .25	1

Figure 12-11: Hydraulic Manifold Assembly

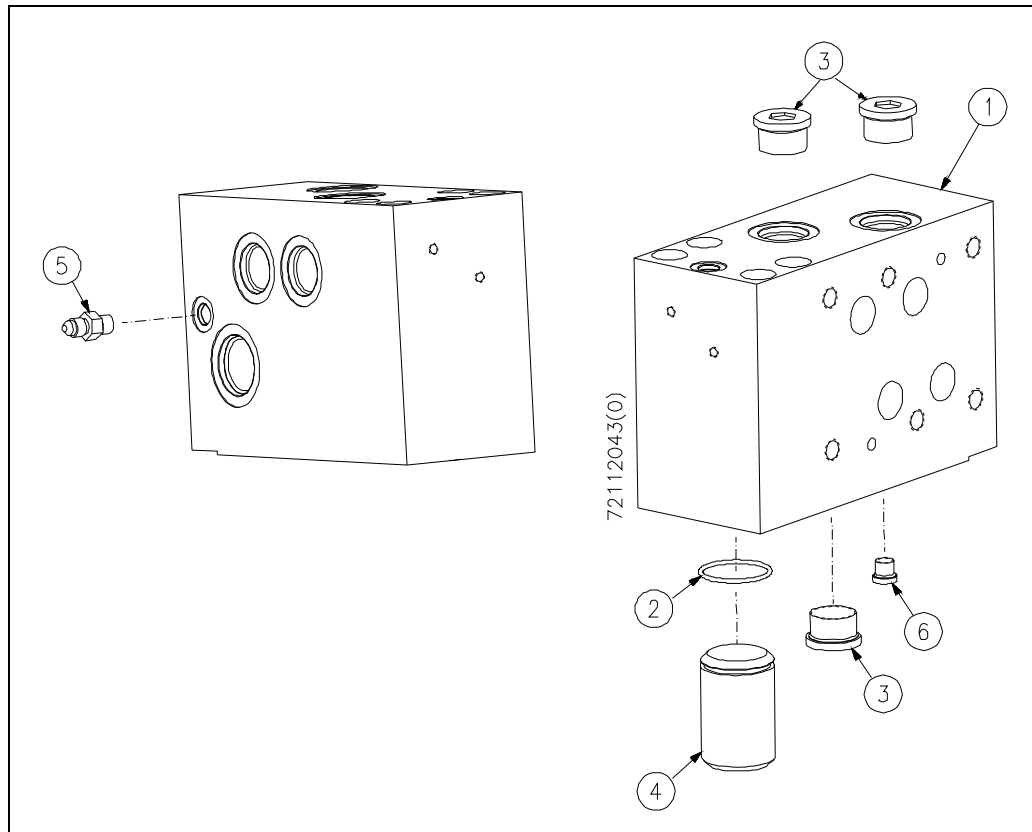




Table 12-12
Hydraulic Hose Connections
20481885

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	72101213	Adapter, Hose/Flange, 3.0 x 2.50	2	11	20485076	Hydraulic Hose Assembly, 1.0 x 45.0	2
2	49872245	Split Flange, 2.50	2	12	20485068	Hydraulic Hose Assembly, 1.0 x 27.0	1
3	80079809	Adapter, FSOR/ORB, 1.0 x .75	4	13	72103196	Radiator Hose, 3.0 x 24.0	1
4	05051214	Hydraulic Hose Assembly, .25 x 39.0	2	14	72103204	Hose Clamp, 3.38	8
5	20485052	Hydraulic Hose Assembly, .25 x 45.0	1	15	05141411	Hydraulic Hose Assembly, .25 x 40.0	2
6	20428507	Hydraulic Hose Assembly, .75 x 38.0	1	16	10119568	Hydraulic Hose Assembly, .25 x 36.0	2
7	72121090	Hydraulic Hose Assembly, .75 x 68.0	1	17	72102973	Hydraulic Hose Assembly, 1.0 x 67.0	1
8	20485034	Hydraulic Hose Assembly, 1.25 x 29.0	1	18	20455077	Hydraulic Hose Assembly, .25 x 24.0	1
9	20468826	Hydraulic Hose Assembly, .75 x 23.0	1	19	10087781	Hydraulic Hose Assembly, .25 x 28.0	1
10	10117067	Hydraulic Hose Assembly, .75 x 17.0	1	20	72102981	Hydraulic Hose Assembly, 1.0 x 42.0	1
				21	20494751	Hydraulic Hose Assembly, .25 x 50.0	1
				22	72125624	Hydraulic Hose Assembly, 1.0 x 25.0	1

Figure 12-12: Hydraulic Hose Connections

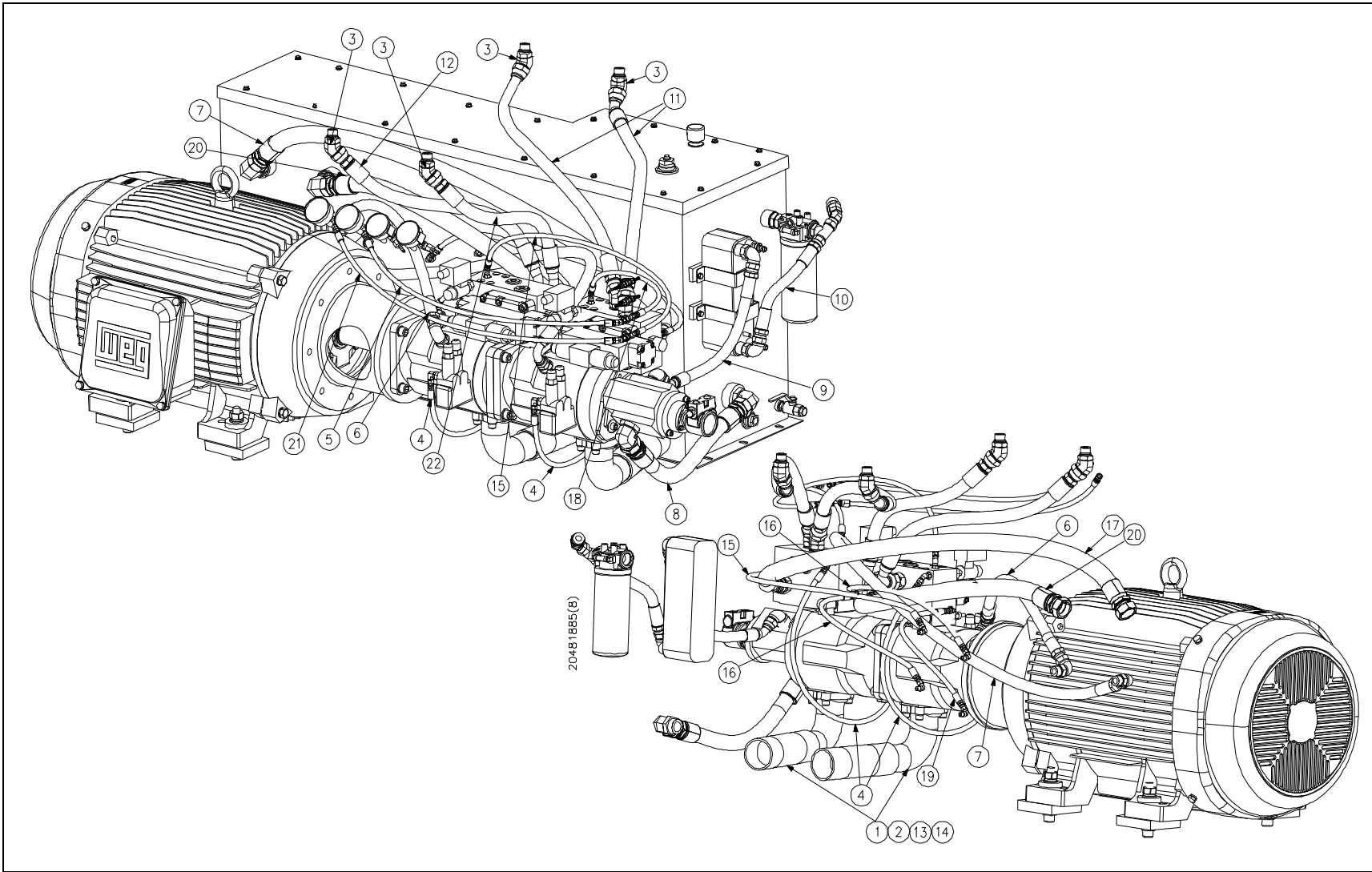




Table 12-13
Reservoir Assembly
20476737

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	20476557	Reservoir Weldment	1	15	20477044	Mounting Pad	4
2	20476561	Reservoir Lid	1	16	10079713	Hose Barb, .50 x .50	2
3	20481079	Gasket, Reservoir	1	17	10091163	Adapter, JIC/ORB, .75 x .75	4
4	05092739	Air Breather	1	18	05145966	Bracket, Heat Exchanger	2
5	05200365	Temperature/Level Switch	1	19	95830766	Lock Washer, .31	4
6	20451474	Level/Temperature Gauge	1	20	95119897	Hex Head Screw, 5/16-18 x 1/2	4
7	05131941	Coupling, ORB, 1.0 x 1.0	1	21	20423326	Ball Valve	1
8	05103809	Filter Head	1	22	05025176	Plug, ORB, .50	1
9	20455107	Tee, JIC/ORB, .75 x 1.0	1	23	10091858	Bulb, Well	1
10	05060777	Elbow, JIC, .75 x .75	1	24	10099760	Adapter, JIC/ORB, 1.25 x 1.25	1
11	05069976	Cap, JIC, .75	1	25	10142644	Adapter, JIC/ORB, .25 x .25	4
12	05079371	Adapter, BSPP/JIC, .75 x .75	1	26	72103006	Adapter, JIC/ORB, 1.25 x 1.50	2
13	05104187	Filter Element	1	27	05101845	Washer	19
14	05145941	Heat Exchanger, Water/Oil	1	28	95252193	Hex Head Screw, 1/4-20 x 1-1/4	19
				29	10082071	Pipe Plug, .38, not shown	1

Figure 12-13: Reservoir Assembly

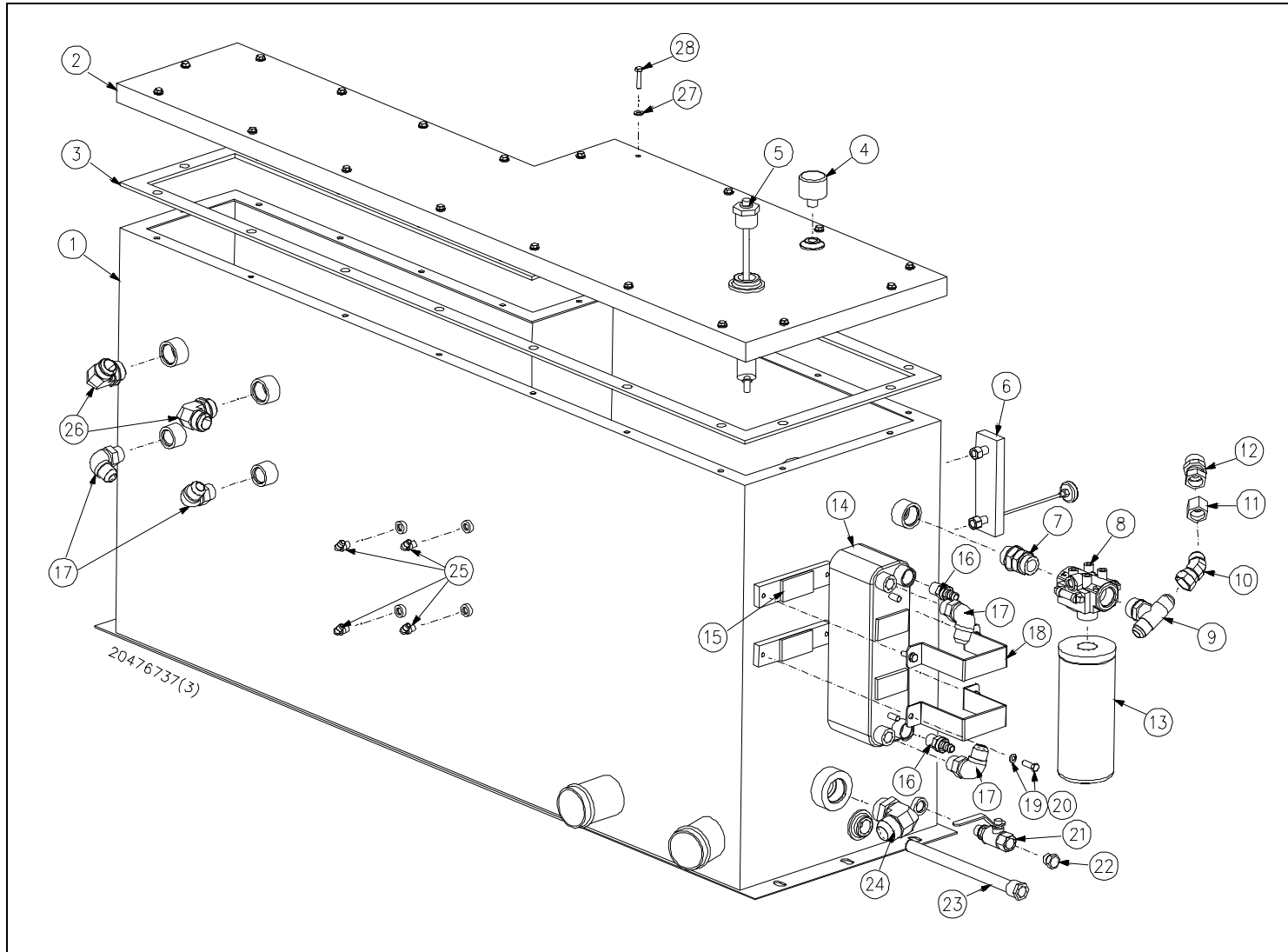




Table 12-14
Bulkhead Pipe Assembly
72121957

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	95680922	Adapter, JIC/Pipe, .50 x .50	1	19	05141379	Elbow, Pipe, .25 x .25	2
2	10091866	Water Modulating Valve	1	20	05139506	Pressure Gauge	2
3	05060207	Pipe Nipple, .50 x 5.0	1	21	05113964	Grommet	4
4	95157418	Adapter, JIC/Pipe, .50 x .50	2	22	10173805	Hose Barb, .50 x .50	4
5	05024815	Solenoid Valve	1	23	10077030	Adapter, Tube/Pipe, .25 x .13	2
6	49886922	Adapter, Bulkhead, .50 x .50	5	24	10189025	Adapter, Hose/JIC, .50 x .50	12
7	20421272	Hose, Push-on, .50	350.0"	25	05142294	Pressure Gauge	2
8	49831480	Grommet	8	26	10079713	Hose Barb, .50 x .50	1
9	10070092	Jam Nut	5	27	05111364	Tee, JIC, .50	2
10	10073823	Tee, .50 x .50	1	28	49895303	Adapter, JIC/Pipe, .50 x .50	1
11	49887011	Adapter, JIC/Pipe, .50 x .50	1	29	10084523	Pipe Nipple, .50 x 4.0	1
12	80087976	LP Water Filter Assembly	1	30	10079903	Poly Tube, .25	24.0"
13	49834328	Adapter, Pipe/Tube, .50 x .25	1	31	49834302	Adapter, Pipe/Tube, .50 x .50	1
14	10192425	Barb Insert, .50 x .50	1	32	49834310	Adapter, Pipe/Tube, .50 x .50	1
16	10077055	Coupling, Bulkhead, .94 x .25	1	33	10100436	Coupling, Pipe, .50 x .50	2
17	49830722	Adapter, Hose/Pipe, .25 x .25	2	34	20413789	Manifold, Inlet Water	1
18	61126172	Hose, Push-on .25	140.0"	35	05140751	Pressure Switch, 30 psi	1
				36	49830714	Adapter, Hose/Pipe, .25 x .25	2



