



STREAMLINE HIGH PRESSURE WATERJET PUMP



OPERATION and SERVICE MANUAL

**SL-IV 100S
480 and 400V**

Manual No. 05142831

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1 SL-IV Waterjet Pump General Information

The Streamline SL-IV Waterjet Pump, maintains the level of component reliability and ease of installation and maintenance that have made the Streamline waterjet pumps the standard of the industry for both water and Hydroabrasive™ applications.

The SL-IV Waterjet Pump uses low pressure water, which meets certain quality requirements, and increases the pressure up to 4,136 bar (60,000 psi) for ultra-high-pressure waterjet cutting, hydroabrasive cutting, cleaning, surface preparation, etc.

This manual provides information for installation, operation, and maintenance of the SL-IV Waterjet Pump.

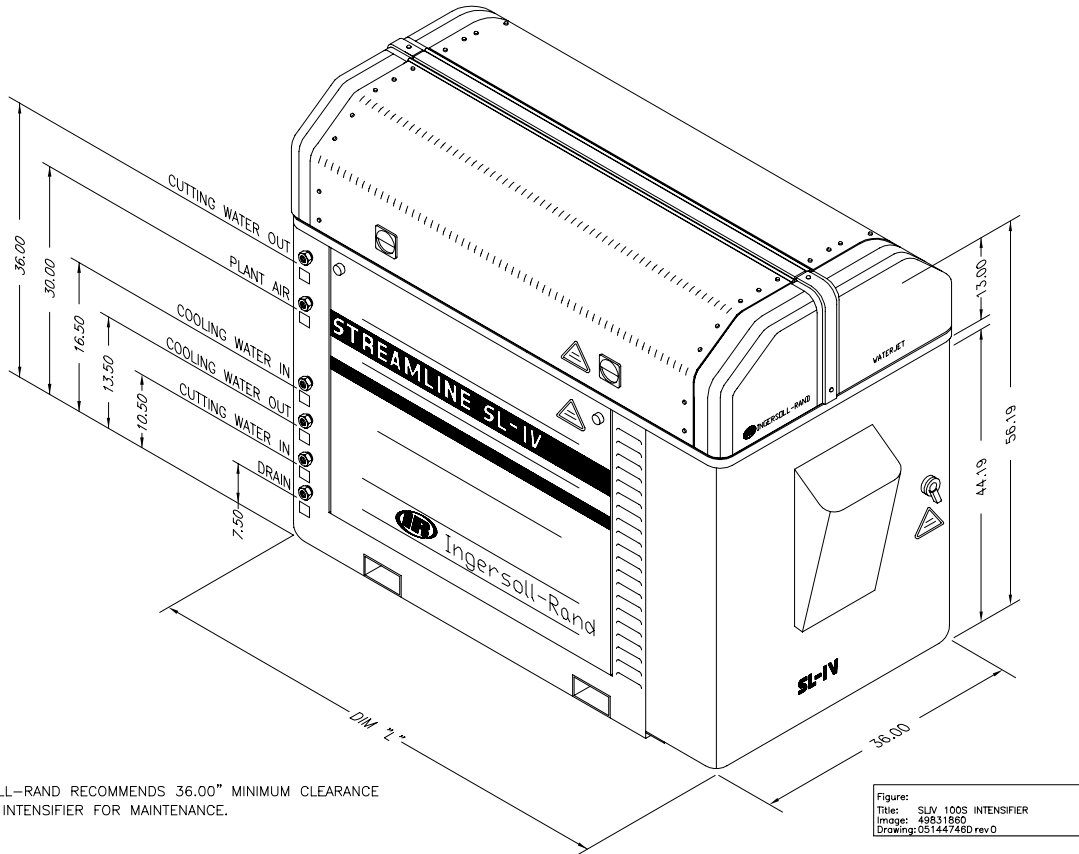
Basic configurations of SL-IV intensifier pumps discussed in this manual are listed in Table 1-1 below.

TABLE 1-1. Model Data- SL-IV Waterjet Intensifier Pumps							
Motor Horsepower Rating		Intensifier Model	HP Water Max Oper Pressure (psi)	Plunger Quantity and Diameter (inches)		Frame Dim "L" (inches)	Redundant Option Available?
Hp	Kw			7/8 (0.875") [22 mm]	1-1/8 (1.125") [29 mm]		
30	22	SL-IV 30+	60,000	2	-	67.75	Yes
50	37	SL-IV 50+		2	-	67.75	Yes
60	45	SL-IV 60+		2	-	77.75	Yes
75	56	SL-IV 75+		-	2	77.75	Yes
100	75	SL-IV 100D		4	-	77.75	No
100	75	SL-IV 100S		-	2	77.75	Yes

1.1 Physical Description

The waterjet pump is equipped with one or two hydraulically operated intensifiers, one or two liters of high pressure attenuator volume, a motor/hydraulic pump assembly, an electric starter panel, control sensors, solenoids and logic, control interface panel, a low pressure water booster pump, and a low pressure water filter.

The high pressure system is conveniently mounted on a drip pan. All service components are easily accessible from at least two sides simplifying maintenance. The entire high pressure system can be removed from the rest of the unit quickly for maintenance and serviceability.



1. INGERSOLL-RAND RECOMMENDS 36.00" MINIMUM CLEARANCE AROUND INTENSIFIER FOR MAINTENANCE.

Figure: SLIV 100S INTENSIFIER
Title: 49831880
Image: 49831880
Drawing: 051447480 rev 0

1.1.1 Standard Equipment

Following is an overview of the standard equipment for the SL-IV Waterjet Pump:

- Variable displacement, pressure compensated hydraulic pump
- Water pressure booster and filtration system with 10-micron double-length filter
- High efficiency heat exchanger in independent recirculation pump circuit
- Stand-alone unit with built-in motor starter (wye delta or across the line).
- High pressure safety dump valve
- Dual pressure compensator
- 1 or 2 liters of high pressure attenuator volume
- Microprocessor control with diagnostic capability
- Water inlet shut-off valve
- Booster pump
- Integral water and oil drip pans
- Electrical remote control interface

1.2 Functional Description

The SL-IV Waterjet Pump meets the automotive and industrial markets needs of low to high volume production of water jet pumps. The maximum HP water pressure is limited by a hydraulic relief valve that is factory certified and sealed. No HP rupture disk is required.

HP water is produced by an intensifier consisting of two HP water cylinders mounted to a hydraulic cylinder. Ceramic plungers (2 per intensifier) attach to the hydraulic piston and extend into each HP cylinder. With two intensifiers mounted on one SL-IV frame, both may operate simultaneously (dual) or one may serve as stand-by for the other (redundant). Piston travel is sensed electronically by proximity switches which control hydraulic flow to/from the double-acting hydraulic piston/cylinder.

Refer to Table 1-2 for HP water performance limits for various power levels of SL-IV waterjet pumps.

TABLE 1-2 HP WATER PERFORMANCE- SL-IV WATERJET INTENSIFIER PUMPS				
Horsepower	55,000 psi		60,000 psi	
	Orifice Size (inches)	Flow Rate (gpm)	Orifice Size (inches)	Flow Rate (gpm)
30	0.011	0.60	0.010	0.52
50	0.014	0.98	0.013	0.88
60	0.015	1.12	0.014	1.02
75	0.017	1.44	0.016	1.33
100	0.020	2.00	0.019	1.88

The recirculation hydraulic loop for cooling and filtering oil runs continuously whenever the motor is running.

1.2.1 Functional Features

Following is a list of SL-IV Waterjet Pump features:

- 4,136 bar (60,000 psi) operating pressure
- Electronic reversing
- 24 vdc safety control
- Standard high pressure water leak detection
- Standard dual pressure control facilitates hole piercing and kiss cut applications
- Exclusive long slow stroke
- Cartridge type hydraulic seal
- Low pressure water booster pump and filtration
- Reduced cooling water requirements
- Choice of English, German, Spanish, Swedish and Italian readouts as standard
- Meets CE requirements

1.3 Worldwide Product Support

The KMT Waterjet Systems Service Department serves the customer, by providing:

- Supervision of equipment installation, start up, and training for the number of days specified in the quotation, and per approved project. Additional time requested will be invoiced on a per diem basis, plus travel and normal living expenses.
- Field Services: on-site technical support is available on request. These services are invoiced on a per diem basis, plus travel, and normal living expenses.
- Technical Assistance: the Service Department is available for technical assistance by phone.
- Training: the Service Department conducts periodic training sessions at KMT Waterjet designated training locations. On-site training is also available.

1.3.1 Service Department

To contact the KMT Waterjet Service Department:

USA: Customer Service Manager

KMT Waterjet Systems

P.O. Box 231

635 West 12th Street

Baxter Springs, KS 66713

USA

Phone: (620) 856-2151

Fax: (620) 856-5050

Email: wj_service@kmtwaterjet.com

Europe: Technical Manager

KMT Waterjet Systems GmbH

Wasserstrahl-Schneidetechnik

Auf der Laukert 11

D-61231 Bad Nauheim

Germany

Phone: 49-(0)6032-997-117

Fax: 49-(0)6032-997-270

Email: order.service@kmt-waterjet.com

1.3.2 Spare Parts

KMT Waterjet maintains a well stocked Spare Parts Department staffed by well trained knowledgeable personnel. Emergency shipment is available.

Contact the Customer Service Department of KMT Waterjet.

1.3.3 Questionnaire

The following equipment and service manual questionnaire will provide information to allow us to serve you better. Please complete them at your convenience and return to the applicable Customer Service Department as shown above.

EQUIPMENT AND SERVICE MANUAL QUESTIONNAIRE

We have just installed a new SL-IV Waterjet Pump at your location. We are interested in your initial impressions of the unit and its installation. Please take a few moments and answer the following questions.

1. General Appearance
Was unit received in good condition? Yes No
Comments: _____

2. Is the unit a convenient size? Yes No

3. Controls
 - a. Are the controls user friendly? Yes No
 - b. Is the unit easy to operate? Yes No
Comments: _____

4. Performance
 - a. Does the unit perform smoothly and meet your expectations? Yes No
Does the unit run quietly? Yes No
Comments: _____

5. Did installation and start-up go smoothly? Yes No
Comments: _____

6. What feature(s) do you consider the most significant with this unit?
Quiet Operation _____
Appearance _____
Performance (Operation) _____
Repair/Maintenance _____
Other _____

7. What areas need improvement?
Appearance _____
Servicability _____
Performance _____
Other _____

Manual Organization

1. Does the table of contents help you find topics easily? Yes No

Comments: _____

2. Is the information well organized? Yes No

Comments: _____

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

Comments: _____

Graphics

1. How do you rate the quality and quantity of the photos/illustrations? Yes No

Comments: _____

Text

1. Does the information in the manual adequately explain how to operate and service the equipment? Yes No

Comments: _____

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

Comments: _____

3. Is there anything you would add or delete from the manual to make it more useful? Yes No

Comments: _____

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

Comments: _____

Name: _____ Title: _____

Company _____










Address: _____

1.4 Safety

Safety procedures and safe practices must be followed during installation, operation, and maintenance of the waterjet pump. In this section we have provided label and sign descriptions used in this manual, as well as recommended safety procedures.

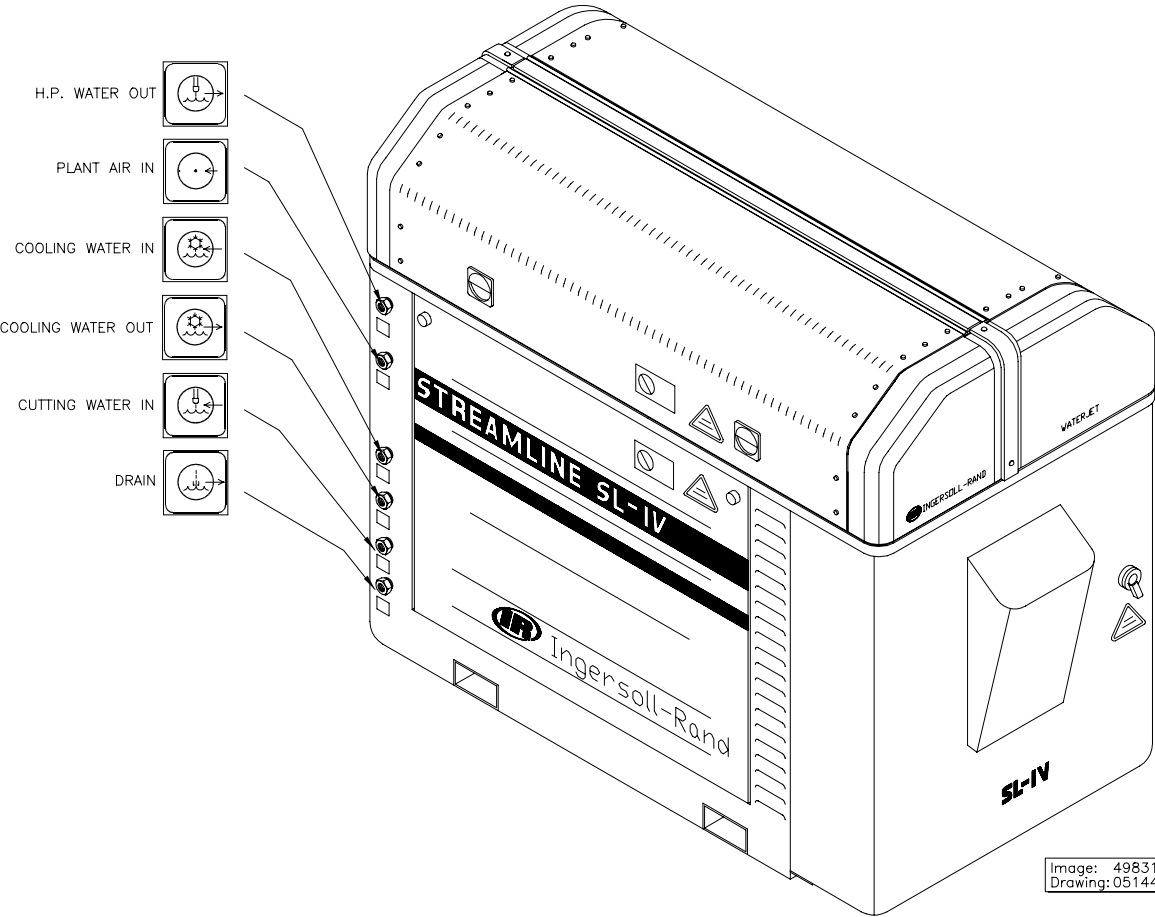
1.4.1 Labels and Abbreviations

The following describes hazard classifications of the waterjet pump.

	<p>Indicates the presence of a hazard, which can cause personal injury, or property damage if the caution instruction is ignored.</p>
	<p>Indicates the presence of a hazard, which can cause severe personal injury, death, or substantial property damage if the warning instruction is ignored.</p>
 <p>(ISO 3021)</p>	<p>High pressure waterjet can cause eye injury. Wear eye protection when operating or working near machine.</p>
	<p>Hazardous noise can cause hearing loss. Wear ear protection when operating or working near machine.</p>
 <p>(ISO 6010)</p>	<p>Hazardous voltage within can cause injury or death. Disconnect and lockout main power before opening cabinet.</p>
	<p>Start/Control Power On</p>
	<p>Stop</p>
 <p>(ISO 1024)</p>	<p>Hot Surface inside. Do not touch.</p>
 <p>(ISO 6060)</p>	<p>Do not operate with guard removed. Replace Guard before operating machine.</p>

Rear of Waterjet Pump

- HP Water "OUT"
- Plant Air "IN"
- Cooling Water "IN"
- Cooling Water "OUT"
- Cutting Water "IN"
- Drain



1.4.2 Safety Procedures

Safety procedures must be observed while working on the pump, or any high pressure part of the installation. **Service should only be performed by qualified personnel.**

- The high pressure water, 4,136 bar (60,000 psi) in waterjet cutting systems should not be a cause for concern. Users must have due respect for these pressures and use proper SAFETY PROCEDURES and SAFE WORK HABITS.
- Everyone associated with the waterjet cutting system must realize that the force of the waterjet cutting stream can penetrate many dense or strong materials.
- Keep all untrained people away from the waterjet cutting area. Use barriers or partitions if needed.
- Safety glasses must be worn at all times in the waterjet cutting area.
- All **EMERGENCY STOP** buttons must be checked periodically. The normal operating position is pulled out.
- To check: turn on power and activate the **EMERGENCY STOP** buttons by pushing them in to see if the power goes off. Each device should be checked on a specified schedule. Each time the device is checked, it must function or be replaced before operating the system.
- Apply High Purity Goop (P/N 10084440) to all threaded high pressure connections. All tubing, fittings and bolted connections should be torqued to recommended values. Do NOT attempt to tighten or loosen a HP water fitting when the circuit is pressurized, see High Pressure (HP) Piping Safety.
- All high pressure leaks must be repaired immediately.
- Inspect all equipment on a scheduled basis.
- Before performing any maintenance on the unit, **MECHANICALLY LOCK THE MAIN CONTROL POWER OFF**, and assure the high pressure has been bled off.
- If steam or fog is noticed inside the clear top cover, this indicates a high pressure leak. Turn off intensifier and bleed pressure before lifting the cover.
- Pressing the emergency stop button turns off the control power to the intensifier, stops the intensifier pump, and bleeds high pressure water through the dump valve. Depressurization of the high pressure system can be heard when the dump valve opens as a loud hissing that fades quickly as the pressure drops.



Never do any work on the unit without making sure the electrical panel disconnect is locked out with a padlock in the OFF position.



Never work on any high pressure component, or loosen any high pressure fittings without first bleeding the system and assuring there is no high pressure water present.



Make sure the safety devices are operational. To panic stop the pump and bleed the high pressure, the EMERGENCY STOP buttons must be pushed in. The system pressure dump valves must be open.



Do not attempt to touch or be exposed to high pressure water. The high pressure water will penetrate all parts of human body without exception.



The liquid stream or material ejected by these extreme pressures can injure or kill.



Do not operate the intensifier with any of the covers opened or removed.

1.4.3 High Pressure (HP) Piping Safety

High pressure piping must be installed without torsional or bending stresses. Proper supports and guides must be provided. 9/16" outside diameter HP tubing and fittings are recommended between the pump and the cutting station. This large tubing size will reduce vibration, strain and motion between the pump piping and the cutting area. The larger piping diameter also reduces pressure drop, and pressure pulsation.



Do not try to repair a leak in a HP water fitting when it is pressurized. Always shut off the power and bleed the HP water before doing maintenance on HP components. Weep holes are provided to release HP water if leakage occurs at a sealing surface. If a fitting is loosened with HP water present, a jet of HP water will exit the nearest weep hole with **possible hazardous results**.



Use extreme caution when handling high pressure equipment. Possible failure from fatigue cracking or over-pressurization can result in a hazardous high pressure leak, or component failure.



A flexible 1/4" HP tube (whip) is frequently used on the cutting system to allow cutting nozzle movement. Supports and guides for the whip must be used, anti-vibration fittings and proper support must be provided to prevent failures from external loads (non-water related stresses).



When tightening or loosening HP connections, always use a supporting wrench to avoid bending forces or stress on the connection. Do not exceed recommended torque values



High pressure piping and fittings designed to 4,100 bar (60,000 psi) must always be used. Failure to do so may lead to catastrophic component failure, which can cause equipment damage, injury or even death.

1.4.4 Emergency Medical Treatment

An information card to aid treating a waterjet injury is included in the binder of each manual. The card is shown below. Contact the address shown for additional cards.