Table 12-14
Bulkhead Pipe Assembly
20481889

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
37	49833882	Adapter, Hose/ORB, .50 x .50	1	43	10078335	Coupling, Pipe, .25 x .13	1
38	20412815	Strainer	1	44	05107875	Adapter, JIC/Pipe, .50 x .50	1
39	20453730	Check Valve	1	45	20484920	Adapter, JIC/Pipe, .25 x .25	2
40	49868813	Temperature Sensor	1	46	20434025	Gauge Bracket	2
41	05142062	Pressure Switch, 60 psi	1	47	20487439	Coupling, Bulkhead	4
42	49888035	Solenoid Valve	1	48	20487447	Hose Barb, .25 x .25	4

Figure 12-14: Bulkhead Pipe Assembly

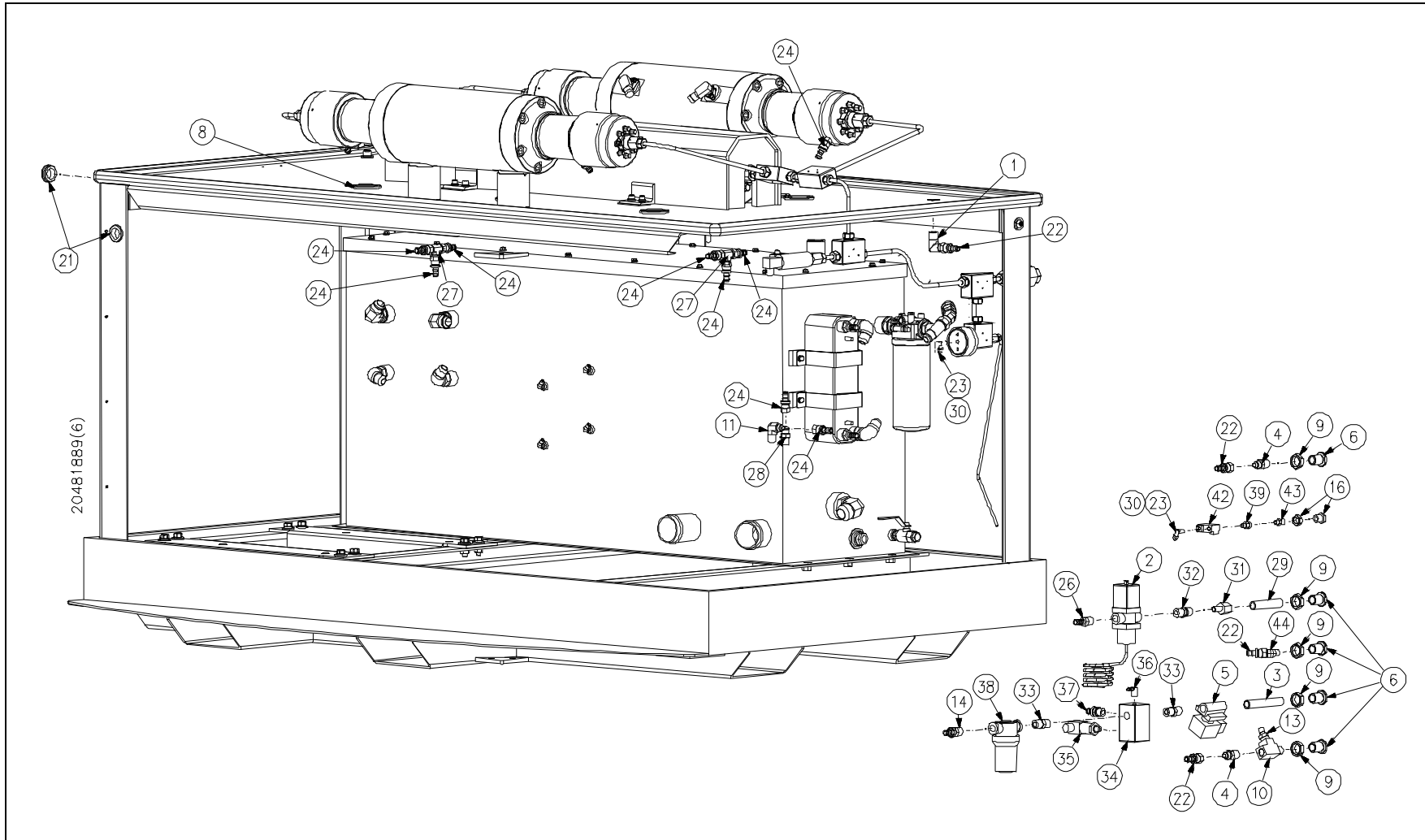


Figure 12-14: Bulkhead Pipe Assembly

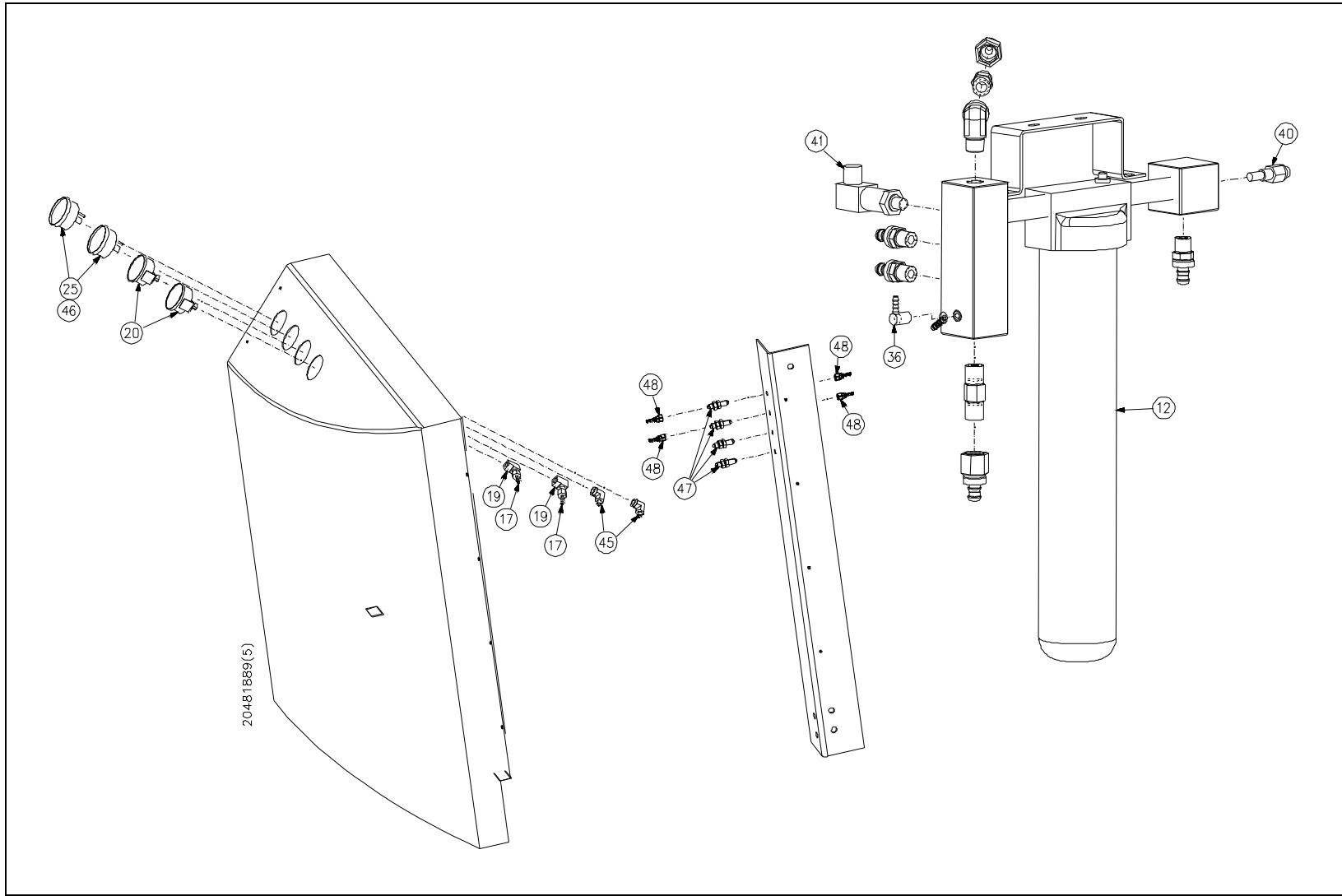




Table 12-15
Electrical Assembly
20489149

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	20489191	Harness, Sensor/Solenoid	1	14	10083012	Lock Nut, .50	3
2	05147251	Bushing, Conduit, 2.0 x 2.0	1	15	10067205	Connector, Cable, .50	3
3	10098937	Gasket Assembly	2	16	10082857	Gasket Assembly	3
4	10098929	Connector, Conduit, 2.0	1	17	05143631	Cable, #18	110.0"
5	10098788	Flexible Conduit, 2.0	58.0"	18	95484382	Hex Nut, 3/8-16	4
6	20452887	Welding Cable	612.0"	19	95750394	Lock Washer, .38	4
7	49886583	Wire, #6, Green	102.0"	20	95277109	Flat Washer, .38	8
8	80080344	Terminal Lug	9	21	20485110	Seal Washer, .38	4
9	05113923	Ring Terminal	2	22	95416350	Hex Head Screw, 3/8-16 x 1-1/4	4
10	10098804	Connector, Conduit, 2.0	1	23	20485250	Pipe Plug, 3.0	1
11	49885619	Bushing, Conduit, 3.0 x 2.0	1	24	05149778	Connector, Crimp Pin, #4	12
12	10125912	Cable Tie	5	25	05107248	Connector, Crimp Ferrule, #3	12
13	20492462	Control Panel Configuration	1	26	05143631	Cable, #18	220.0"

Figure 12-15: Electrical Assembly

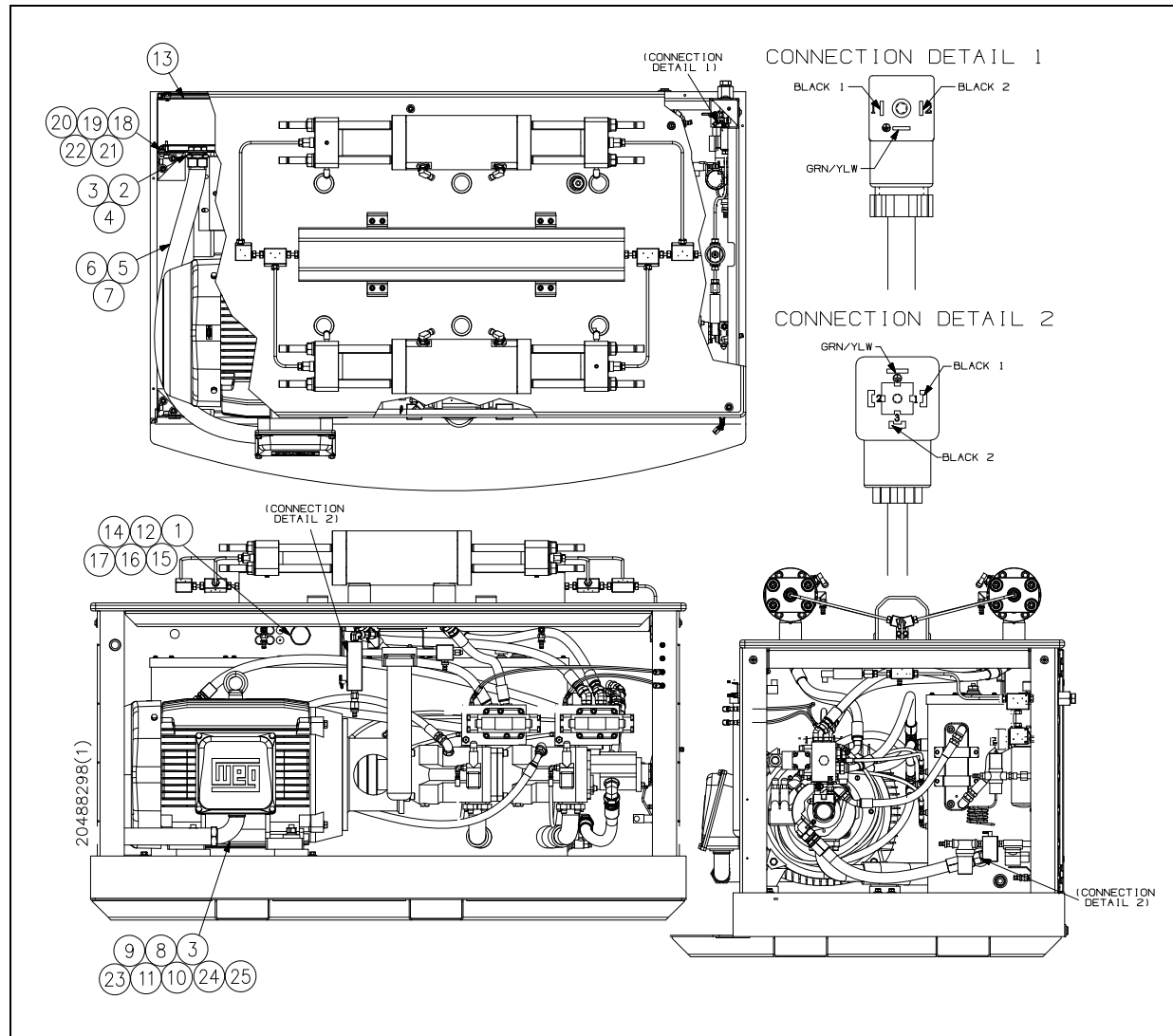




Table 12-16
Controls Subassembly
20490305

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	10176410	Wire, #16, Blue	3,900.0"	20	05140637	Contact Block	3
2	10170165	Wire, #16, Green/Yellow	190.0"	21	10149094	Pilot Light, Green	1
3	05032420	Terminal Block	9	22	05113634	Terminal Block	20
4	80078363	DIN Rail	1	23	49874225	Hole Seal, 2.0	1
5	10157667	Pan Head Screw, 10-32 x 3/4	12	24	20486869	Cable, #20	144.0"
6	10170132	Rivet	30	25	20416825	Operator, Illuminated	2
7	20416802	Switch, Emergency Stop	1	27	10083012	Lock Nut	4
8	20419143	Contact Block	4	28	20490024	Subplate	1
9	20489743	Legend Plate	1	29	05140629	Legend Holder	1
10	05032438	Terminal Block	59	30	20480122	Relay	5
11	05032362	End Anchor	10	31	10157659	Lock Washer	3
12	05032370	End Barrier	4	32	10110336	Wiring Duct	2.8
13	05032388	Jumper, Terminal Block	2	33	20489290	Power Supply	1
14	20421165	Marker, Terminal Block	0.6	34	49874191	Hole Seal, .50	8
15	20489727	Marker, Terminal Block	0.9	35	05140926	Wire, #16, Orange	192.0"
16	10186104	Relay, Tube Base	1	36	10185395	Connector, Crimp Ferrule	220
17	20496726	Relay Base	1	37	49833411	Selector Switch	1
18	10170504	Switch, White	1	38	20490049	Electrical Enclosure	1
19	20497660	Lamp Block	2				



Table 12-16
Controls Subassembly
72115778

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
39	05114889	Legend Plate	1	52	10093854	Hex Head Screw, 1/4-20 x 1-1/2	2
40	10170157	Wire, #10, Green/Yellow	36.0"	53	20488579	Relay Diode	1
41	10094712	Ring Terminal	4	54	05117601	End Barrier	1
42	95416335	Hex Nut, 1/4-20	6	55	05140579	Mounting Adapter	1
43	10149086	Pilot Light, Red	1	56	20486877	Cable, Ethernet	120.0"
44	20479707	Display	1	57	20487504	Terminal Block	1
45	61140466	Spiral Wrap	144.0"	58	20487522	End Anchor	1
46	20436867	Plug, Disconnect	20	59	05032388	Jumper, Terminal Block	1
47	49839335	Circuit Breaker	1	60	20479703	Controller	1
48	20465070	Connector, Cable	2	61	20486885	Data Plug	2
49	80079924	Cable, #20	40.0"	62	80070618	Cord Connector	2
50	05109898	Wire, #14, Black	54.0"	63	10082857	Gasket Assembly	4
51	05019617	Connector, Crimp Ferrule, #14	8	64	05061312	Hole Seal	1

Figure 12-16: Controls Subassembly

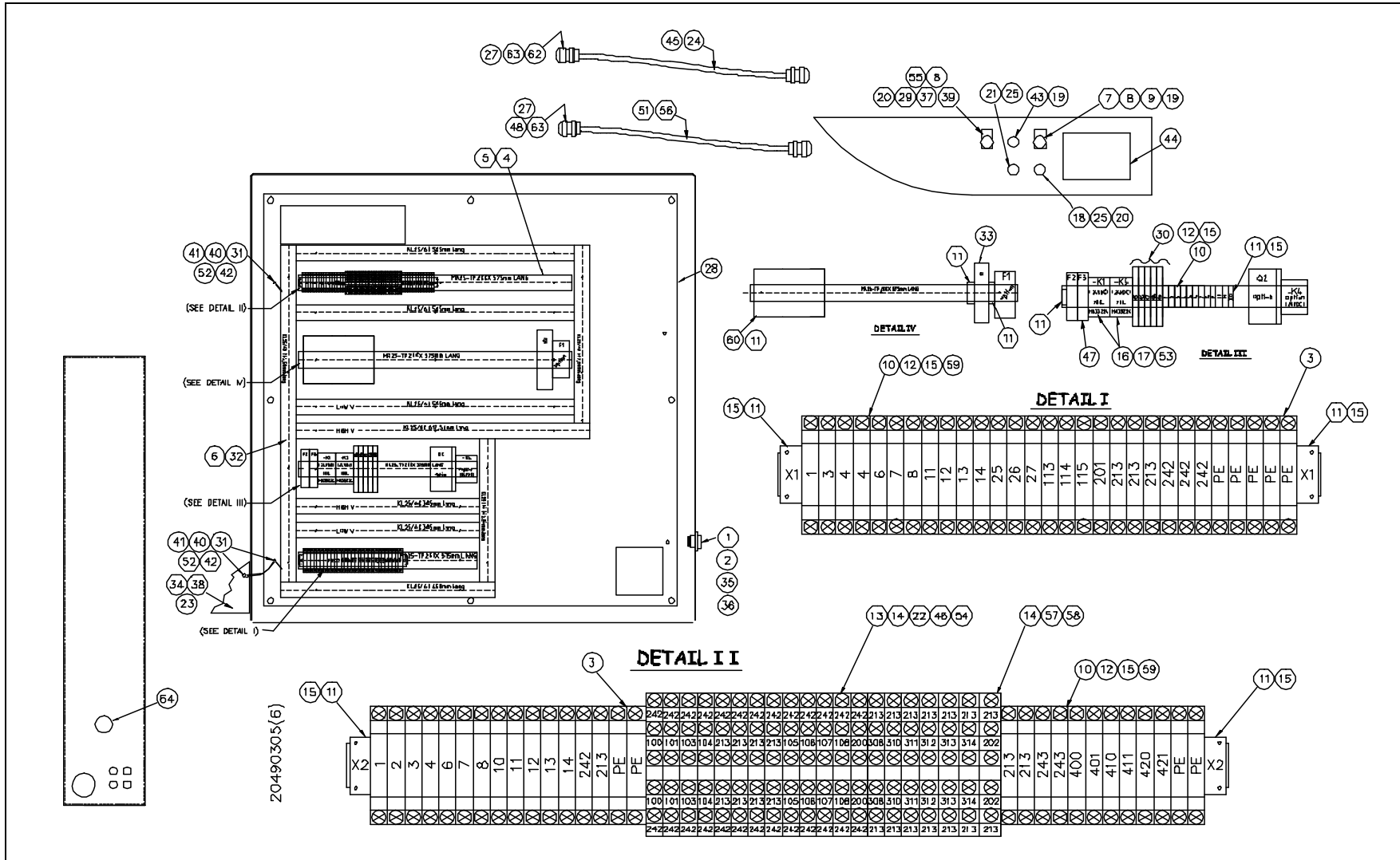
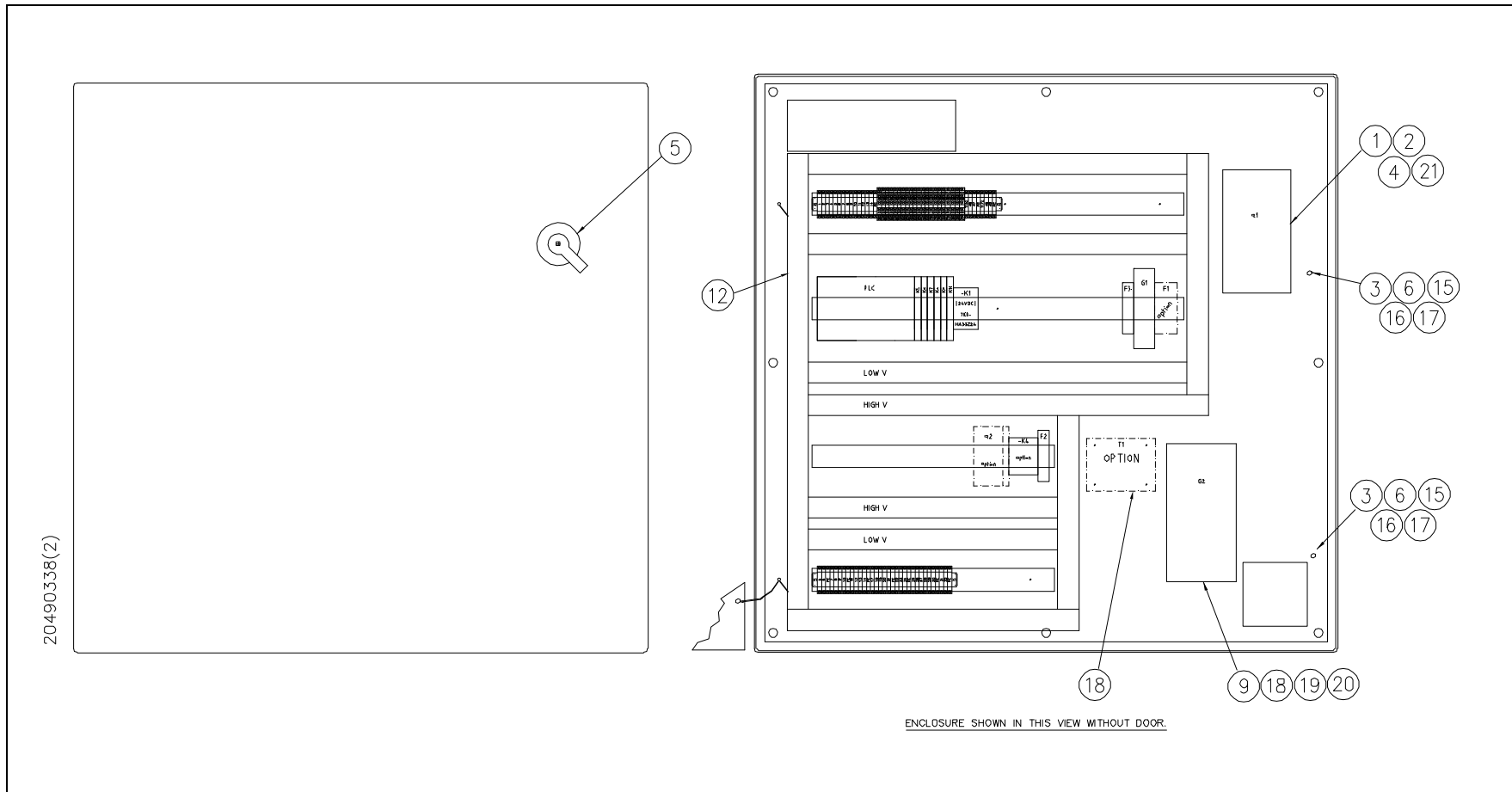




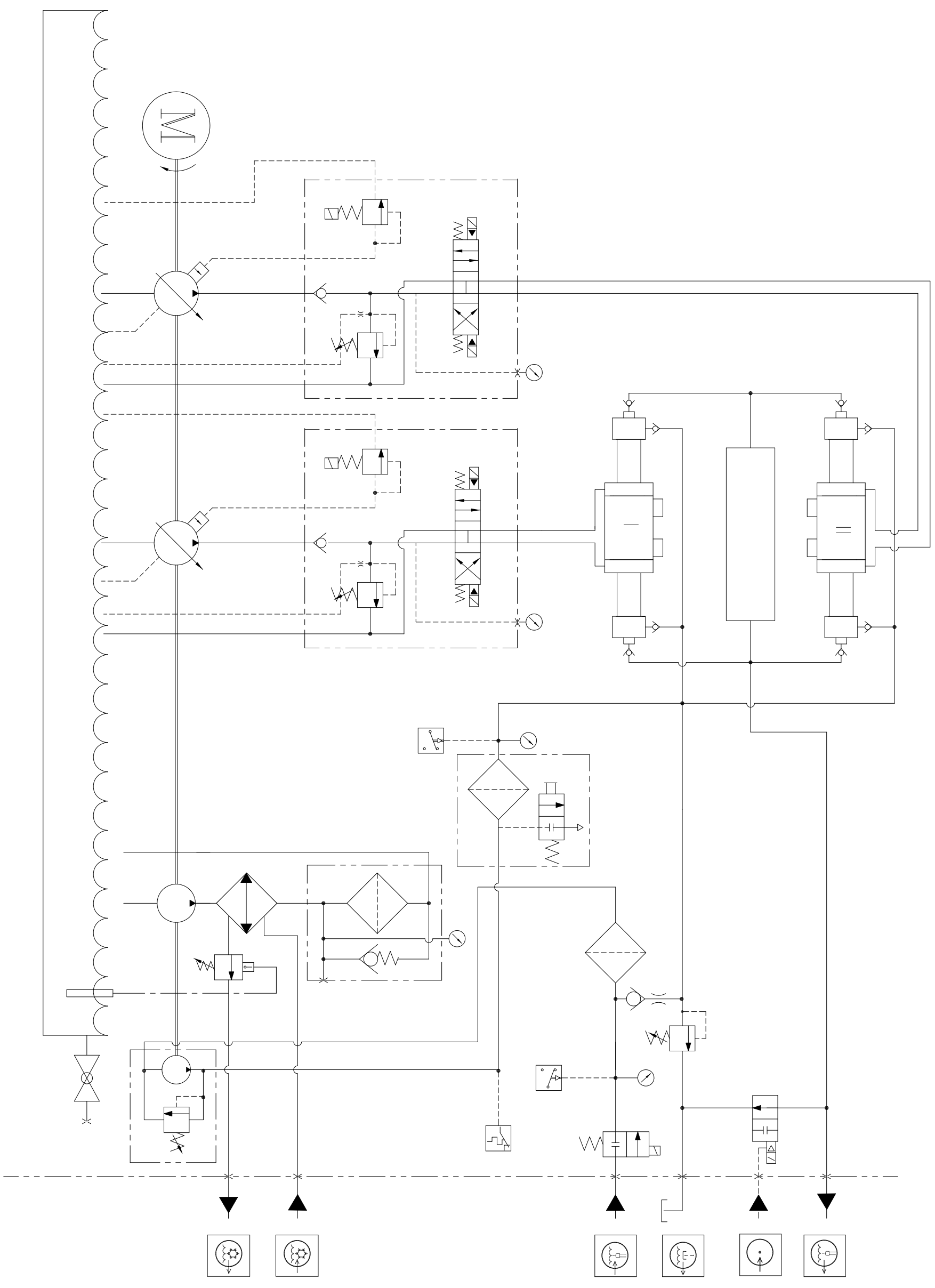
Table 12-17
Control Panel Configuration
20492462

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	80077894	Circuit Breaker	1	12	20490305	Controls Subassembly	1
2	05031620	Socket Head Screw, 10-32 x 1-3/4	4	13	10185395	Connector, Crimp Ferrule, #6	18
3	80079742	Interlock Washer	2	14	10176410	Wire, #16, Blue	48.0"
4	80080385	Breaker, Terminal Cover	2	15	10069755	Flat Washer, .31	4
5	80080377	Rotary Drive	1	16	10099281	Hex Nut, 5/16-18	4
6	95830766	Lock Washer, .31	2	17	95829230	Hex Head Screw, 5/16-18 x 1-1/2	2
7	05019799	Welding Cable	72.0"	18	10157667	Pan Head Screw, 10-32 x 3/4	4
8	05071030	Connector, Crimp Ferrule	6	19	20435751	Filter, Softstart	2
9	20488290	Contact, Softstart	1	20	20435759	Module, Protective	1
10	05019898	Wire, #14, Black	84.0"	21	20465033	Terminal Lug	6
11	05019617	Connector, Crimp Ferrule	16				

Figure 12-17: Control Panel Configuration

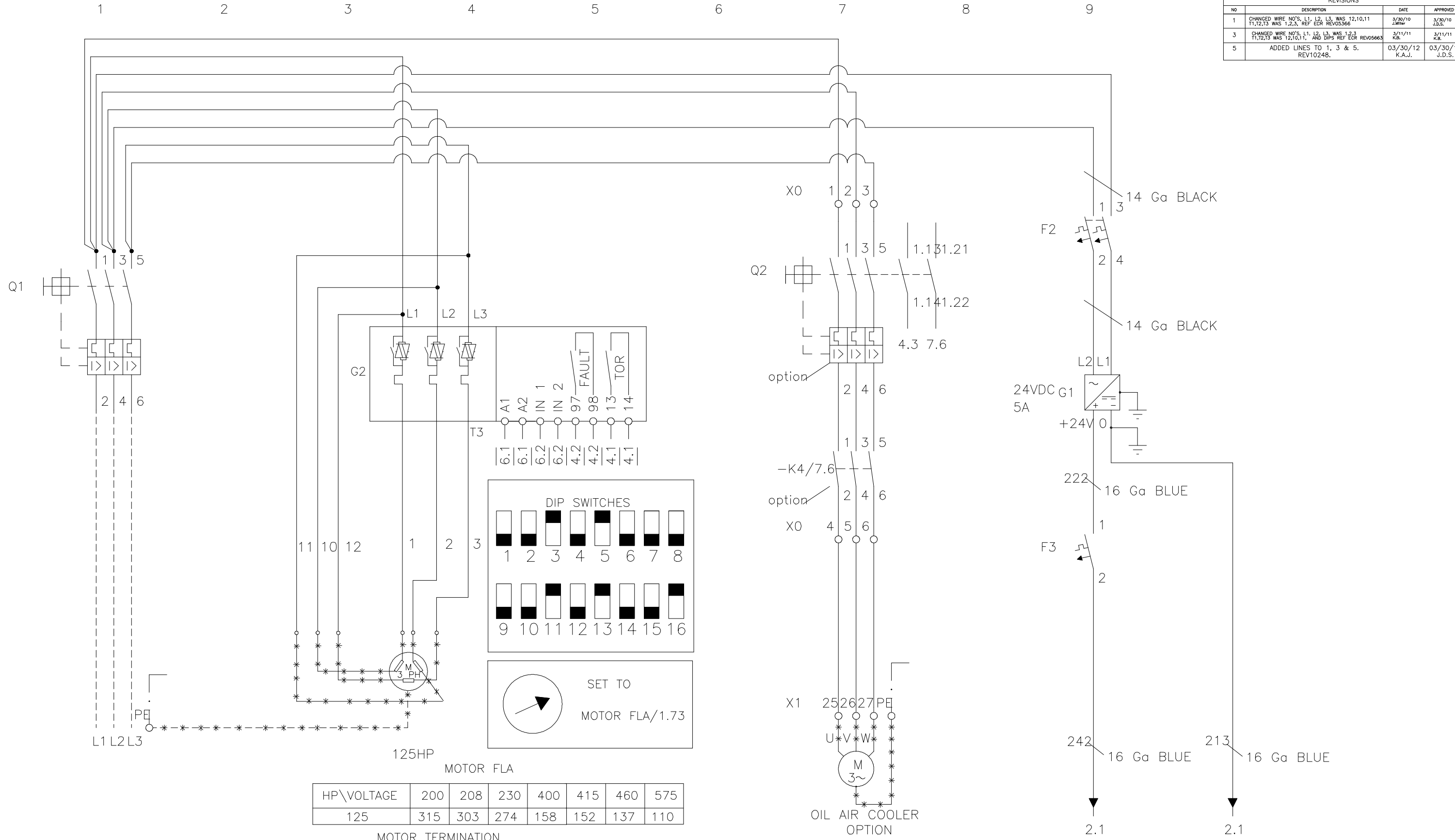


REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED
1	CHANGED HP ATEN PLUMBING REF DESN. REV03232 WATER IN AND COOLING WATER OUT DECSLS. REF CDR REV05465	10/28/09 JJS	10/28/09 JJS
2		7/22/10 JJS	7/22/10 JJS



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<p>KMT Waterjet</p>		<p>TITLE</p> <p>SCHEMATIC—SYSTEM, SL PRO 125</p>	
<p>SCALE: — THIRD ANGLE PROJECTION</p>		<p>FIG. NO. 20485266D</p>	
<p>TITLE BLOCK REGION: 2</p>		<p>SHEET 1 OF 1</p>	

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED
1	CHANGED WIRE NO'S, L1, L2, L3, WAS 12,10,11 T1,T2,T3 WAS 1,2,3, REF ECR REV05366	3/30/10 J.Miller	3/30/10 J.D.S.
3	CHANGED WIRE NO'S, L1, L2, L3, WAS 1,2,3 T1,T2,T3 WAS 12,10,11, AND DIPS REF ECR REV05663	3/11/11 K.B.	3/11/11 K.B.
5	ADDED LINES TO 1, 3 & 5. REV10248.	03/30/12 K.A.J.	03/30/12 J.D.S.