(Front Side)

<p style="text-align: center;">Medical Alert</p> <p style="text-align: center;">This card is to be carried by personnel working with high pressure waterjet equipment. Obtain medical treatment immediately for ANY high pressure waterjet injuries.</p> <p style="text-align: center;"><u>KMT Waterjet Systems</u> P.O. box 231, 635 West. 12th Street Baxter Springs, KS 66713 (620) 856-2151</p>

(Back Side)

<p style="text-align: center;">This person has been working with water jetting at pressures to 55,000 psi (374MPa, 3740 bar, 3867 Kg/cm²) with a jet velocity of 3,000 fps (914 mps). Foreign material (sand) may have been injected with water. Unusual infections with microaerophilic organisms occurring at lower temperatures have been reported, such as gram negative pathogens as are found in sewage. Bacterial swabs and blood cultures may therefore be helpful. This injury must be treated as an acute surgical emergency and be evaluated by a qualified surgeon. Circulation may be compromised, therefore, DO NOT APPLY HEAT TO INJURED PART. For first aid: (1) Elevate injured part (2) Antibiotics (3) Keep injured person NPO.</p>
--

2 Installation

The installation, start-up, operation, and maintenance of the SL-IV Waterjet Pump requires complete reading and study of this manual to understand the system in detail.

2.1 Installation Overview

- Read the manual and become familiar with the operation of each component and its nomenclature.
- Understand the complete system and its function before operating it.
- Safety procedures and safe practices must be followed during installation, operation, and maintenance of the SL-IV Waterjet Pump.

2.1.1 Buyer Obligations

Equipment installation requires cooperation between the user and KMT Waterjet. If on-site support is requested, the KMT Waterjet Service Department will require the following tasks be accomplished before arrival at the customer site.

- The waterjet cutting equipment should be uncrated, positioned and leveled, with electrical and fluid services brought to the unit.
- Provide and install power drops with fused disconnects sized to the equipment power requirements.
- Provide and install pneumatic drops with manual shutoff valves.
- Provide all mounting and support brackets and hardware for high pressure tubing runs.
- Provide and install water conditioning equipment necessary to meet water purity requirements. Provide and install manual shutoff valves.
- Provide and install necessary cooling water inlet/outlet, and drain water connections to the intensifier pump, and/or cutting equipment and manual shut-off valves.
- Provide suitably located and sized drains and proper disposal of waste water.
- Provide, install and connect wiring between the intensifier pumps, and the cutting station control system.
- KMT Waterjet supplies a pre-filled hydraulic system. If fluid is low or empty due to leakage during transit, the system must be filled per specifications.

2.1.2 Seller Obligations

If KMT Waterjet Service is requested, the following tasks will be the responsibility of the KMT Waterjet technician at installation.

- Insure site preparation is satisfactory.
- Remove internal strapping and blocking material.
- Insure that power is connected prior to equipment turn on.
- Insure that connections have been made for water and pneumatic service.
- Test motor rotation direction and correct if necessary.
- Check and test electrical signal connections between intensifier pump and cutting area.
- Power up and check out pump (and cutting station, if supplied by KMT Waterjet for proper operation.
- Set boost pump discharge pressure.
- Install and test high pressure plumbing.
- Follow the standard test procedure to insure satisfactory performance.
- Train maintenance personnel in the performance of maintenance and repair procedures.
- Sign off the installation and testing on KMT Waterjet's standard acceptance document.

2.2 Installation Requirements (Utilities)

Environment: The SL-IV Waterjet Pump must be installed indoors. Ambient conditions must not exceed maximum specifications.

Moving: The SL-IV Waterjet Pump has provisions to be moved with a forklift. Check weight specifications.



The waterjet pump is top heavy. Avoid situations that could result in the equipment overturning



Electrical connections must be made by qualified personnel, and must meet national and local electrical codes.

2.2.1 Equipment Location/Environment

Space Requirements: There should be a minimum of 900mm (36 inches) clearance on all sides of the pump to facilitate service.

Electrical Wiring: Power supplied to the pump must be in accordance with national and local electrical codes. See specifications or requirements.

Control Wiring: Wiring for remote control of the pump must be in accordance with national and local electrical codes. The SL-IV Waterjet Pump has a 24vdc electrical control system and has provisions for remote operation in the pump control panel.

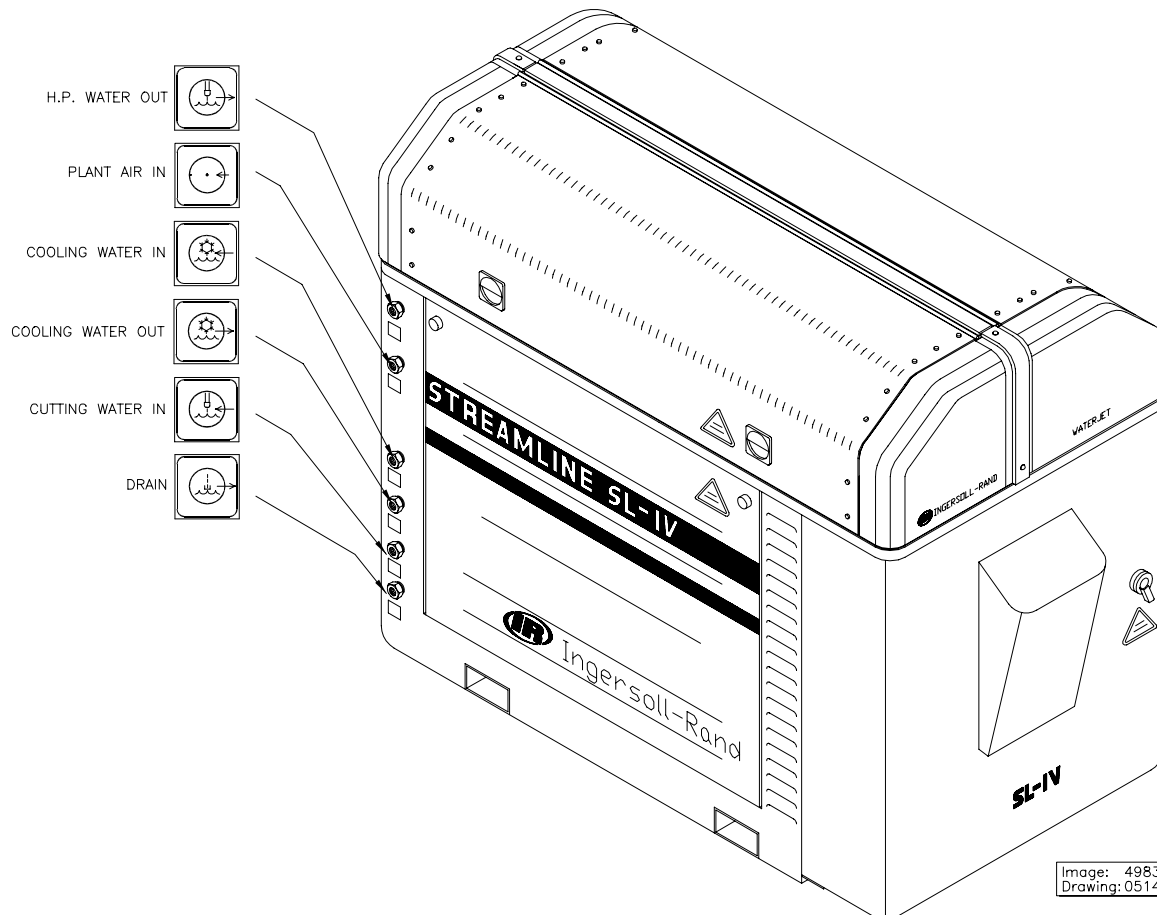
2.2.2 Service Connections

Cooling Water IN/OUT: Supply piping must be properly sized to handle the necessary flow, and pressure. Piping must meet national and local piping codes.

Cutting Water IN: Supply piping must be properly sized to handle the necessary flow and pressure. Piping must meet national and local piping codes.

HP Water OUT: Properly rated, sized, and well supported high pressure (HP) piping must be connected to the pump.

Drain: Cutting water released in the pump is discharged from the drain port and must be piped to an appropriate location (i.e. sewer line). Piping must meet national and local piping codes.



2.2.3 Tools and Equipment

Determine Tube Length - Measure, the distance (L), between the fittings, then add two times the tube engagement length in the following table. Cut tubing to length and deburr.



High-pressure piping and fittings rated for 4,138 bar (60,000 psi) must be used. Failure to do so may cause component failure causing equipment damage, personal injury, or death.