HP\ VOLTAGE	200	208	230	400	415	460	575
125	315	303	274	158	152	137	110

MOTOR TERMINATION

CONNECT	L1	L2	L3	T1	T2	T3	
HIGH VOLTAGE	12	10	11	1	2	3	4-7,5-8,6-9
LOW VOLTAGE	6-12	4-10	5-11	1-7	2-8	3-9	

NOTES:

- WIRING BY CUSTOMER IN ACCORDANCE WITH LOCAL REGULATIONS.
- *-*-* WIRING BY KMT EXTERNAL TO PANEL

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SURFACE FINISH - ✓
STANDARD TOLERANCES:
X.X = ±.063
X.XX = ±.015
X.XXX = ±.005
ANGLE = ±.2°

GD&T TO ASME Y14.5M 1994
ALL DIMENSIONS IN INCHES [mm]
MATERIAL -
HEAT TREAT -
HARDNESS -
REF. DWG -
DRAWN BY & DATE JDS 9/2/09
CHECKED BY & DATE -
ENG. APPROVAL & DATE JDS 9/2/09

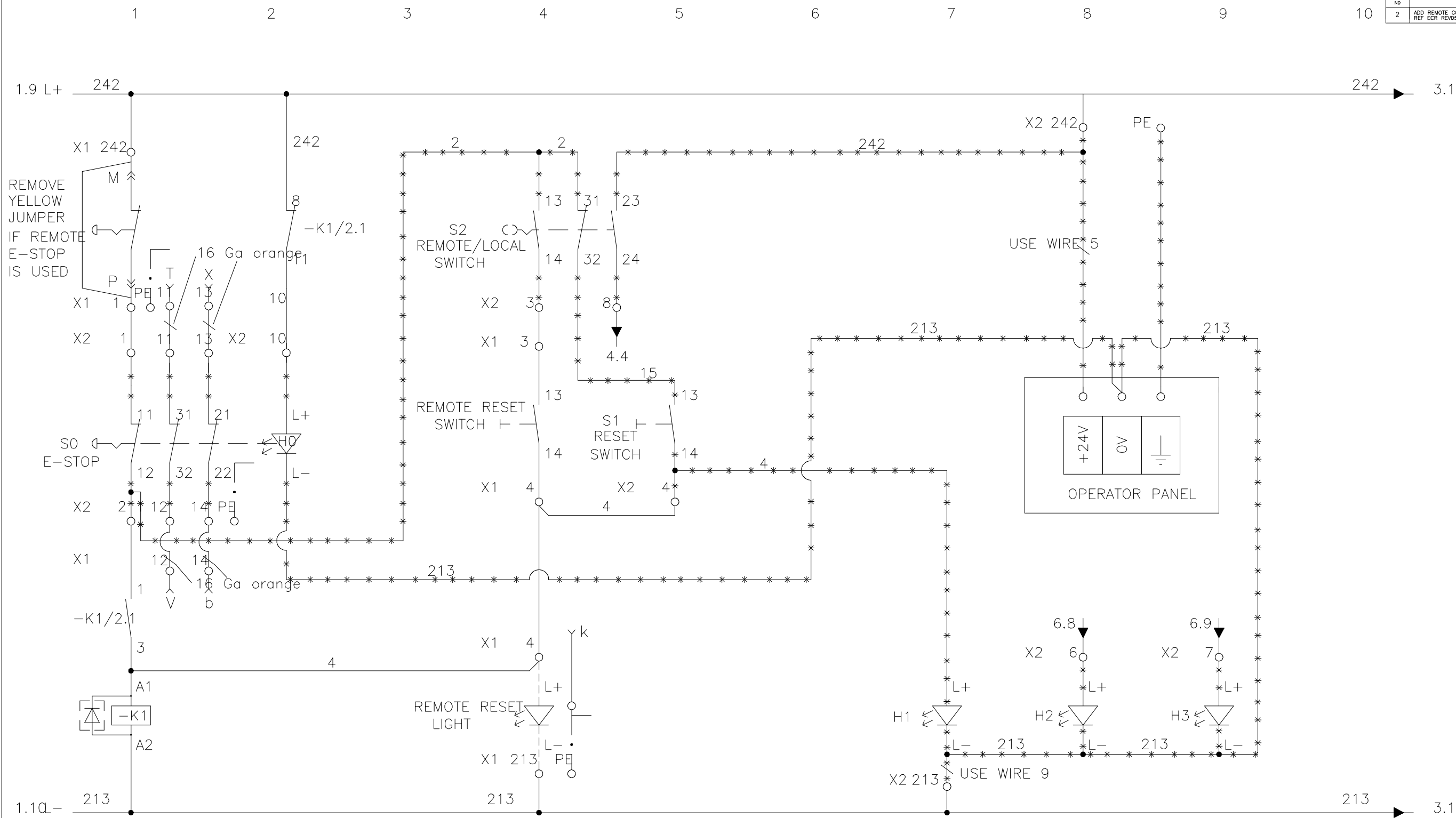
KMT WATERJET™
KMT Waterjet

SCHEM-ELEC,
SLPRO 125

DWG. NO. 20490083D REV. 6

THIRD ANGLE PROJECTION
SCALE: -
TITLE BLOCK REVISION: 2
SHEET 1 OF 8

REVISIONS			
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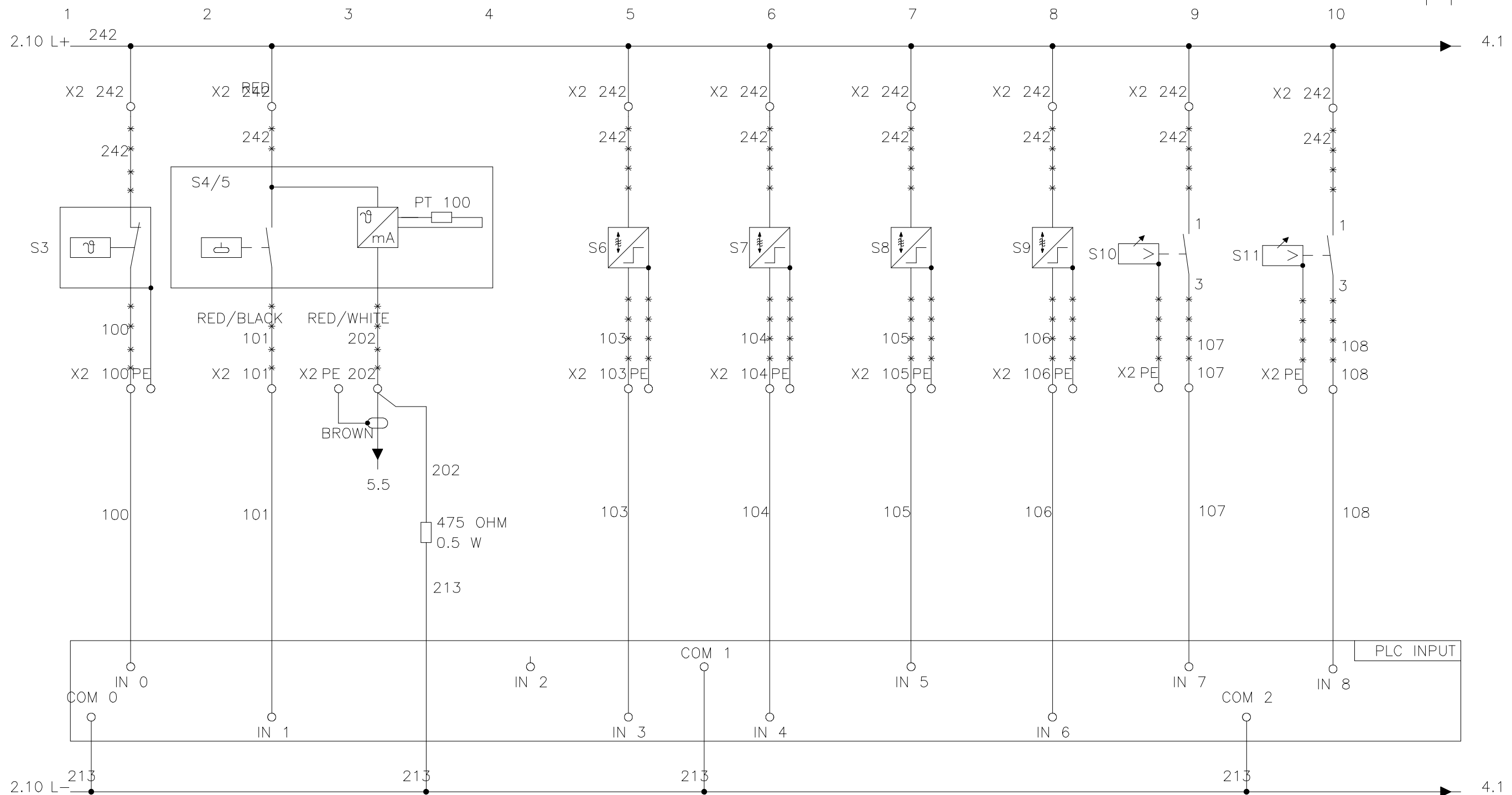
LOCAL/REMOTE

RESET LIGHT RUNNING LIGHT FAULT LIGHT

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		THIRD ANGLE PROJECTION		SCALE: -	TITLE BLOCK REVISION: 2	SHEET 2 OF 8

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED

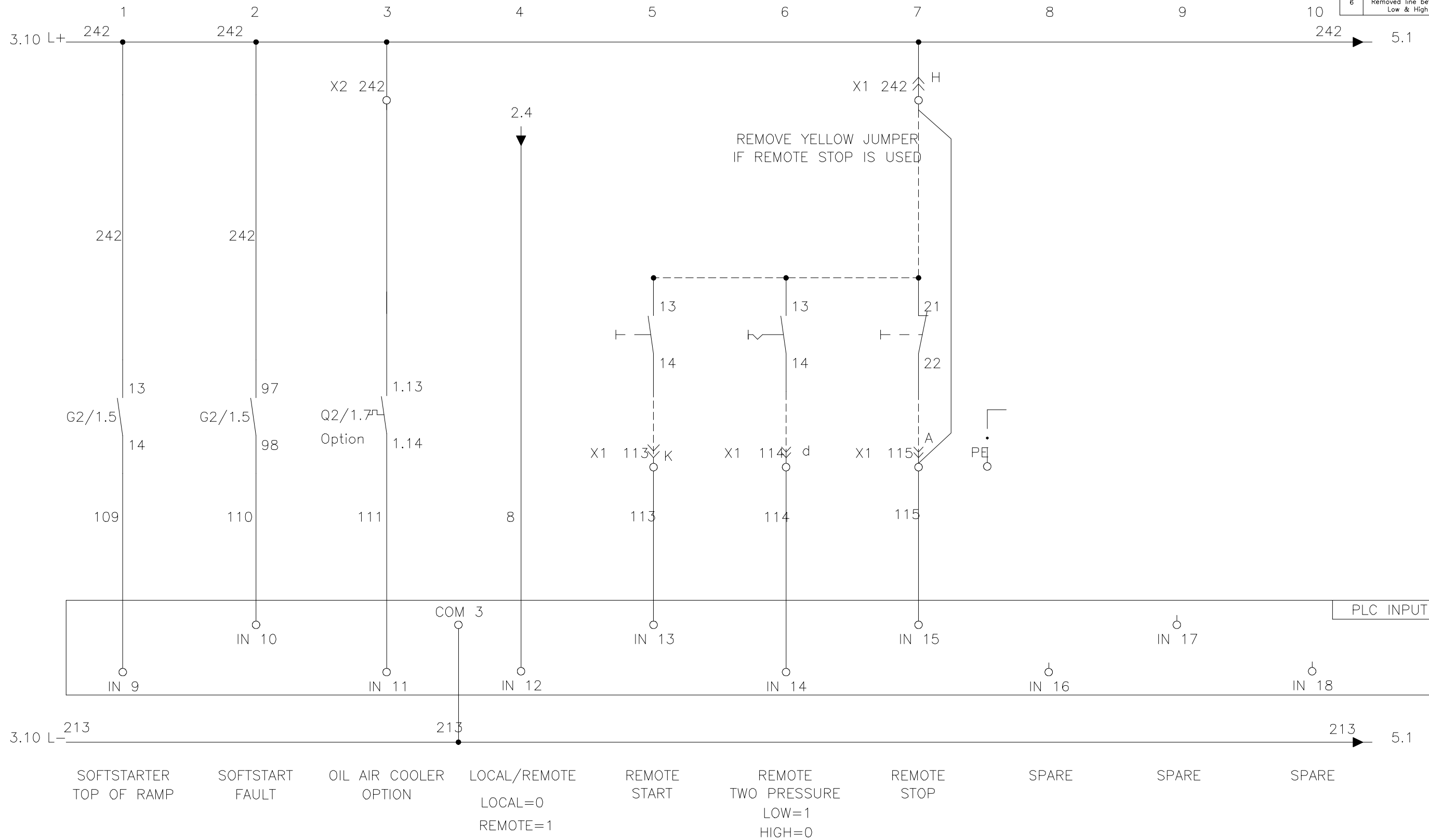


1 BOOSTER PUMP TEMPERATURE
 2 OIL LEVEL 2V (4mA) = 14°F
 3 OIL TEMPERATURE 10V (20mA) = 212°F
 4 SPARE
 5 LEFT PROX TOPWORKS 1
 6 RIGHT PROX TOPWORKS 1
 7 LEFT PROX TOPWORKS 2
 8 RIGHT PROX TOPWORKS 2
 9 INLET WATER PRESSURE (30 PSI)
 10 BOOSTER OUTLET PRESSURE (60 PSI)

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	SCALE: —		THIRD ANGLE PROJECTION		TITLE BLOCK REVISION: 2		SHEET 3 OF 8	

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
2	ADD REMOTE CONNECTOR PIN LOCATIONS REF ECR REV05490	8/05/10 K.B.	8/05/10 K.B.
4	ADD LOCAL REMOTE AND HI LOW STATE LABELS REF ECR REV05680	4/04/11 K.B.	4/04/11 K.B.
6	Removed line between 4 & 5. Flipped Low & High 0/1. REV10387.	06/15/12 K.A.J.	06/15/12 J.D.S.

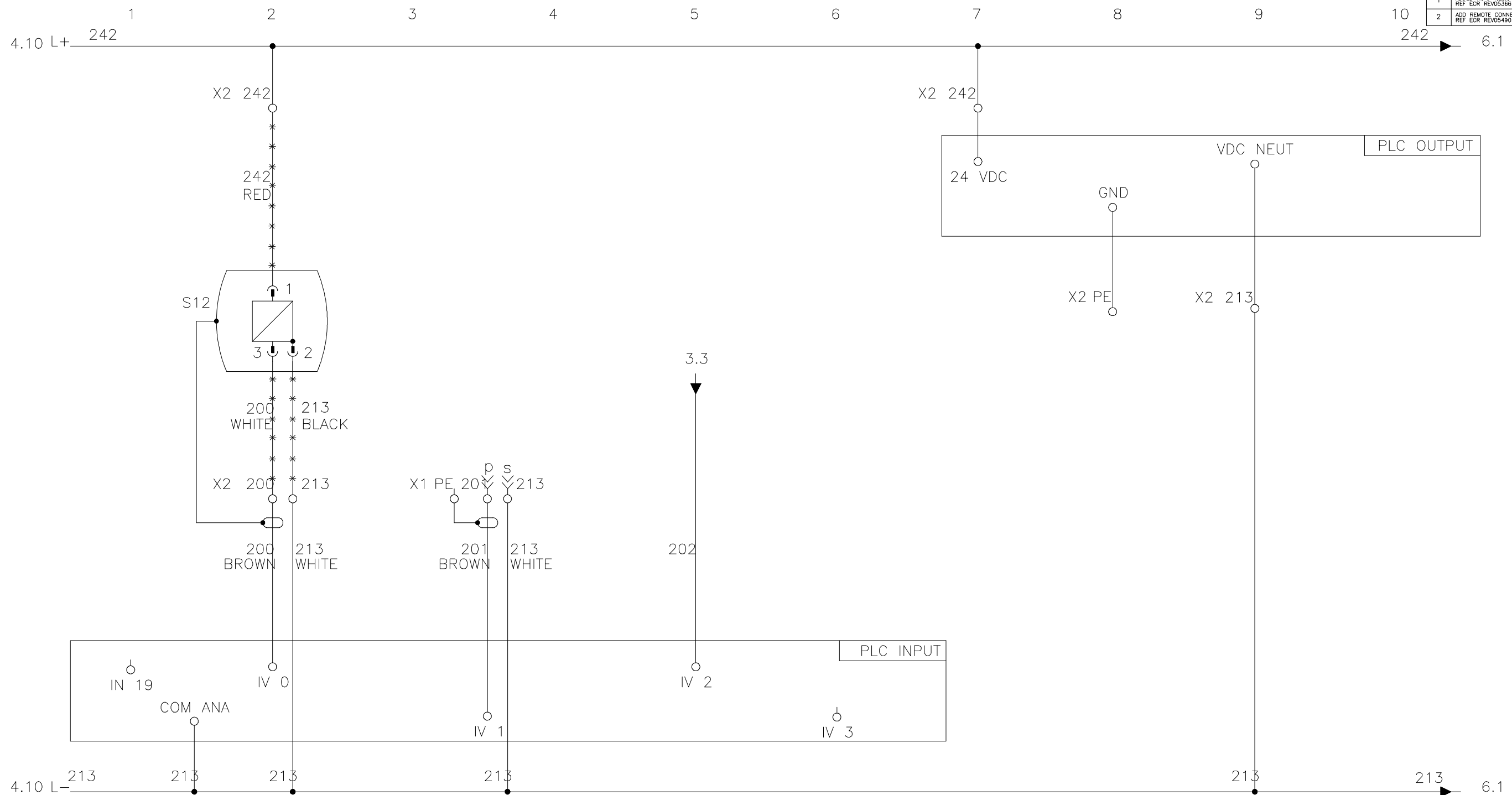


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	<p>WARNING !</p> <p>The export or reexport of this drawing or a product produced by this drawing is subject to U.S. Export Administration regulations and other applicable governmental restrictions or regulations.</p>	<p>This document contains confidential and trade secret information, is the property of KMT Waterjet Systems, and is given to the receiver in confidence. The receiver by reception and retention of the document accepts the document in confidence and agrees that, except as authorized in writing by KMT Waterjet Systems, it will (1) not use the document on any copy thereof or the confidential or the trade secret information therein; (2) not copy the document; (3) not disclose to others either the document or the confidential or trade secret information therein; and (4) upon completion of the need to retain the document, or upon demand return the document, all copies thereof, and all material copied therefrom.</p>	<p>UNLESS OTHERWISE NOTED:</p> <p>ALL DIAMETERS ON COMMON CENTERLINE COAXIAL TO .005</p> <p>BREAK SHARP EDGES AND CORNERS .015</p> <p>SURFACE FINISH - ✓</p> <p>STANDARD TOLERANCES:</p> <p>X.X = ±.063</p> <p>X.XX = ±.015</p> <p>X.XXX = ±.005</p> <p>ANGLE = ±2°</p>		<p>REF. DWG -</p> <p>DRAWN BY & DATE JDS 9/4/09</p> <p>CHECKED BY & DATE</p> <p>HEAT TREAT -</p> <p>ENG. APPROVAL & DATE JDS 9/4/09</p>
					<p>DWG. NO. 20490083D</p> <p>REV. 6</p>

SCALE: — TITLE BLOCK REVISION: 2 SHEET 4 OF 8

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
1	ADDED NO'S 1,2,3, TO S12 REF ECR REV05366	3/30/10 J.Miller	3/30/10 J.D.S.
2	ADD REMOTE CONNECTOR PIN LOCATIONS REF ECR REV05490	8/05/10 K.B.	8/05/10 K.B.

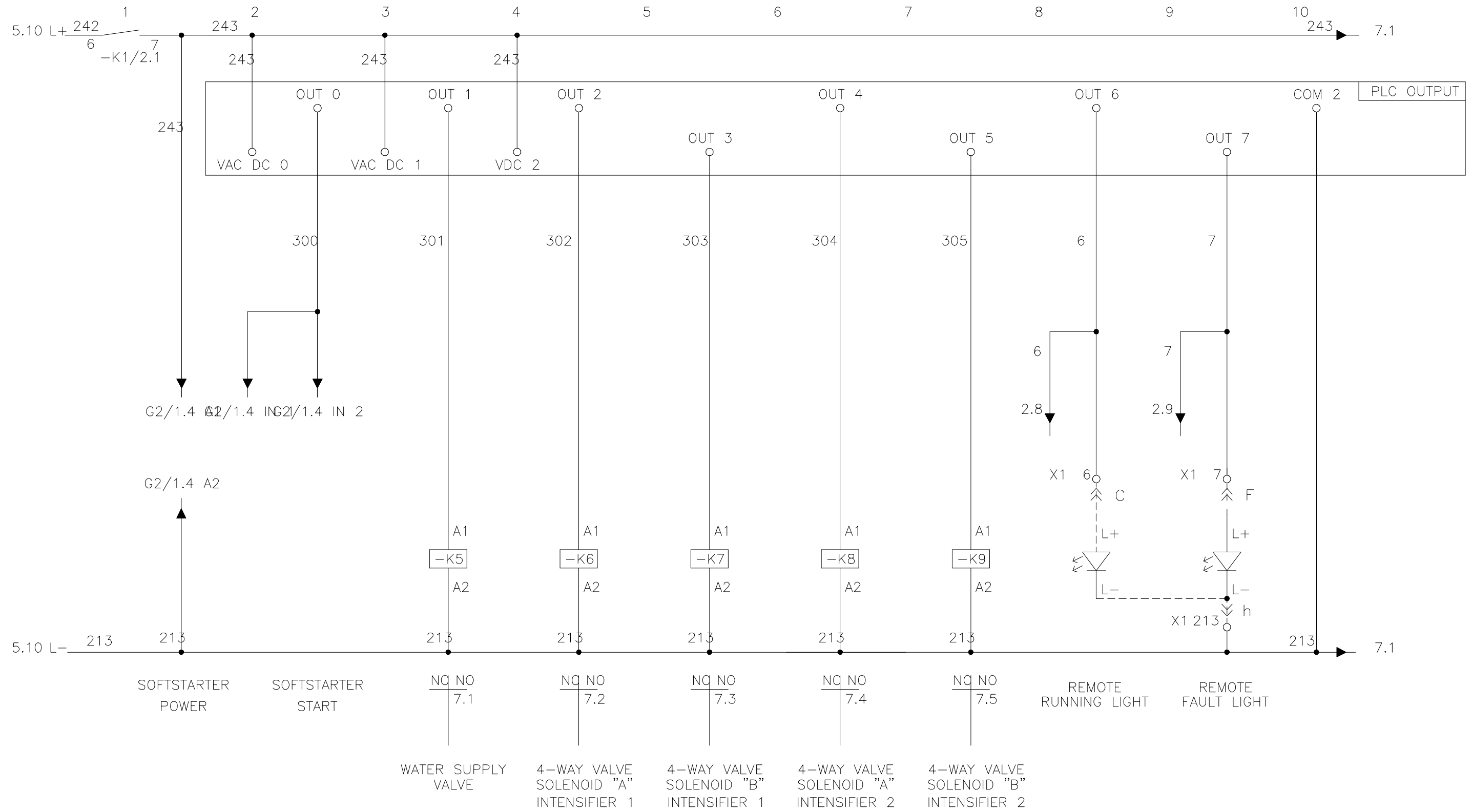


SPARE PRESSURE TRANSDUCER REMOTE PRESSURE CONTROL (0-10V) OIL TEMPERATURE SPARE

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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 other applicable governmental restrictions or regulations.				THIRD ANGLE PROJECTION	SCALE: — TITLE BLOCK REVISION: 2 SHEET 5 OF 8

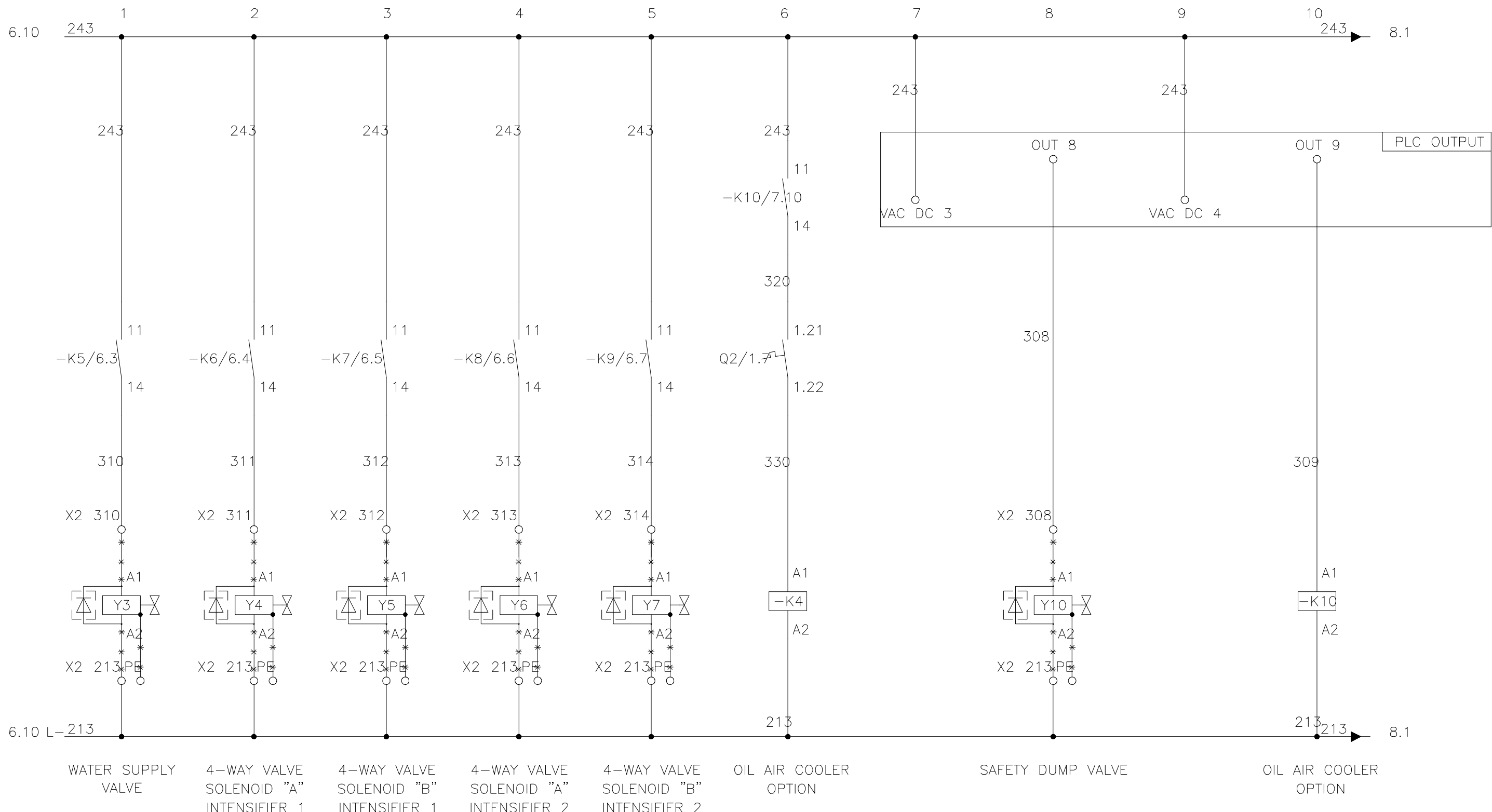
REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
2	ADD REMOTE CONNECTOR PIN LOCATIONS REF EDR REV05490	8/05/10 K.B.	8/05/10 K.B.



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<p>THIRD ANGLE PROJECTION</p>					<p>DWG. NO. 20490083D</p>
<p>SCALE: —</p>				<p>TITLE BLOCK REVISION: 2</p>	<p>SHEET 6 OF 8</p>

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED

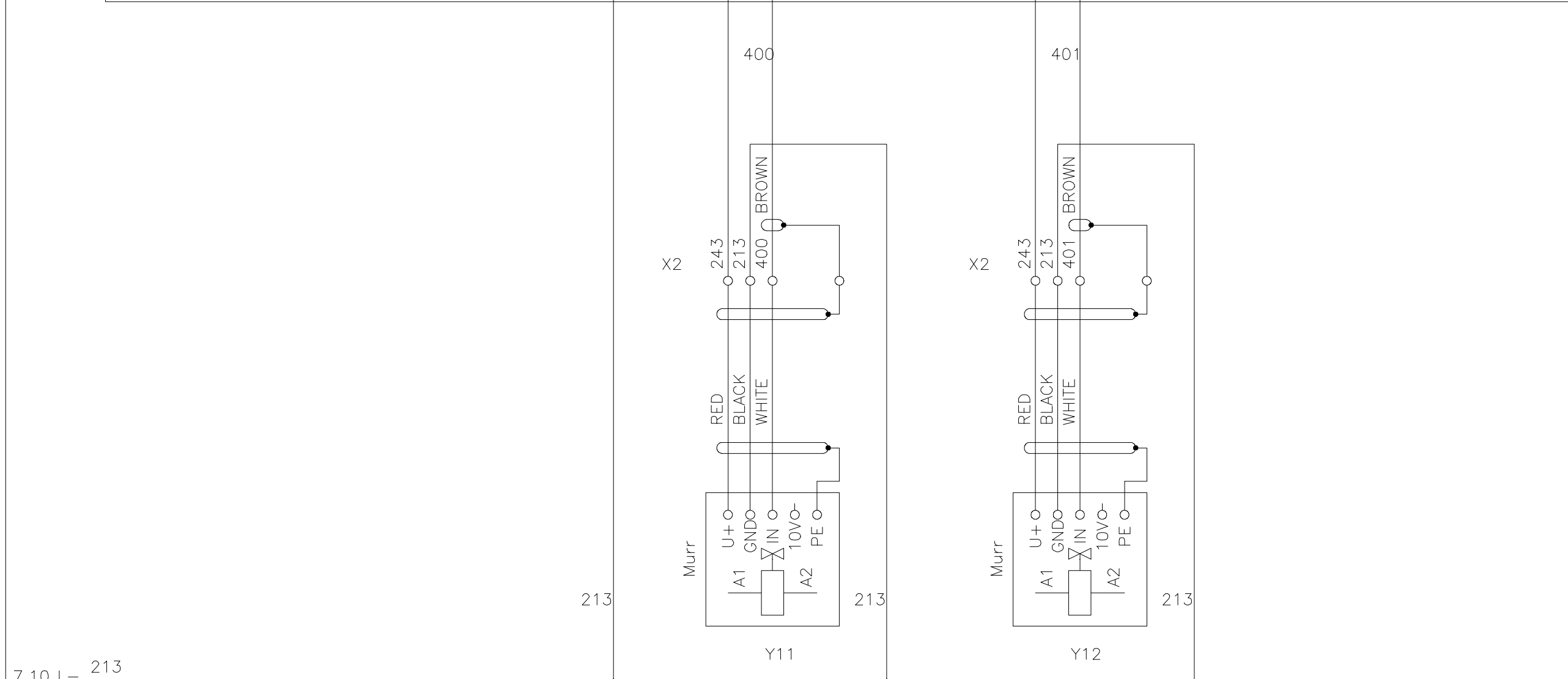
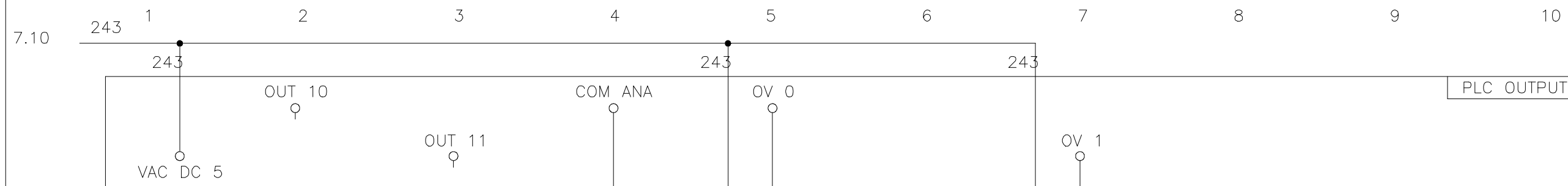


6.10 L-213

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	THIRD ANGLE PROJECTION		SCALE: —	TITLE BLOCK REVISION: 2	SHEET 7 OF 8			

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
1	CHANGED WIRE COLORS, RED, BLACK, WHITE WERE BROWN, WHITE GREEN, REMOVED, 410, 411, 420, 421 REF FOR REV05366	3/30/10 J.Miller	3/30/10 J.D.S.