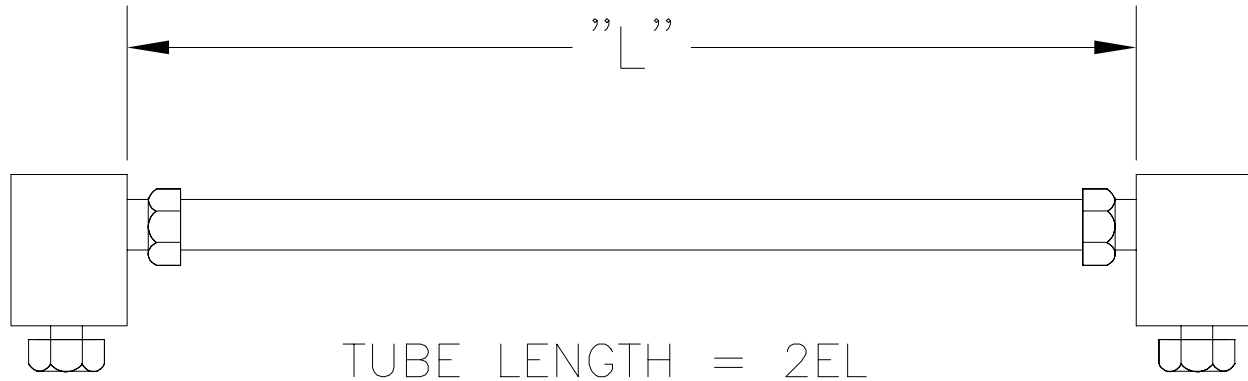


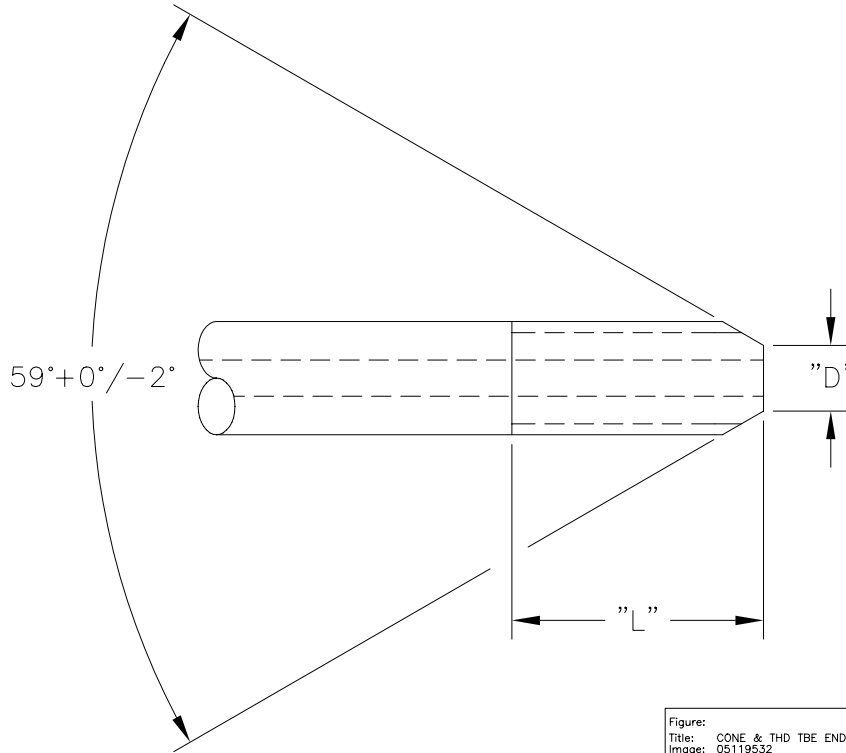
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Drawing: HP TUBING rev --

Tube Engagement Length and Gland Nut Torque

HP Tube Diameter (inch)	Engagement Length (EL) mm (inch)	Gland Nut Torque N-m (ft-lb)
1/4"	12.7 (0.50)	34 (25)
3/8"	17.5 (0.69)	68 (50)
9/16"	21.3 (0.84)	102 (75)

Cone and Thread Tube

Cone and thread both ends of the tube per following diagram and procedure.

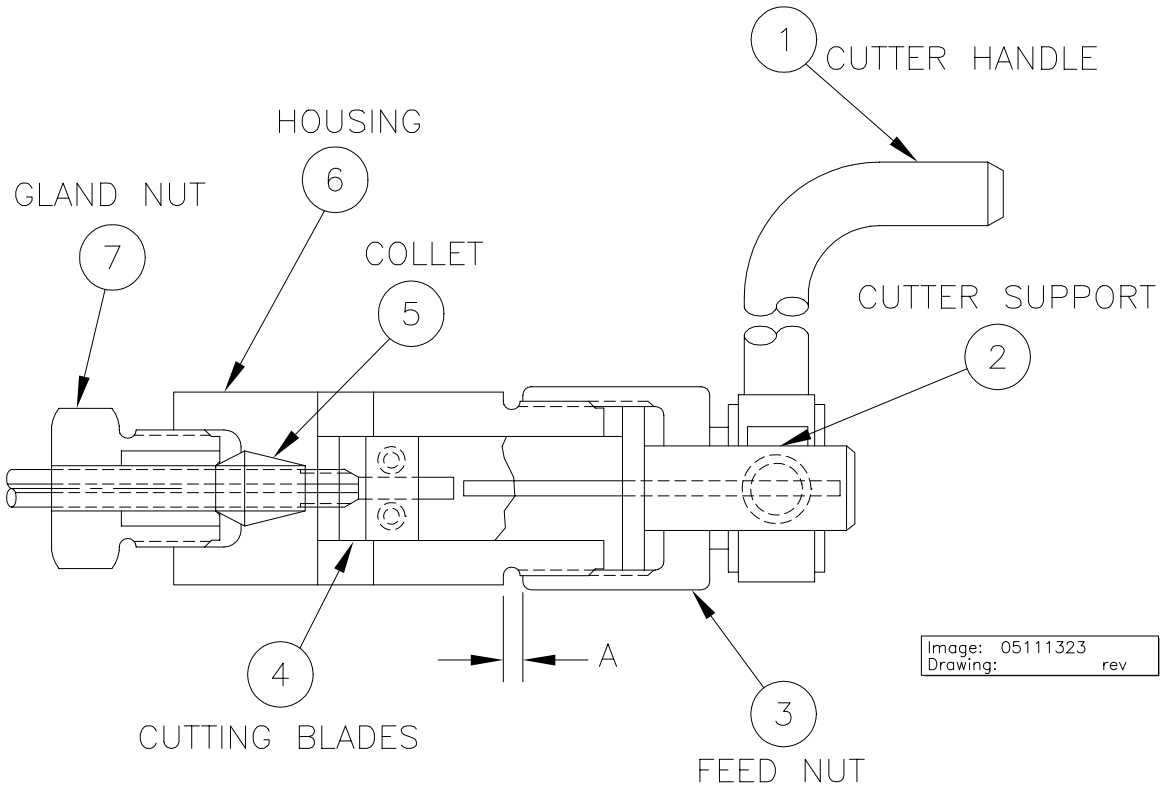


Cone and Thread Dimensions

O.D. Size mm (inch)	I.D. size mm (inch)	D (max) mm (inch)	L (max) mm (inch)	Thread NF-LH
6.35 (1/4")	2.11 (0.083)	3.58 (0.141)	14.3 (0.562)	(1/4"- 28)
9.52 (3/8")	3.18 (0.125)	5.56 (0.219)	19.1 (0.750)	(3/8"- 24)
14.27 (9/16")	4.78 (0.188)	7.14 (0.281)	23.8 (0.938)	(9/16"- 18)

To cone the tubing, use the following figure as reference.

Cone and Threading Tool



Item Description

- | | | |
|--------------------|--------------------|---------------|
| (1) Cutter Handle | (2) Cutter Support | (3) Feed Nut |
| (4) Cutting Blades | (5) Collet | (6) Housing |
| | | (7) Gland Nut |

Tube Size (inch)	1/4"	3/8"	9/16"
A mm (inch)	3.30 (0.13)	4.07 (0.16)	7.11 (0.28)
Coning Tool (KMT Part)	10079556	10097418	10079663
Threading Tool (KMT Part)	10079697	10097434	10097442

Coning

- Place appropriate size coning tool in vise so that lubricant can flow to cutting blades (4).
- Set feed nut (3) location as shown in dimension A.
- Slide tubing through collet (5) until end contacts cutting blades (4) and tighten gland nut (7) just enough to slightly grip tubing.
- Turn feed nut (3) counterclockwise to back cutters away from tubing, and tighten gland nut (7) with wrench.
- Apply cutting oil through coning tool opening. A medium weight cutting oil having high sulfur content is recommended. Use cutting oil freely throughout the cutting operation.
- Turn feed nut (3) clockwise until cutting blades (4) contact end of tubing.
- Rotate cutter handle (1) in clockwise direction while simultaneously turning the feed nut (3) in a clockwise direction at a rate to assure that the cutting blades (4) are taking a light cut at all times.
- Continue rotating cutter handle until feed nut bottoms on housing (6), then rotate cutter handle several more revolutions to face-off end of cone.
- Unscrew feed nut (3), and remove the blade spindle (2) from the coning tool. Loosen the collet, slide the tubing (8) into the housing (6) until it extends approximately 100mm (4 inches) then retighten collet.

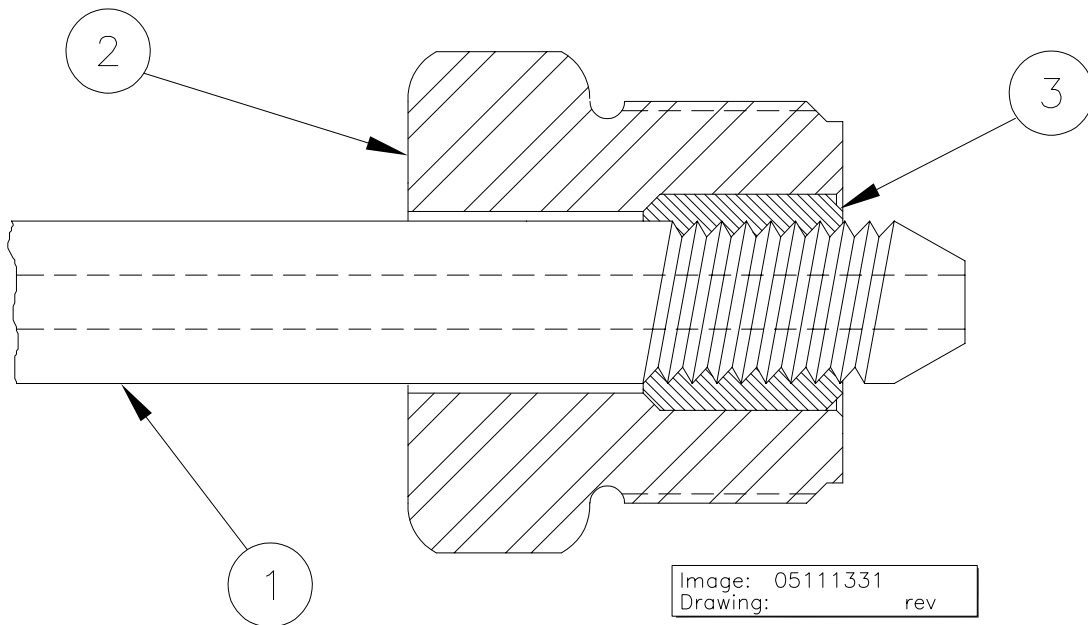
Threading

Place appropriate size threading tool on coned end of tubing, apply pressure to start cutting action and rotate die holder counterclockwise until threads are cut per cone and thread dimension table.

HP Tube End Connection - Regular

The following type of connection is for general applications, where the only load on tubing is due to internal pressure.

1. Slip gland nut (2) on tubing (1) as shown and lubricate thread with High Purity Goop. Thread collar (3) on tubing until one to two threads are exposed between collar item (3) and tube cone.
2. Lubricate male threads of gland with High Purity Goop. Insert tubing in fitting, engage gland nut and tighten finger-tight.
3. Tighten gland to specified torque as given in the torque table specifications.



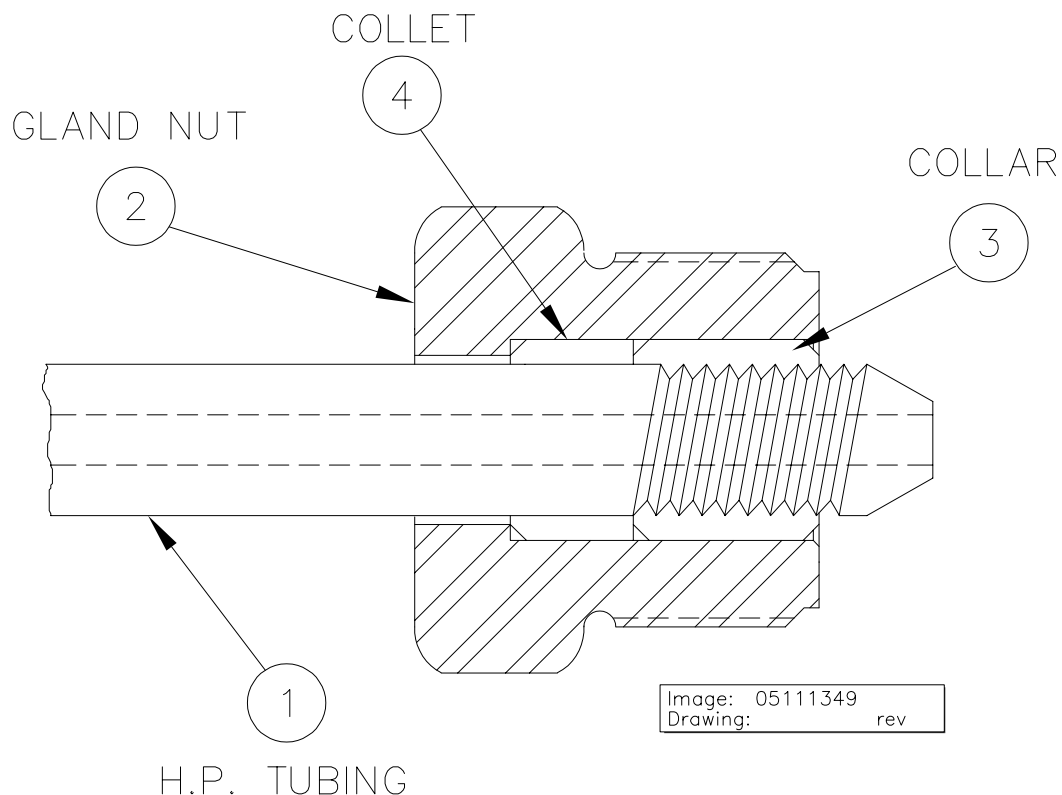
HP Tube End Connection – Anti-vibration

The following type of connection must be used when tubing is subjected to vibration, rotation, movement, and side loads (i.e. whip tubing). Lubricate threads as above.

**WARNING**

Do not depend on end connection to take load alone. Proper piping support and guide must be provided.

1. Slip gland nut (2) and collet (4) on tubing (1), thread collar (3) until one to two threads are exposed between collar and tube cone.
2. Lubricate male threads of gland nut with High Purity Goop. Insert tubing in fitting, engage gland nut and finger tighten.
3. Tighten gland nut to the specified torque according to the table of Recommended Torque Values in this section.



Section 3 OPERATION**3 SL-IV PUMP OPERATION-**

Note: all operational control functions for this KMT Waterjet SL-IV pump are provided by the motion / cutting table / box OEM. For a description of the KMT Waterjet model SL-IV pump sensors and solenoids, see Section 8: 'Electrical Systems'.

This section is devoted to an explanation of the SL-IV+ control logic and operators interaction with it. The SL-IV+ has comprehensive fault detection and troubleshooting logic in the control, and allows operator control of the sensitivity of the overstroke detection in order to optimize the logic for specific operating conditions. The operator functions and warnings programmed in the control of this intensifier offers an unprecedented and comprehensive view of the operating parameters, impending faults, shutdown faults, and suggested remedies. The operator's interface is through a touch sensitive control display on the control console where several menu screens can be selected for various purposes. The screens and their use are explained in this section. The pages following will explain the functions available in the control and how to select and use them.

Following is an explanation of the functions of the control logic, including the start-up sequence.

- The intensifier is equipped with a booster pump output pressure switch. Seven seconds after the intensifier is started, the switch is monitored. If the switch opens, a warning is issued (message and flashing red light). If the condition persists for 30 consecutive seconds, the intensifier is shut down.
- The intensifier is equipped with an inlet cutting water pressure switch. If the switch is not closed, the intensifier will not start and a warning is issued (message and red flashing light). After the intensifier is started, if the switch opens, the same warning is issued. If the condition persists for 20 consecutive seconds, the intensifier is shut down.
- The intensifier is equipped with separate total hour and maintenance hour meters for intensifier one and intensifier two. The operator can reset both maintenance meters. Both total meters can be set to any value via a password protected configuration screen. Without access to this screen, the hour meters can not be reset or changed.
- The Intensifier is equipped with a maintenance function to allow the user to set the plunger in either the left or right position for ease of maintenance.

- Overstroke (**no longer called Leak**) shutdown level is adjustable between 30% and 120% of full capacity. The overstroke warning level is automatically set 10% below the shutdown level set by the operator. Overstroke warnings, pending shutdowns and shutdowns are issued in three types, left, right and intensifier. An intensifier warning or shutdown indicates that the intensifier is shifting too fast in both directions and would point more towards a problem with the orifice or plumbing rather than check valves or seals. If a left or right shutdown occurs, the display tells the operator which parts are suspect. Sometimes, especially if the intensifier is running near full capacity an intensifier shutdown can be displayed when it is actually caused by a left or right fault. This can be diagnosed further by turning the operating pressure down and watching the **Alarms** screen, which displays all alarm occurrences.
 - Real-time running capacity and stroke rate are shown on the display.
 - A resettable stroke counter for both intensifier one and intensifier two are provided on the display.
 - The part numbers for both the PLC and display logic along with the software revision number running on the machine are shown on the Maintenance Screen.
 - The PLC monitors the motor overload relay and displays a message when the overloads trip. The overloads will now be set on automatic reset rather than manual so the enclosure does not have to be opened to reset them.
 - The display will give a message (**motor feedback failure**) if the start relay does not close at start-up or opens due to fault.
 - The start-up sequence will depend on the circumstances.
- (1) **Standard machine-start up after machine has been E-stopped:** Safety dump valve will be open. It will close 3 seconds after the intensifier begins stroking. The pump will be held in low pressure for 20 seconds after motor is started after which pressure will go to high if high is selected, otherwise will stay in low.

The purpose for this is to allow entrapped air to be bled from any HP cylinder that has been maintained to avoid hot air burning the plunger seals.

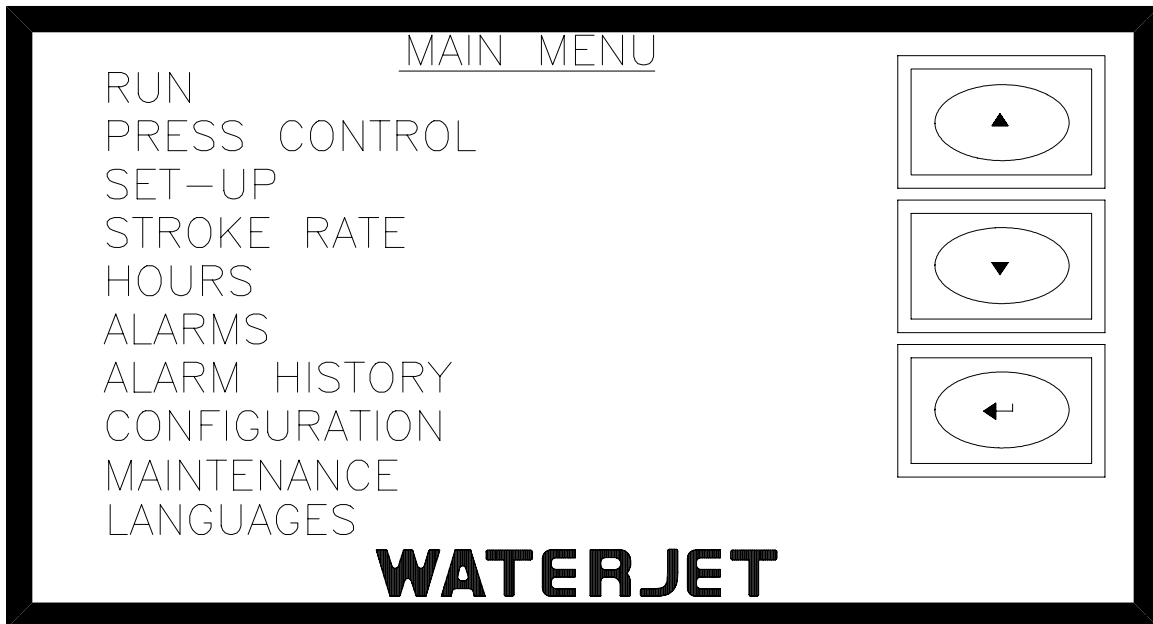
- (2) **Standard machine-start up after normal stop:** Safety dump valve will be closed, pump will be held in low pressure for 20 seconds after motor is started, after which the pressure will go to high if high is selected, otherwise will stay in low. The purpose for this is to allow entrapped air to be bled from any HP cylinder that has been maintained to avoid hot air burning the plunger seals.