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STANDARD TOLERANCES UNLESS OTHERWISE NOTED: ALL DIAMETERS ON COMMON CENTERLINE COAXIAL TO .005 BREAK SHARP EDGES AND CORNERS .015 SURFACE FINISH - $\sqrt{\quad}$ X.X = ± 0.063 X.XX = ± 0.015 X.XXX = ± 0.005 ANGLE = $\pm 2^\circ$	GD&T TO ASME Y14.5M 1994 ALL DIMENSIONS IN INCHES [mm] MATERIAL - HEAT TREAT - HARDNESS -
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REF. DWG - DRAWN BY & DATE JDS 9/8/09 CHECKED BY & DATE	ENG. APPROVAL & DATE JDS 9/8/09
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KMT Waterjet

SCHEM-ELEC,
SLPRO 125

DWG. NO. 20490083D REV. 6

SCALE: - TITLE BLOCK REVISION: 2 SHEET 8 OF 8

NEXT ASSEMBLY



MATERIAL SAFETY DATA SHEET

PURE GOOP™

November 2003

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.

5. FIRE FIGHTING MEASURES



MATERIAL SAFETY DATA SHEET

PURE GOOP™

November 2003

- 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.

Auto ignition	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: 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™

November 2003

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 or 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, and IARC

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™

November 2003

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	November 2003

Revision Date: 12/10/2004

Issue date: 12/13/2004

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product name: Loctite(R) 222 Threadlocker Low Strength
Product Use: Sealant
Company address:
Henkel Canada, Inc.
2255 Meadowpine Boulevard
Mississauga, Ontario L5N 7P2

Item No. : 21464
Region: Canada
Contact Information:
Telephone: 905.814.6511
Emergency telephone: 905.814.6511
Internet: www.loctite.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

<u>Hazardous components</u>	<u>%</u>	<u>ACGIH TLV</u>	<u>OSHA PEL</u>	<u>OTHER</u>
Polyglycol dimethacrylate 25852-47-5	30-60	None	None	None
Polyglycol oleate 9004-96-0	30-60	None	None	None
Silica, amorphous, treated 68909-20-6	5-10	10 mg/m ³ (Inhal)	20mppcf	6 mg/m ³
Saccharin 81-07-2	1-5	None	None	None
Propylene glycol 57-55-6	1-5	None	None	None
Cumene hydroperoxide 80-15-9	1-5	None	None	1 ppm (6 mg/m ³) Skin (WEEL)

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Physical state: Liquid
Color: Purple
Odor: Mild
WHMIS hazard class: D.2.B

WARNING: CAUSES EYE IRRITATION.
MAY CAUSE ALLERGIC SKIN REACTION.
MAY CAUSE SKIN IRRITATION.
MAY CAUSE RESPIRATORY TRACT IRRITATION.

Relevant routes of exposure: Skin, Inhalation, Eyes

Potential Health Effects

Inhalation: May cause respiratory tract irritation.
Skin contact: May cause allergic skin reaction. May cause skin irritation.
Eye contact: Contact with eyes will cause irritation.
Ingestion: Not expected to be harmful by ingestion.

Existing conditions aggravated by exposure: Eye, skin, and respiratory disorders.

See Section 11 for additional toxicological information.

Item No. : 21464

Product name: Loctite(R) 222 Threadlocker Low Strength

4. FIRST AID MEASURES

Inhalation:	Remove to fresh air. If symptoms develop and persist, get medical attention.
Skin contact:	Wash with soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Get medical attention if symptoms occur.
Eye contact:	Flush with copious amounts of water, preferably, lukewarm water for at least 15 minutes, holding eyelids open all the time. Get medical attention.
Ingestion:	Do not induce vomiting. Keep individual calm. Obtain medical attention.

5. FIRE-FIGHTING MEASURES

Flash point:	Greater than 93°C (200°F) Tagliabue closed cup
Autoignition temperature:	Not available
Flammable/Explosive limits-lower %:	Not available
Flammable/Explosive limits-upper %:	Not available
Extinguishing media:	Foam, dry chemical or carbon dioxide.
Special fire fighting procedures:	Wear self-contained breathing apparatus and full protective clothing, such as turn-out gear.
Unusual fire or explosion hazards:	None
Hazardous combustion products:	Oxides of carbon. Oxides of sulfur. Oxides of nitrogen. Irritating organic vapors.
Sensitivity to mechanical impact:	Not available.
Sensitivity to static discharge:	Not available.

6. ACCIDENTAL RELEASE MEASURES

Environmental precautions:	Prevent product from entering drains or open waters.
Clean-up methods:	Soak up with inert absorbent. Store in a partly filled, closed container until disposal.

7. HANDLING AND STORAGE

Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing vapor and mist. Wash thoroughly after handling. Use only with adequate ventilation.
Storage:	For safe storage, store at or below 38°C (100°F). Keep in a cool, well ventilated area away from heat, sparks and open flame. Keep container tightly closed until ready for use.
Incompatible products:	Refer to Section 10.

For information on product shelf life contact Loctite Canada Customer Service at (905) 814-6511.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering controls:	No specific ventilation requirements noted, but forced ventilation may still be required if concentrations exceed occupational exposure limits.
Respiratory protection:	Use NIOSH approved respirator if there is potential to exceed exposure limit(s).

Item No. : 21464

Product name: Loctite(R) 222 Threadlocker Low Strength

Skin protection: Use impermeable gloves and protective clothing as necessary to prevent skin contact. Neoprene gloves. Butyl rubber gloves. Natural rubber gloves.

Eye/face protection: Safety goggles or safety glasses with side shields.

See Section 2 for exposure limits.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid
Color: Purple
Odor: Mild
Odor Threshold: Not available
Vapor pressure: Less than 5 mm Hg at 27°C (80°F)
pH: Not applicable
Boiling point/range: Greater than 149°C (300°F)
Melting point/range: Not available
Specific gravity: 1.08 at 20°C (68°F)
Vapor density: Not available
Evaporation rate: Not available
Solubility in water: Slight
Partition coefficient (n-octanol/water): Not available
VOC content: 11.8%; 127 grams/liter (EPA Method 24)

10. STABILITY AND REACTIVITY

Stability: Stable.

Hazardous polymerization: Will not occur.

Hazardous decomposition products: Oxides of carbon. Oxides of sulfur. Oxides of nitrogen. Irritating organic vapors.

Incompatibility: Strong oxidizers.

Conditions to avoid: See "Handling and Storage" (Section 7) and "Incompatibility" (Section 10).

11. TOXICOLOGICAL INFORMATION

Product toxicity data: Acute oral LD50 greater than 10,000 mg/kg (rat). Acute dermal LD50 greater than 5000 mg/kg (rabbit).

Toxicologically synergistic products: Not available.

Refer to the following for Irritancy of Product, Sensitization to Product, Carcinogenicity, Reproductive Toxicity, Teratogenicity, and Mutagenicity.

Ingredient Toxicity Data & Carcinogen Status

Hazardous components	LD50s & LC50s (NIOSH) :	Other LD50s and LC50s:	NTP Carcinogen	IARC Carcinogen	OSHA Carcinogen	ACGIH - Carcinogens
Polyglycol dimethacrylate 25852-47-5	None	None	No	No	No	No
Polyglycol oleate 9004-96-0	Oral LD50 (Mouse) > 25 g/kg	None	No	No	No	No
Silica, amorphous, treated 68909-20-6	None	None	No	No	No	No
Saccharin 81-07-2	Oral LD50 (Mouse) = 17 g/kg	None	No	No	No	No

Item No. : 21464

3 of 5

Product name: Loctite(R) 222 Threadlocker Low Strength

Propylene glycol 57-55-6	Oral LD50 (Rat) = 20 g/kg Dermal LD50 (Rabbit) = 20800 mg/kg Oral LD50 (Mouse) = 22 g/kg	None	No	No	No	No
Cumene hydroperoxide 80-15-9	Inhalation LC50 (Mouse) = 200 ppm Inhalation LC50 (Rat) = 220 ppm Oral LD50 (Rat) = 382 mg/kg	None	No	No	No	No

Literature Referenced Target Organ & Other Health Effects

Hazardous components	Health Effects/Target Organs
Polyglycol dimethacrylate 25852-47-5	Allergen, Irritant
Polyglycol oleate 9004-96-0	Irritant
Silica, amorphous, treated 68909-20-6	No Target Organs
Saccharin 81-07-2	No Target Organs
Propylene glycol 57-55-6	Irritant
Cumene hydroperoxide 80-15-9	Allergen, Central nervous system, Corrosive, Irritant, Mutagen

12. ECOLOGICAL INFORMATION

Ecological information: Not available

13. DISPOSAL CONSIDERATIONS

Information provided is for unused product only.

Recommended method of disposal: Dispose of in accordance with federal and local regulations.

14. TRANSPORT INFORMATION

Canada Transportation of Dangerous Goods - Ground:

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None

International Air Transportation (ICAO/IATA):

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None

Water Transportation (IMO/IMDG):

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None
Marine pollutant: None

Item No. : 21464

Product name: Loctite(R) 222 Threadlocker Low Strength

15. REGULATORY INFORMATION

Canada Regulatory Information

CEPA DSL/NDL Status: All components are listed on or are exempt from listing on the Domestic Substances List.

United States Regulatory Information

TSCA 8 (b) Inventory Status: All components are listed or are exempt from listing on the Toxic Substances Control Act Inventory.

16. OTHER INFORMATION

This material safety data sheet contains changes from the previous version in sections: New Material Safety Data Sheet format.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Product Regulations.

Prepared by: Kyra Kozak Woods, Health and Regulatory Affairs Specialist

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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	Supercedes: 03/17/00 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.:
Molybdenum Disulfide	1317-33-5
Silica, Fused	60676-86-0
Graphite	7782-42-5
Silica, Crystalline	14808-60-7
Lubricating Oils, Petroleum, Hydrotreated, Spent	64742-58-1
Residual Oils (Petroleum), Solvent Dewaxed	64742-62-7
Solvent-Refined Heavy Paraffinic Distillate (Petroleum)	64741-88-4
Solvent -Dewaxed Hydrotreated Heavy Paraffinic Distillate (Petroleum)	64742-65-0
Hydrotreated Heavy Paraffinic Distillate (Petroleum)	64742-54-7
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 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

FORMULA:

Calcium Soap, USP Mineral Oil and Additives

GENERIC/CHEMICAL NAME:

Petroleum Lubricating Grease

NSF Registration No's:

125742, 125740, 125741

Manufacturer's Name:

Fiske Brothers Refining Co.

Emergency Telephone Number:

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

Address:

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

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>
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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:	Used to capture fumes and vapors	Special: N/A
	Mechanical (General)		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.

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: MOBIL DTE 26
Product Description: Base Oil and Additives
Product Code: 201560102030, 602649-00, 970101
Intended Use: Hydraulic fluid

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA

24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300
ExxonMobil Transportation No. 281-834-3296
MSDS Requests 713-613-3661
Product Technical Information 800-662-4525, 800-947-9147
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

No Reportable Hazardous Substance(s) or Complex Substance(s).

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL HEALTH EFFECTS

Low order of toxicity. Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0
HMIS Hazard ID:	Health: 0	Flammability: 1	Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use

mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. 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.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Pressurized mists may form a flammable mixture.

Hazardous Combustion Products: Aldehydes, Smoke, Fume, Sulfur oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: >204C (399F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7	HANDLING AND STORAGE
------------------	-----------------------------

HANDLING

Prevent small spills and leakage to avoid slip hazard.

Static Accumulator: This material is a static accumulator.

STORAGE

Do not store in open or unlabelled containers.

SECTION 8	EXPOSURE CONTROLS / PERSONAL PROTECTION
------------------	--

Exposure limits/standards for materials that can be formed when handling this product: When mists / aerosols can occur, the following are recommended: 5 mg/m³ - ACGIH TLV, 10 mg/m³ - ACGIH STEL, 5 mg/m³ - OSHA PEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

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Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9

PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid

Color: Brown

Odor: Characteristic

Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 C): 0.881

Flash Point [Method]: >204C (399F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: > 316C (600F)

Vapor Density (Air = 1): > 2 at 101 kPa

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Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 C

Evaporation Rate (n-butyl acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5

Solubility in Water: Negligible

Viscosity: 71.2 cSt (71.2 mm²/sec) at 40 C | 8.5 cSt (8.5 mm²/sec) at 100C

Oxidizing Properties: See Sections 3, 15, 16.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -18°C (0°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Route of Exposure	Conclusion / Remarks
Inhalation	
Toxicity (Rat): LC50 > 5000 mg/m ³	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data.	Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components.
Ingestion	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Irritation (Rabbit): Data available.	Negligible irritation to skin at ambient temperatures. Based on assessment of the components.
Eye	
Irritation (Rabbit): Data available.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.

CHRONIC/OTHER EFFECTS

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-

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specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

Additional information is available by request.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC

3 = IARC 1

5 = IARC 2B

2 = NTP SUS

4 = IARC 2A

6 = OSHA CARC

SECTION 12

ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13

DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

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 as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

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Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, 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.

SECTION 14	TRANSPORT INFORMATION
-------------------	------------------------------

LAND (DOT) : Not Regulated for Land Transport

LAND (TDG) : Not Regulated for Land Transport

SEA (IMDG) : Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA) : Not Regulated for Air Transport

SECTION 15	REGULATORY INFORMATION
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OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purposes, this material is not classified as hazardous in accordance with OSHA 29 CFR 1910.1200.

NATIONAL CHEMICAL INVENTORY LISTING: PICCS, TSCA, EINECS, IECSC, AICS, ENCS, KECI, DSL

EPCRA: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: None.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The Following Ingredients are Cited on the Lists Below:

Chemical Name	CAS Number	List Citations
ZINC ALKYL DITHIOPHOSPHATE	68649-42-3	15

--REGULATORY LISTS SEARCHED--

1 = ACGIH ALL	6 = TSCA 5a2	11 = CA P65 REPRO	16 = MN RTK
2 = ACGIH A1	7 = TSCA 5e	12 = CA RTK	17 = NJ RTK
3 = ACGIH A2	8 = TSCA 6	13 = IL RTK	18 = PA RTK
4 = OSHA Z	9 = TSCA 12b	14 = LA RTK	19 = RI RTK
5 = TSCA 4	10 = CA P65 CARC	15 = MI 293	

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16	OTHER INFORMATION
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Product Name: MOBIL DTE 26

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N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 06: Notification Procedures - Header was modified.

Section 13: Empty Container Warning was modified.

Section 08: Hand Protection was modified.