(3) Machine equipped with HP transducer-start up after E-stop:
same as (1) above.

(4) Machine equipped with HP transducer-start up after normal stop: If pressure is allowed to bleed through orifice to below 1,000 psi, dump valve will open and start up will be like (1) above, if pressure is not allowed to bleed, start up will be as (2) above.

- The display screen will always default to the **Run** screen after being on any other screen more than 5 minutes.
- If the intensifier is equipped with a HP transducer, the displayed pressure can be shown in psi or Bar. Recalibration of the transducer is automatic and does not require operator input.
- If the intensifier is equipped with an hp transducer, another level of overstroke protection is obtained by shutting down at the warning level if the pressure is less than 3,000 psi.
- The display saves the last 100 alarm shutdown messages, which can be viewed with times, dates and message contents.

MAIN MENU Scroll up and down to page through the various screens and press **ENTER** to select desired screen



Run Screens -(4) Start, stop, recirc, recirc time, select high or low pressure, select intensifier if redundant. Run Screens appear according to options.

Pressure Control Screens - (2) Increment or decrement pressure setting. Display machine pressure. These screens will appear only on machines equipped with analog pressure control.

Set-up Screens -(2) Water reset function, idle shutdown time. Transducer and Proportional Pressure Select, Redundant select. Screen configures display for a particular machine. Analog Also contains PSI/BAR select button .

Stroke Rate Screens (2) - Set and observe machine stroke rate, stroke count.

Hours Screen- (2)Displays total operating hours and re-settable maintenance hours.

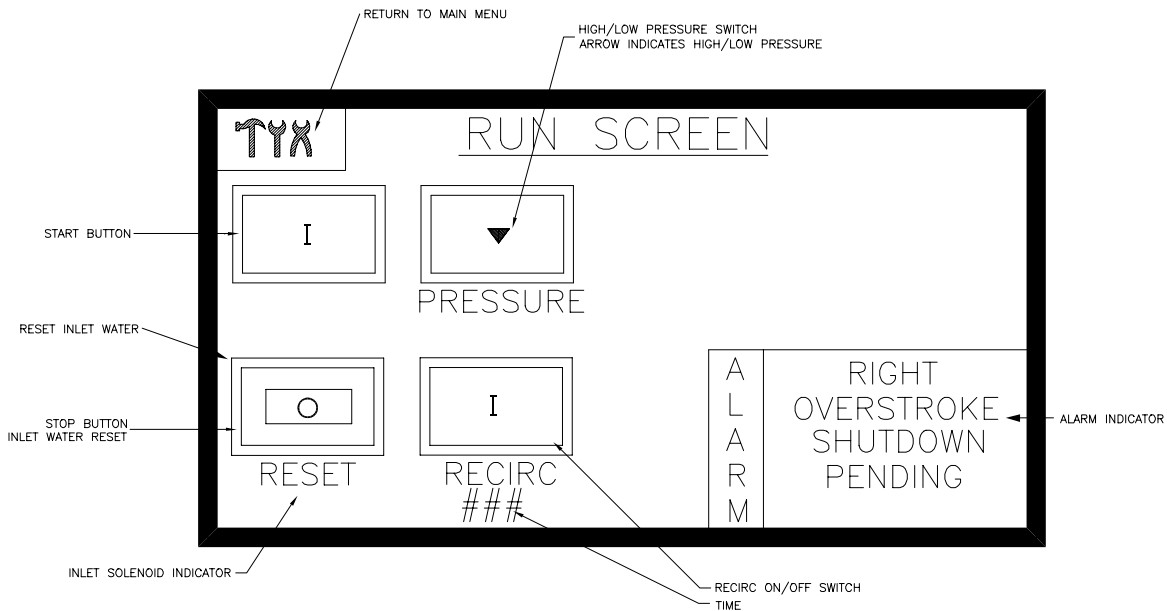
Alarm Screen - Displays all alarm conditions.

Alarm History Screen - Displays time and date of shutdown alarms and keeps history up to 100 past alarms.

Configuration Screen - Secure screen used by manufacturer to change certain display settings.

Maintenance Screen - Stop, start recirc, jog left, jog right for maintenance.

Language Screen - Select five languages



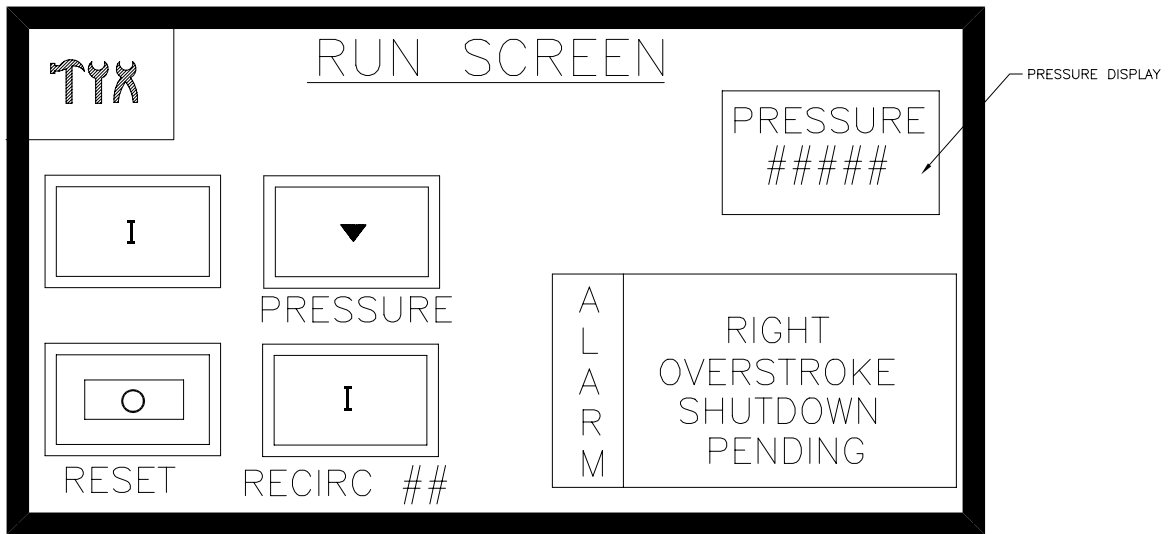
RUN SCREEN

THIS IS THE ONLY SCREEN WITH A MACHINE START FUNCTION

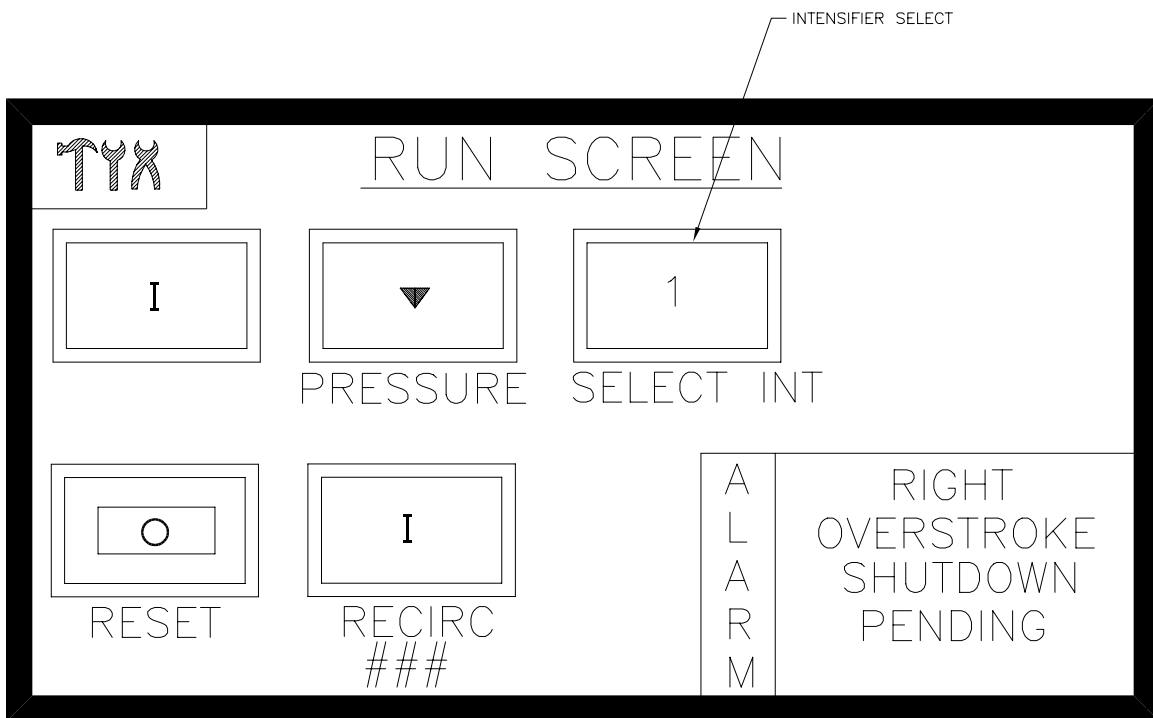
- I** **START** On all screens this indicates **start** or **on**.
- O** **STOP** On all screens this indicates stop or off.
- Pressure** When equipped with pressure transducer (Run Screen 2).
- ALARM** In alarm state, the **last** alarm sensed by machine will be displayed. Multiple alarms can be displayed on the alarm screen.
Select intensifier 1 or 2 if equipped.
On power-up display will default to this screen.
After 5 minutes on any screen, display will return to Run Screen.
- Recirc** Select this to toggle the recirculation mode on or off. The recirc mode runs the machine without generating high pressure, and is used to circulate the hydraulic oil through the heat exchanger to cool the oil following a high temperature shutdown.
 - (I)** Indicates recirc on
 - (O)** Indicates recirc is off.
- Stop** Stop Recirc with this button.
- High-Low Pressure Switch** Select high or low water pressure. (Machine always starts in low pressure.) Arrow indicates selected pressure following machine startup delay expiration.
- RESET** Indicates inlet water function must be reset. Reset by pressing **STOP** button.

Run Screen ALARMS

1. **High Oil temperature** – Indicates high hydraulic oil temperature-150° F.
2. **High Pressure Warning** – Indicates that output pressure is above 64,000 psi or 4,413 BAR.
3. **Booster Temperature High** – Indicates booster pump water temperature is high and machine shutdown is pending-128° F.
4. **Low Booster Pressure** – Indicates that booster pump output pressure is inadequate for proper machine operation and shutdown is pending, less than 60psi.
5. **Low Inlet Water Pressure** – indicates that cutting supply water pressure is inadequate to permit proper machine operation and shutdown is pending, less than 30psi.
6. **Bleed High Pressure Lines** – Indicates that the intensifier is shut down and that high pressure is present in the discharge plumbing of the intensifier that should be bled off to avoid the possibility of injury.
7. **Left/Right/Intensifier Overstroke Warning and Shutdown Pending** – Indicates an abnormally high stroke rate caused by an external or internal leak. If the condition persists, the machine will be shut down with an Overstroke Shutdown alarm.
8. **Reset Inlet Water** - Indicates inlet water must be reset. RESET will flash and can be reset by pressing stop button

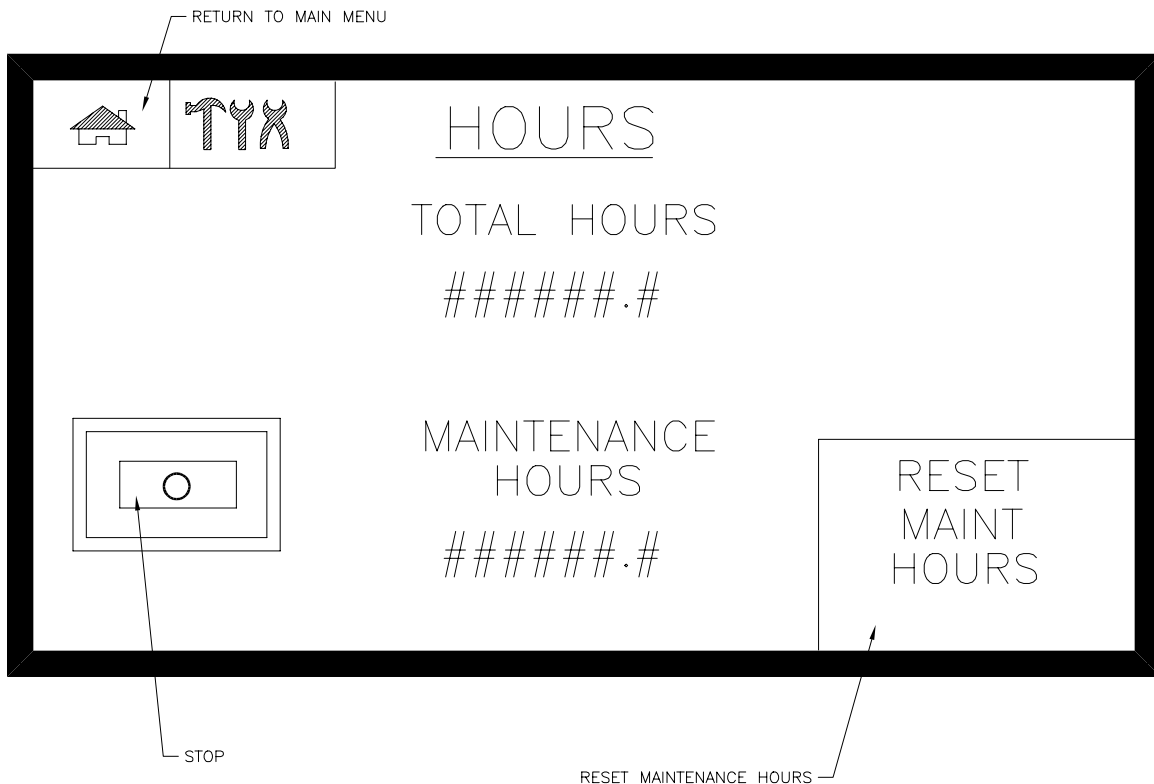


RUN SCREEN 2



RUN SCREEN 3 (REDUNDANT)

This screen will be displayed if **REDUNDANT** button on the **SETUP** screen is **ON**. **SELECT INT** button is used to select intensifier one or two



HOURS

Machine can be Stopped from this screen.

HOURS This screen displays total machine hours and resettable maintenance hours to 9,999,999 for intensifiers 1 and 2.

TOTAL HOURS cannot be reset.

MAINTENANCE HOURS on intensifiers 1 and 2 can be reset by pressing the RESET MAINT HOURS display button.



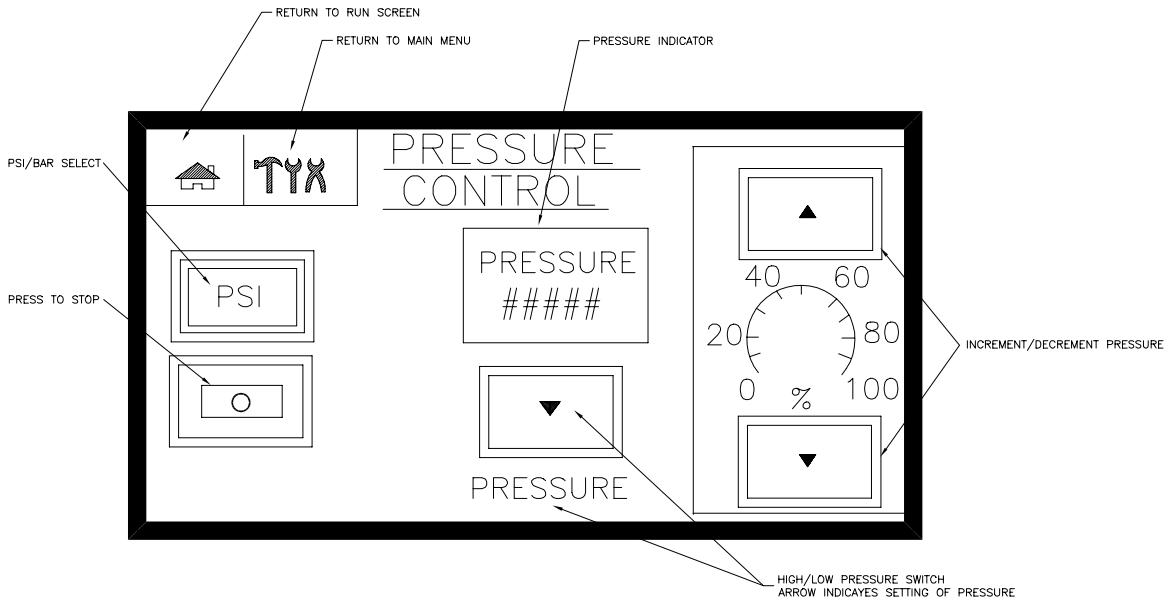
(EXAMPLE)

ALARM HISTORY SCREEN

The alarm list stores the last 100 triggered alarms indicating date, time and type of alarm.

Scroll up and down to see alarm history.

The Alarm History Screen does not have an intensifier **STOP** function.



PRESSURE CONTROL SCREEN

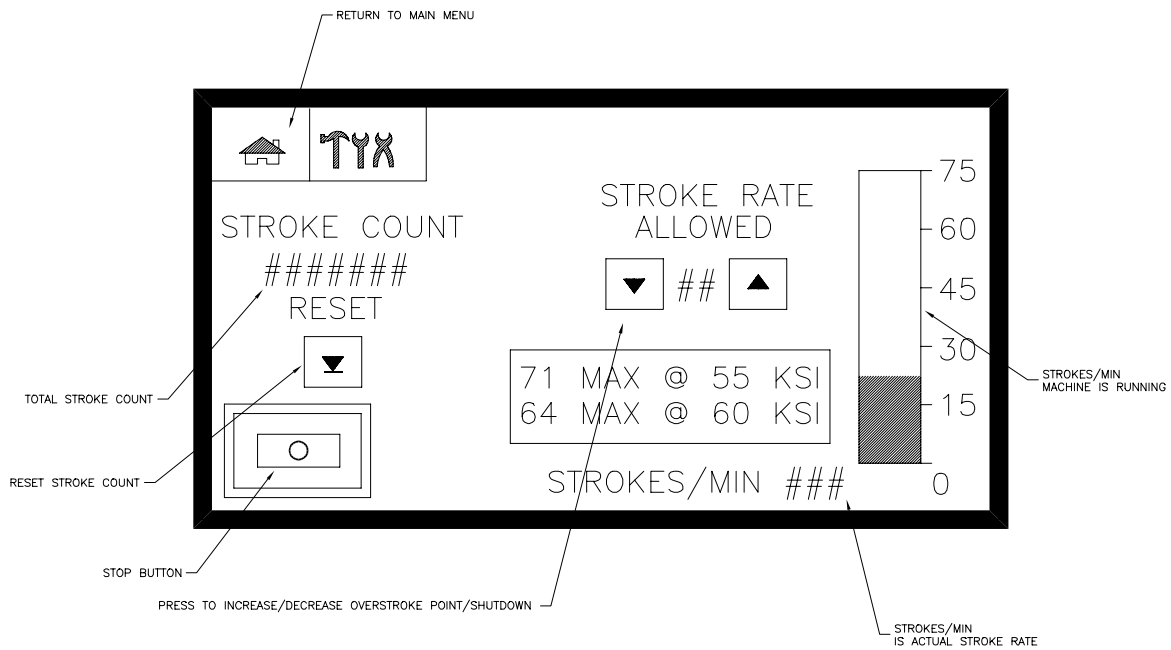
SET PRESSURE Set pressure to desired setting from 0 to 100 % in 1 % increments. UP arrow to increase pressure, DOWN arrow to decrease pressure.