Section 15: List Citation Table - Header was modified.

Section 15: National Chemical Inventory Listing was modified.

Section 06: Notification Procedures was modified.

Section 15: TSCA Class 2 Statement was deleted.

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Internal Use Only

MHC: 0, 0, 0, 0, 0, 0

PPEC: A

DGN: 2007812XUS (546747)

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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
Proprietary additives 64742-01-4 0-99.5
<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"/>

460 F (238 C) (Grade 220)
 490 F (254 C) (Grade 320)
 509 F (265 C) (Grade 460)

 Flash Point (typical): 450 F (232 C) (Grade 32)
 460 F (238 C) (Grade 46)
 470 F (243 C) (Grade 68)
 515 F (268 C) (Grade 100)
 530 F (277 C) (Grade 150)
 545 F (285 C) (Grade 220)
 580 F (304 C) (Grade 320)
 585 F (307 C) (Grade 460)

 Method: COC
 Autoignition: Not Available
 Flammable limits in Air, % by Volume
 LEL: Undetermined
 UEL: Undetermined

 Extinguishing Media
 Water Spray, Foam, Dry Chemical, CO2.

 Fire Fighting Instructions
 Water or foam may cause frothing. Use water to keep fire-exposed
 containers cool. Water may be used to flush spills away from
 exposures.

 Products of combustion may contain carbon monoxide, carbon dioxide,
 and other toxic materials. Do not enter enclosed or confined space
 without proper protective equipment including respiratory protection.

6. ACCIDENTAL RELEASE MEASURES

 Safeguards (Personnel)
 NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections
 before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE
 EQUIPMENT during clean-up.

 Remove source of heat, sparks, and flame.

 Initial Containment
 Dike spill. Prevent material from entering sewers, waterways, or
 low areas.

 Spill Clean Up
 Recover free liquid for reuse or reclamation. Soak up with sawdust,
 sand, oil dry or other absorbent material.

7. HANDLING AND STORAGE

 Handling (Personnel)
 Avoid breathing vapors or mist. Avoid contact with eyes. Avoid
 prolonged or repeated contact with skin. Wash thoroughly after
 handling. Wash contaminated clothing prior to reuse.

 Handling (Physical Aspects)
 Close container after each use. Do not pressurize, cut, weld, braze,
 solder, grind, or drill on or near full or empty container. Empty
 container retains residue (liquid and/or vapor) and may explode in

- 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
- ISO 32 32.5 5.4
- ISO 46 45 6.7
- ISO 68 68.2 8.77
- ISO 100 101.1 11.3
- ISO 150 149 14.6

<input type="checkbox"/>	ISO 320	318	23.9	<input type="checkbox"/>
<input type="checkbox"/>	ISO 460	464	30.6	<input type="checkbox"/>

<input type="checkbox"/>	10. STABILITY AND REACTIVITY			<input type="checkbox"/>

<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 produce carbon monoxide.			<input type="checkbox"/>
<input type="checkbox"/>	Polymerization			<input type="checkbox"/>
<input type="checkbox"/>	Polymerization will not occur.			<input type="checkbox"/>

<input type="checkbox"/>	11. TOXICOLOGICAL INFORMATION			<input type="checkbox"/>

<input type="checkbox"/>	Animal Data			<input type="checkbox"/>
<input type="checkbox"/>	Mouse skin painting studies have shown that highly refined petroleum lube base oils similar to ingredients in this product have not caused skin tumors. <input type="checkbox"/>			<input type="checkbox"/>

<input type="checkbox"/>	12. ECOLOGICAL INFORMATION			<input type="checkbox"/>

<input type="checkbox"/>	Ecotoxicological Information			<input type="checkbox"/>
<input type="checkbox"/>	No specific aquatic data available for this product.			<input type="checkbox"/>

<input type="checkbox"/>	13. DISPOSAL CONSIDERATIONS			<input type="checkbox"/>

<input type="checkbox"/>	Waste Disposal			<input type="checkbox"/>
<input type="checkbox"/>	Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system. <input type="checkbox"/>			<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 promptly shipped to the supplier or a drum reconditioner. All other containers should be disposed of in an environmentally safe manner. <input type="checkbox"/>			<input type="checkbox"/>

<input type="checkbox"/>	14. TRANSPORTATION INFORMATION			<input type="checkbox"/>

<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"/>

<input type="checkbox"/>	15. REGULATORY INFORMATION			<input type="checkbox"/>

<input type="checkbox"/>	U.S. Federal Regulations			<input type="checkbox"/>
<input type="checkbox"/>	OSHA HAZARD DETERMINATION <input type="checkbox"/>			<input type="checkbox"/>
<input type="checkbox"/>	This material is not known to be hazardous as defined by OSHA's Hazard Communication Standard, 29 CFR 1910.1200. <input type="checkbox"/>			<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		☐
☐☐				
☐☐				



SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT IDENTIFICATION: . . : GERALYN AW 68

MANUFACTURER IDENTIFICATION

Company Name : FUCHS LUBRICANTS CO.
 Address : 17050 LATHROP AVE.
 HARVEY IL 60426
 Telephone : 708-333-8900
 Emergency Contact : Regulatory Compliance Department
 Emergency Telephone . . . : 708-333-8900 (8am - 5pm CST, M-F)
 800-255-3924 (24 Hours)

MSDS PRINT DATE : 07/26/2007

* EMERGENCY OVERVIEW

This product is a liquid that is insoluble in water.
 Direct eye contact may cause minor, short term irritation. Short term skin exposure is not expected to be irritating. Inhalation and ingestion are not anticipated routes of exposure during normal conditions of use.

* HMIS Rating: Health- 1 Flammability- 1 Reactivity- 0 PPE- X

SECTION 2 - COMPONENT DATA

Components listed in this section may contribute to the potential hazards associated with exposure to the concentrate. The product may contain additional non-hazardous or trade-secret components.

Mineral Oil	Cas#: proprietary	Percent: > 90
Exposure Limit:		
ACGIH TLV:	5 mg/m3 (as mist)	
ACGIH STEL:	10 mg/m3 (as mist)	
OSHA PEL:	5 mg/m3 (as mist)	

- Carcinogenic Components: This product contains no carcinogens.

SECTION 3 - HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS and SYMPTOMS from SHORT TERM/ACUTE EXPOSURE:

- EYE EXPOSURE -
 This product is not expected to cause eye irritation under normal conditions of use. Symptoms of slight eye irritation may result when direct contact occurs, or when exposed to high mist levels in poorly ventilated areas.

- SKIN EXPOSURE -
 Short term skin contact is not expected to cause skin irritation. Prolonged or repeated direct exposure to the skin may result in



PRODUCT NAME: GERALYN AW 68

symptoms of irritation and redness. In severe cases, prolonged or repeated contact may result in dermatitis accompanied by symptoms of irritation, itching, dryness, cracking and/or inflammation.

- INHALATION -

This product has low volatility and so is not expected to cause respiratory tract irritation during normal conditions of use. Exposure to high mist levels in poorly ventilated areas may cause upper respiratory tract irritation and difficulty breathing.

- INGESTION -

Ingestion may cause slight stomach irritation and discomfort.

POTENTIAL CHRONIC HEALTH EFFECTS:

No further data known.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:

No further data known.

CARCINOGENICITY:

This product is not listed as a known or suspected carcinogen by IARC, OSHA, or the NTP.

SECTION 4 - FIRST AID MEASURES

EYE CONTACT:

Upon direct eye contact, hold eyelids open and flush with a steady, gentle stream of water for at least 15 minutes. If irritation is due to exposure to mist or vapors, remove the individual to fresh air. If irritation persists, flush the eyes with clean water until the irritation subsides. If symptoms persist, contact a physician.

SKIN CONTACT:

Remove product from the skin by washing with a mild soap and water. Contaminated clothing should be removed to prevent prolonged exposure. If symptoms of exposure persist, contact a physician.

INHALATION:

Inhalation is not an expected route of exposure. If respiratory irritation or distress occurs, remove the employee to fresh air. Contact a physician or other medical professional if irritation or distress persists.

INGESTION:

If small amounts are ingested, first aid measures are not likely to be necessary. If larger amounts are ingested or if symptoms of ingestion occur, dilute stomach contents with two glasses of water or milk. (NOTE: Do NOT give anything by mouth to an unconscious person.) Do not induce



PRODUCT NAME: GERALYN AW 68

vomiting without medical supervision. If vomiting occurs spontaneously keep airway clear. If symptoms of ingestion persist, seek medical attention.

NOTE TO PHYSICIAN:
No further data known.

SECTION 5 - FIRE FIGHTING MEASURES

FIRE AND EXPLOSIVE PROPERTIES:

Flashpoint	:	445.0	CF	COC
Flammability Limits	:	LEL		-N/A
		UEL		-N/A

EXTINGUISHING MEDIA:

In accordance with NFPA guidance, dry chemical, foam, or CO2 fire extinguishers are all acceptable. Note that while water fog extinguishers are also acceptable, do NOT apply a direct stream of water onto burning product because it may cause spreading and increase fire intensity.

UNUSUAL FIRE & EXPLOSION HAZARDS:

No further data known.

FIRE-FIGHTING PROCEDURES AND EQUIPMENT:

Emergency responders in the danger area should wear bunker gear and self-contained breathing apparatus for fires beyond the incipient stage. See Section 8 of the MSDS for other PPE to be worn as conditions warrant.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

CLEAN-UP MEASURES:

Important: As with any spill or leak, before responding ensure that you are familiar with the potential hazards and recommendations of the MSDS. Appropriate personal protective equipment must be worn. See Section 8 of this MSDS for PPE recommendations.

If possible, safely contain the spill with dikes or other spill response equipment appropriate for petroleum or organic material releases. Take measures to prevent spreading of product. Note that while product will ignite it will not readily burn. However, as a precaution eliminate ignition sources. Prevent from entering sewers or waterways. Large volumes may be transferred to an appropriate container for proper disposal. Small volumes or residues may be soaked up with absorbents. Spill response materials should be collected for proper disposal.

SECTION 7 - HANDLING AND STORAGE

HANDLING:



PRODUCT NAME: GERALYN AW 68

As with any industrial chemical, handle the product in a manner that minimizes exposure to practicable levels. Prior to handling, consult Section 8 of this MSDS to evaluate personal protective equipment needs. Open containers slowly to relieve any pressure. Follow all other standard industrial hygiene practices.

Empty containers may contain product residue. All safety precautions taken when handling this product should also be taken when handling empty drums and containers. Keep containers closed when not in use.

Product residue in empty containers is combustible but will not readily burn. NOTE however, that excessive heating or cutting of empty containers may create an ignition source sufficient to start a fire and in extreme cases, cause an explosion.

STORAGE:

Protect product quality by storing indoors and away from extreme temperatures. Close all containers when not in use.

SPECIAL COMMENTS:

No further data known.

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION

PERSONAL PROTECTIVE EQUIPMENT:

Selection of personal protective equipment should be based upon the anticipated exposure and made in accordance with OSHA's Personal Protective Equipment Standard found in 29 CFR 1910 Subpart I. The following information may be used to assist in PPE selection.

- EYE PROTECTION -

Wear eye protection appropriate to prevent eye exposure. Where splashing is not likely, chemical safety glasses with side shields are recommended. Where splashing may occur, chemical goggles or full face shield is recommended.

- SKIN PROTECTION -

Gloves are not normally needed during normal conditions of use. If health effects are experienced, oil or chemical resistant gloves such as butyl or nitrile are recommended.

Where splashing or soaking is likely, wear oil or chemical resistant clothing to prevent exposure.

- RESPIRATORY PROTECTION -

A respirator may be worn to reduce exposure to vapors, dust, or mist. Select a NIOSH/MSHA approved respirator appropriate for the type and physical character of the airborne material. A self-contained breathing



PRODUCT NAME: GERALYN AW 68

apparatus is recommended in all situations where airborne contaminant concentration has not been confirmed to be below safe levels. Respirator use should comply with the OSHA Respirator Protection Standard found in 29 CFR 1910.134.

ENGINEERING CONTROLS:

Normal general ventilation is expected to be adequate. It is recommended that ventilation be designed in all instances to maintain airborne concentrations at lowest practicable levels. Ventilation should at a minimum, prevent airborne concentrations from exceeding any exposure limits listed in Section 2 of this MSDS.

The user may wish to refer to 29 CFR 1910.1000(d)(2) and the ACGIH "Threshold Limit Values for Chemical Substances and Physical Agents Biological Exposure Indices" (Appendix C) for the determination of exposure limits of mixtures. An industrial hygienist or similar professional may be consulted to confirm that the calculated exposure limits apply.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Physical Appearance : Water white
Odor : Mild petroleum
Physical State : Liquid
Water Solubility : Insoluble
Specific Gravity : .868

SECTION 10 - STABILITY AND REACTIVITY

INCOMPATIBILITIES:

This product is incompatible with strong oxidizing agents.

DECOMPOSITION PRODUCTS MAY INCLUDE:

Thermal decomposition products are dependent on combustion conditions. A complex mixture of airborne solid, liquid, particulates and gasses may evolve when the material burns. Combustion byproducts may include:
oxides of carbon,
incompletely burned hydrocarbons as fumes and smoke.

CONDITIONS TO AVOID:

Avoid contact with incompatible materials and exposure to extreme temperatures.

POLYMERIZATION:

This product is not expected to polymerize.

STABILITY:



PRODUCT NAME: GERALYN AW 68

This product is stable.

SECTION 11 - TOXICOLOGICAL INFORMATION

EYE EFFECTS:

No further toxicological data known.

SKIN EFFECTS:

No further toxicological data known.

ORAL EFFECTS:

No further toxicological data known.

INHALATION EFFECTS:

No further toxicological data known.

OTHER:

No further data known.

SECTION 12 - ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION:

This product has not been evaluated for ecotoxicity. As with any industrial chemical, exposure to the environment should be prevented and minimized wherever possible.

ENVIRONMENTAL FATE:

The degree of biodegradability and persistence of this product has not been determined.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL:

Ensure that collection, transport, treatment, and disposal of waste product, containers and rinsate complies with all applicable laws and regulations. Note that use, mixture, processing, or contamination of the product may cause the material to be classified as a hazardous waste. It is the responsibility of the product user or owner to determine at the time of disposal, whether the product is regulated as a hazardous waste.

SECTION 14 - TRANSPORT INFORMATION

DOT HAZARDOUS MATERIAL INFORMATION:

* Not otherwise DOT regulated.

SECTION 15 - REGULATORY INFORMATION

FEDERAL REGULATIONS:



PRODUCT NAME: GERALYN AW 68

SARA 313:

This product contains NONE of the substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

Clean Water Act / Oil Pollution Act:

This product contains mineral oil and is subject to regulation by Section 311 of the Clean Water Act and the Oil Pollution Act. Releases of the product into or leading to surface waters must be reported to the National Response Center at 1-800-424-8802.

CERCLA Reportable Quantity:

Any components listed below have been assigned a reportable quantity (RQ) by the Federal EPA. Releases of the product into the environment that exceed the RQ for a particular component must be reported to the National Response Center at 1-800-424-8802.

Component	RQ
* - * - * - * - * - * - * - * - * - * - * - * - * - *	

Toxic Substances Control Act:

The components of this product are listed on the TSCA Inventory.

Ozone Depleting Substances:

This product contains no ozone depleting substances as defined by the Clean Air Act.

Hazardous Air Pollutants:

Any components listed below are defined by the Federal EPA as hazardous air pollutants.

Component	
* - * - * - * - * - * - * - * - * - * - * - * - * - *	

STATE REGULATIONS:

This product contains mineral oil, and as used, may be regulated by state used oil regulations. Check with the appropriate state agency to determine whether such a regulation exists.

No further data known.

SECTION 16 - OTHER INFORMATION

Prepared by : Corporate Regulatory Compliance
 Date of issue : 07/26/2007
 Last Revision Date : 11/01/2006
 C4302368

FUCHS LUBRICANTS CO.



PRODUCT NAME: GERALYN AW 68

NOTICE: This MSDS provides a good faith representation of information believed to be accurate as of the last revision date. This document does not create any express or implied product warranties. Since conditions of use are beyond the control of Fuchs Lubricants Co., all risks associated with product use are assumed by the user.



Revision Date: 04/12/2006

Issue date: 04/12/2006

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product name: 242® Threadlocker
Product type: Anaerobic Sealant
Company address:
Henkel Corporation
1001 Trout Brook Crossing
Rocky Hill, Connecticut 06067

Item No. : 24231
Region: United States
Contact Information:
Telephone: 860.571.5100
Emergency telephone: 860.571.5100
Internet: www.loctite.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

<u>Hazardous components</u>	<u>%</u>	<u>ACGIH TLV</u>	<u>OSHA PEL</u>	<u>OTHER</u>
Polyglycol dimethacrylate 25852-47-5	60-100	None	None	None
Polyglycol oleate 9004-96-0	10-30	None	None	None
Saccharin 81-07-2	1-5	None	None	None
Silica, amorphous, fumed, crystalline-free 112945-52-5	1-5	6 mg/m ³ TWA	10 mg/m ³ TWA	3 mg/m ³ TWA respirable dust
Cumene hydroperoxide 80-15-9	1-5	None	None	1 ppm (6 mg/m ³) Skin (WEEL), 1ppm, skin TWA, (WEEL)
Propylene glycol 57-55-6	1-5	None	None	10 mg/m ³ TWA, (WEEL)

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

HMIS:

Physical state: Liquid
Color: Blue
Odor: Mild

HEALTH: 2*
FLAMMABILITY: 1
PHYSICAL HAZARD: 1
Personal Protection: See Section 8

WARNING: CAUSES EYE IRRITATION.
MAY CAUSE SKIN IRRITATION.
MAY CAUSE ALLERGIC SKIN REACTION.
MAY CAUSE RESPIRATORY TRACT IRRITATION.

Relevant routes of exposure: Skin, Inhalation, Eyes

Potential Health Effects

Inhalation: May cause respiratory tract irritation.
Skin contact: May cause allergic skin reaction. May cause skin irritation.
Eye contact: Contact with eyes will cause irritation.
Ingestion: Not expected to be harmful by ingestion.

Item No. : 24231

Product name: 242® Threadlocker

Existing conditions aggravated by exposure:

Eye, skin, and respiratory disorders.

See Section 11 for additional toxicological information.

4. FIRST AID MEASURES

Inhalation: Remove to fresh air. If symptoms develop and persist, get medical attention.

Skin contact: Wash with soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Get medical attention if symptoms occur.

Eye contact: Flush with copious amounts of water, preferably, lukewarm water for at least 15 minutes, holding eyelids open all the time. Get medical attention.

Ingestion: Do not induce vomiting. Keep individual calm. Obtain medical attention.

5. FIRE-FIGHTING MEASURES

Flash point: Greater than 93°C (200°F) Tagliabue closed cup

Autoignition temperature: Not available

Flammable/Explosive limits-lower %: 2.6 % (propylene glycol)

Flammable/Explosive limits-upper %: 12.5 % (propylene glycol)

Extinguishing media: Foam, dry chemical or carbon dioxide.

Special fire fighting procedures: None

Unusual fire or explosion hazards: None

Hazardous combustion products: Oxides of carbon. Oxides of sulfur. Oxides of nitrogen. Irritating organic vapors.

6. ACCIDENTAL RELEASE MEASURES

Environmental precautions: Prevent product from entering drains or open waters.

Clean-up methods: Soak up with inert absorbent. Store in a partly filled, closed container until disposal.

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes, skin and clothing. Avoid breathing vapor and mist. Wash thoroughly after handling.

Storage: For safe storage, store at or below 38°C (100°F). Keep in a cool, well ventilated area away from heat, sparks and open flame. Keep container tightly closed until ready for use.

Incompatible products: Refer to Section 10.

For information on product shelf life contact Henkel Customer Service at (800) 243-4874.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering controls: No specific ventilation requirements noted, but forced ventilation may still be required if concentrations exceed occupational exposure limits.

Item No. : 24231

Product name: 242® Threadlocker

Respiratory protection: Use NIOSH approved respirator if there is potential to exceed exposure limit(s).

Skin protection: Use impermeable gloves and protective clothing as necessary to prevent skin contact. Neoprene gloves. Butyl rubber gloves. Natural rubber gloves.

Eye/face protection: Safety goggles or safety glasses with side shields.

See Section 2 for exposure limits.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid
Color: Blue
Odor: Mild
Vapor pressure: Less than 5 mm Hg at 27°C (80°F)
pH: Not applicable
Boiling point/range: Greater than 149°C (300°F)
Melting point/range: Not available
Specific gravity: 1.1 at 23.9°C (75°F)
Vapor density: Not available
Evaporation rate: Not available
Solubility in water: Slight
Partition coefficient (n-octanol/water): Not available
VOC content: 4.48%; 49.3 grams/liter (EPA Method 24)

10. STABILITY AND REACTIVITY

Stability: Stable.

Hazardous polymerization: Will not occur.

Hazardous decomposition products: Oxides of carbon. Oxides of sulfur. Oxides of nitrogen. Irritating organic vapors.

Incompatibility: Strong oxidizers. Free radical initiators. Strong reducing agents. Alkalis. Oxygen scavengers. Other polymerization initiators. Copper. Iron. Zinc. Aluminum. Rust.

Conditions to avoid: See "Handling and Storage" (Section 7) and "Incompatibility" (Section 10).

11. TOXICOLOGICAL INFORMATION

Product toxicity data: Acute oral LD50 greater than 10,000 mg/kg (rat). Acute dermal LD50 greater than 5000 mg/kg (rabbit).

Carcinogen Status

Hazardous components	NTP Carcinogen	IARC Carcinogen	OSHA Carcinogen
Polyglycol dimethacrylate 25852-47-5	No	No	No
Polyglycol oleate 9004-96-0	No	No	No
Saccharin 81-07-2	No	No	No
Silica, amorphous, fumed, crystalline-free 112945-52-5	No	No	No
Cumene hydroperoxide 80-15-9	No	No	No
Propylene glycol 57-55-6	No	No	No

Literature Referenced Target Organ & Other Health Effects

Item No. : 24231

3 of 5

Product name: 242® Threadlocker

Hazardous components	Health Effects/Target Organs
Polyglycol dimethacrylate 25852-47-5	Allergen, Irritant
Polyglycol oleate 9004-96-0	Irritant
Saccharin 81-07-2	No Target Organs
Silica, amorphous, fumed, crystalline-free 112945-52-5	Nuisance dust
Cumene hydroperoxide 80-15-9	Allergen, Central nervous system, Corrosive, Irritant, Mutagen
Propylene glycol 57-55-6	Irritant

12. ECOLOGICAL INFORMATION

Ecological information: Not available

13. DISPOSAL CONSIDERATIONS

Information provided is for unused product only.

Recommended method of disposal: Dispose of according to Federal, State and local governmental regulations.

EPA hazardous waste number: Not a RCRA hazardous waste.

14. TRANSPORT INFORMATION

U.S. Department of Transportation Ground (49 CFR):

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None

International Air Transportation (ICAO/IATA):

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None

WaterTransportation (IMO/IMDG):

Proper shipping name: Unrestricted
Hazard class or division: None
Identification number: None
Packing group: None
Marine pollutant: None

15. REGULATORY INFORMATION

United States Regulatory Information

TSCA 8 (b) Inventory Status:	All components are listed or are exempt from listing on the Toxic Substances Control Act Inventory.
TSCA 12 (b) Export Notification:	4-Methoxyphenol (150-76-5).
CERCLA/SARA Section 302 EHS:	None above reporting de minimus.
CERCLA/SARA Section 311/312:	Immediate Health Hazard, Delayed Health Hazard
CERCLA/SARA 313:	This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40 CFR 372). Cumene hydroperoxide (CAS# 80-15-9) .
California Proposition 65:	This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.

Canada Regulatory Information

CEPA DSL/NDSL Status:	All components are listed on or are exempt from listing on the Domestic Substances List.
WHMIS hazard class:	D.2.B

16. OTHER INFORMATION

This material safety data sheet contains changes from the previous version in sections: 15

Prepared by: Kyra Kozak Woods, Product Safety and Regulatory Affairs Specialist

DISCLAIMER: The data contained herein are furnished for information only and are believed to be reliable. However, Henkel Corporation does not assume responsibility for any results obtained by persons over whose methods Henkel Corporation has no control. It is the user's responsibility to determine the suitability of Henkel's products or any production methods mentioned herein for a particular purpose, and to adopt such precautions as may be advisable for the protection of property and persons against any hazards that may be involved in the handling and use of any of Henkel Corporation's products. In light of the foregoing, Henkel Corporation specifically disclaims all warranties, express or implied, including warranties of merchantability and fitness for a particular purpose, arising from sale or use of Henkel Corporation's products. Henkel Corporation further disclaims any liability for consequential or incidental damages of any kind, including lost profits.

Revision Date: 04/01/2004

Issue date: 04/01/2004

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product name: Loctite(R) 7649 Primer N
Product type: Accelerator
Company address:
Henkel Corporation
1001 Trout Brook Crossing
Rocky Hill, Connecticut 06067

Item number: 19269
Region: United States
Contact Information:
Telephone: 860.571.5100
Emergency telephone: 860.571.5100
Internet: www.loctite.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

<u>Hazardous components</u>	<u>%</u>	<u>ACGIH TLV</u>	<u>OSHA PEL</u>	<u>OTHER</u>
Acetone 67-64-1	60-100	500 ppm TWA 750 ppm STEL	1000 ppm TWA 2400 mg/m ³ TWA	None
2-Ethylhexanoic acid 149-57-5	0.1-1	5 mg/m ³ TWA	None	None

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

HMIS:

Physical state: Liquid
Color: Green
Odor: Acetone

HEALTH: 2*
FLAMMABILITY: 3
PHYSICAL HAZARD: 0
Personal Protection: See Section 8

DANGER: FLAMMABLE LIQUID AND VAPOR.
CAUSES EYE AND SKIN IRRITATION.
MAY CAUSE RESPIRATORY TRACT IRRITATION.

Relevant routes of exposure: Inhalation, Skin contact, Eye contact, Ingestion

Potential Health Effects

Inhalation: Harmful if inhaled. Vapors and mists will irritate nose and throat and possibly eyes. May cause respiratory tract irritation. Headache, dizziness, nausea, and loss of coordination are indications of excessive exposure to vapors or spray mists.

Skin contact: May cause skin irritation. Solvent action can dry and defat the skin, causing the skin to crack, leading to dermatitis.

Eye contact: Vapors may irritate eyes. Contact with eyes will cause irritation.

Ingestion: Harmful if swallowed.

Existing conditions aggravated by exposure: Eye, skin, and respiratory disorders.

See Section 11 for additional toxicological information.

4. FIRST AID MEASURES

Inhalation:	Remove to fresh air. If discomfort persists seek medical attention.
Skin contact:	Wash with soap and water.
Eye contact:	Flush with copious amounts of water, preferably, lukewarm water for at least 15 minutes, holding eyelids open all the time.
Ingestion:	If conscious, drink plenty of water. Do not induce vomiting. Keep individual calm. Obtain medical attention.

5. FIRE-FIGHTING MEASURES

Flash point:	-20°C (-4°F) (estimated)
Autoignition temperature:	465°C (869°F)
Flammable/Explosive limits-lower %:	2.6 %
Flammable/Explosive limits-upper %:	13 %
Extinguishing media:	Foam, dry chemical or carbon dioxide.
Special fire fighting procedures:	None
Unusual fire or explosion hazards:	Vapors may accumulate in low or confined areas, travel considerable distance to source of ignition, and flash back.
Hazardous combustion products:	Oxides of carbon. Oxides of nitrogen. Irritating organic vapors.

6. ACCIDENTAL RELEASE MEASURES

Environmental precautions:	Prevent product from entering drains or open waters.
Clean-up methods:	Remove all ignition sources. Ensure adequate ventilation. Soak up with inert absorbent. Store in a closed container until ready for disposal.

7. HANDLING AND STORAGE

Handling:	Avoid contact with eyes, skin and clothing. Avoid breathing vapor and mist. Wash thoroughly after handling. During use and until all vapors are gone: Keep area ventilated - do not smoke; extinguish all flames, pilot lights, and heaters; turn off stoves, electrical tools and appliances, and any other sources of ignition.
Storage:	Store away from heat, sparks, flames, or other sources of ignition. For safe storage, store at or below 49°C (120°F).
Incompatible products:	Refer to Section 10.

For information on product shelf life contact Henkel Customer Service at (800) 243-4874.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering controls:	Use local ventilation if general ventilation is insufficient to maintain vapor concentration below established exposure limits.
Respiratory protection:	Use NIOSH approved respirator if there is potential to exceed exposure limit(s).

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Skin protection: Chemical resistant, impermeable gloves.
Eye/face protection: Safety goggles or safety glasses with side shields.

See Section 2 for exposure limits.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid
Color: Green
Odor: Acetone
Vapor pressure: 172 mmHg at 20 °C (68 °F)
pH: Not applicable
Boiling point/range: 56°C (133°F)
Melting point/range: Not available
Specific gravity: 0.7936
Vapor density: 2.0
Evaporation rate: 1.9 (Ether = 1)
Solubility in water: Completely miscible
Partition coefficient (n-octanol/water): Not available
VOC content: 1.48%; 11.7 grams/liter (EPA Method 24)

10. STABILITY AND REACTIVITY

Stability: Stable.
Hazardous polymerization: Will not occur.
Hazardous decomposition products: Oxides of carbon. Oxides of nitrogen. Irritating organic vapors.
Incompatibility: Strong oxidizers.
Conditions to avoid: See "Handling and Storage" (Section 7) and "Incompatibility" (Section 10).

11. TOXICOLOGICAL INFORMATION

Carcinogen Status

Hazardous components	NTP Carcinogen	IARC Carcinogen	OSHA Carcinogen
Acetone	No	No	No
2-Ethylhexanoic acid	No	No	No

Literature Referenced Target Organ & Other Health Effects

Hazardous components	Health Effects/Target Organs
Acetone	Blood, Central nervous system, Irritant, Reproductive
2-Ethylhexanoic acid	Developmental, Eyes, Irritant, Liver, Reproductive

12. ECOLOGICAL INFORMATION

Ecological information: Not available

13. DISPOSAL CONSIDERATIONS

Information provided is for unused product only.

Recommended method of disposal: Dispose of according to Federal, State and local governmental regulations.

EPA hazardous waste number: D001: Ignitable.

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14. TRANSPORT INFORMATION

U.S. Department of Transportation Ground (49 CFR):

Proper shipping name: Acetone
Hazard class or division: 3
Identification number: UN 1090
Packing group: II
Exceptions: Consumer Commodity ORM-D (Not more than 1 Liter)

International Air Transportation (ICAO/IATA):

Proper shipping name: Acetone
Hazard class or division: 3
Identification number: UN 1090
Packing group: II
Exceptions: Consumer Commodity ID8000 (Not more than 500 ml)

WaterTransportation (IMO/IMDG):

Proper shipping name: Acetone
Hazard class or division: 3
Identification number: UN 1090
Packing group: II
Exceptions: Dangerous goods in limited quantities of class 3 (Not more than 1 liter(s))
Marine pollutant: None

15. REGULATORY INFORMATION

United States Regulatory Information

TSCA 8 (b) Inventory Status: All components are listed or are exempt from listing on the Toxic Substances Control Act Inventory.
TSCA 12 (b) Export Notification: Acetone (CAS# 67-64-1).

CERCLA/SARA Section 302 EHS: None.
CERCLA/SARA Section 311/312: Immediate Health Hazard, Delayed Health Hazard, Fire
CERCLA/SARA 313: None above reporting de minimus.

California Proposition 65: This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm. Nickel (CAS# 7440-02-0). Cobalt (CAS# 7440-48-4). Formaldehyde (CAS# 50-00-0). Acetaldehyde (CAS# 75-07-0). Benzene (CAS# 71-43-2).

Canada Regulatory Information

CEPA DSL/NDSL Status: All components are listed on or are exempt from listing on the Domestic Substances List.
WHMIS hazard class: B.2, D.2.A, D.2.B

16. OTHER INFORMATION

This material safety data sheet contains changes from the previous version in sections: Expanded chemical information in Section 2 and related sections.

Prepared by: Kyra Kozak Woods, Health and Regulatory Affairs Specialist

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