PRESSURE CONTROL SCREENS will not appear if analog module (pressure transducer and/or proportional valve) is not installed on the machine. If pressure control on main menu is selected and a proportional valve is not installed, a screen will appear indicating **“THIS UNIT IS NOT EQUIPPED WITH PROPORTIONAL CONTROL”**.

The **PRESSURE CONTROL SCREEN** that is required can be selected on the **SET-UP SCREEN** for the appropriate pressure control, used if a proportional valve, a pressure transducer, or both are used on machine. These are the **TRANSDUCER SELECT** and **PROPORTIONAL SELECT** buttons on the **SET-UP SCREEN**.

HIGH/LOW pressure switch and **UP/DOWN** arrow indicating high or low pressure also on this screen. The same function is on the **RUN** screen.

Machine **PRESSURE** is also indicated on this screen in either PSI or BAR. Can be changed on **PSI/BAR SELECT** button. This function is only found on machines with a transducer installed.



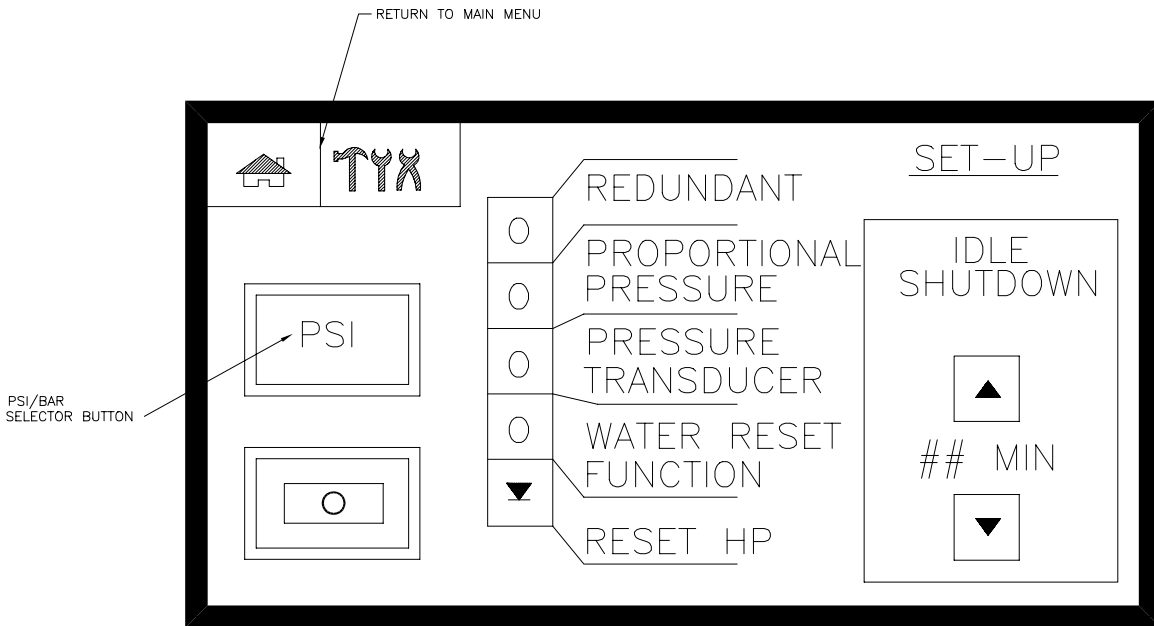
STROKE RATE SCREEN

Set STROKE RATE 2 to 4 strokes above normal running rate to shutdown machine in case of overstroke condition.

RESET Press to reset intensifier stroke count.

STROKES/MIN is actual stroke rate.

The **bar graph** illustrates strokes/minute.



SET-UP SCREEN (2)

This screen will be displayed if analog control present. Select if Proportional Pressure, Pressure Transducer, or both are in unit. **PSI/BAR** selector button changes pressure display on **RUN** screen and **PRESSURE CONTROL** screen

There are two **SET-UP SCREENS** – If analog pressure control is not installed on the machine, a screen will appear that does not include the **TRANSDUCER** and **PROPORTIONAL SELECT** buttons. These buttons are used only if a pressure transducer and/or a proportional valve are installed on the machine

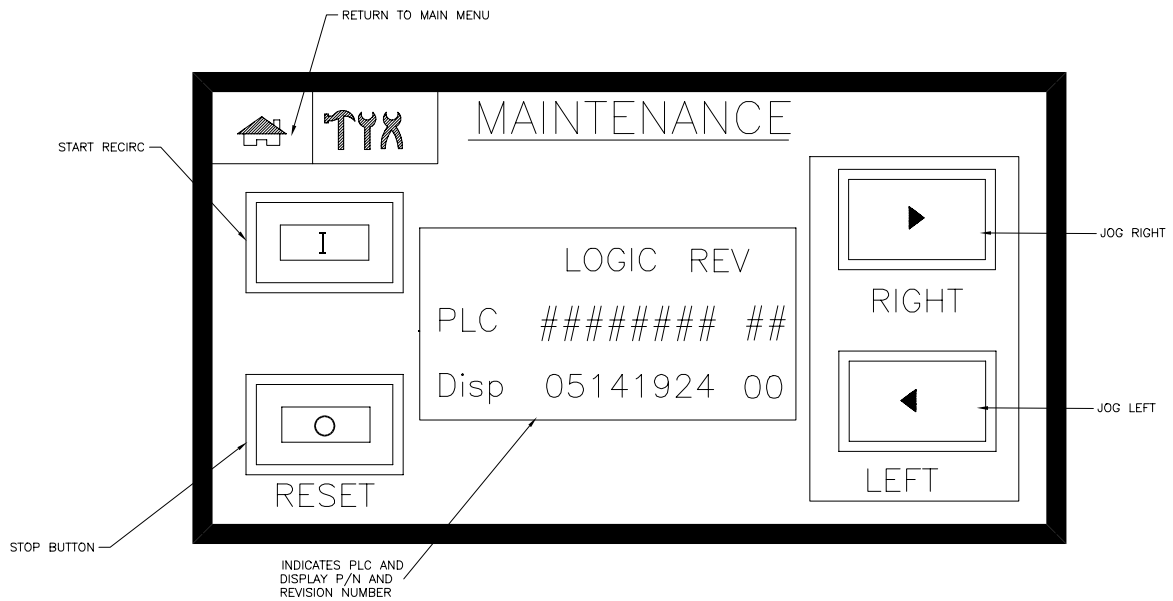
WATER RESET FUNCTION

Press on **(I)** to shut water off five (5) minutes after machine shuts down. Selecting this function will insure that the inlet cutting water is shut off following a shutdown fault. This can prevent water from leaking past a damaged water seal following an overstroke shutdown caused by a seal failure.

IDLE SHUTDOWN TIMER

To set idle shutdown time press up/down arrows from 5-30 minute increments. This feature saves energy by automatically shutting down the intensifier if it is not being used.

Redundant-press on **(I)** if two topworks are present. This function changes screens to indicate two topworks are present.

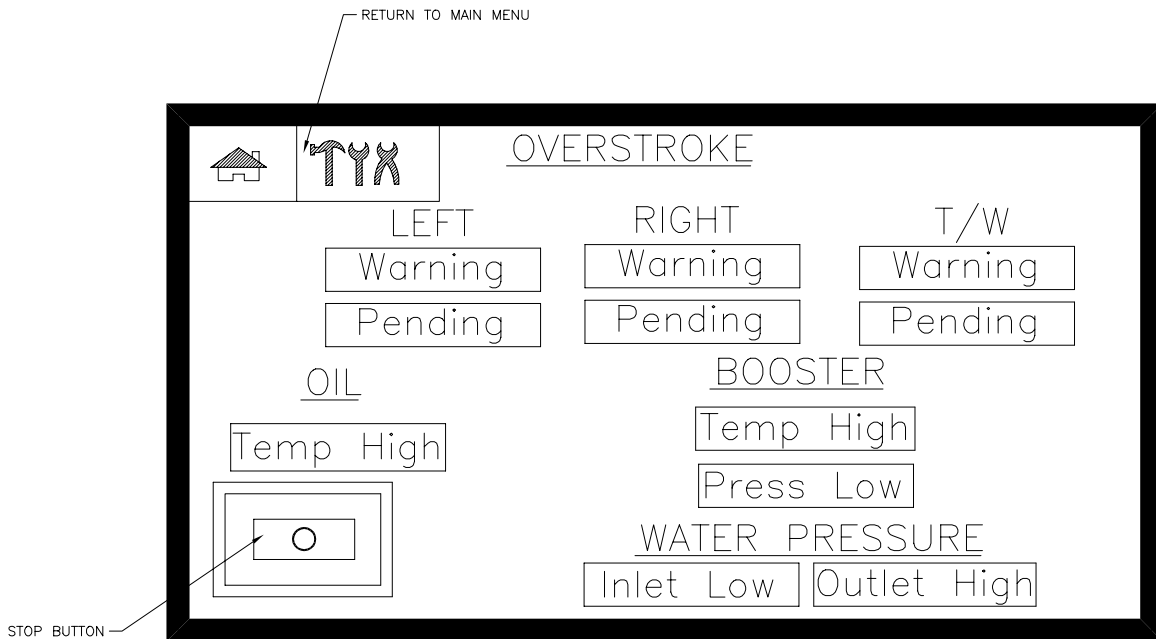


MAINTENANCE SCREEN

Start button will start unit in RECIRC mode and will open dump valve. STOP button will stop unit. Jog right will extend piston to the right giving full exposure to the right plunger once the unit is disassembled. Jog left will do the same to the left plunger.

CAUTION: Unit must be completely assembled to use Jog functions.

PLC and display part and revision numbers are displayed on this screen to indicate programs installed.



ALARM SCREEN

In **ALARM** condition, Message/Alarm, will flash. Messages are not visible if an alarm condition does not exist. All alarm conditions are visible on this screen and on **START** screen.

OIL Indicates high oil temperature. High oil temperature will shut the machine off 60 seconds after detection of this alarm condition.

Low oil level (not on this screen) will immediately shut the machine off. This alarm will appear on the **ALARM BANNER**.

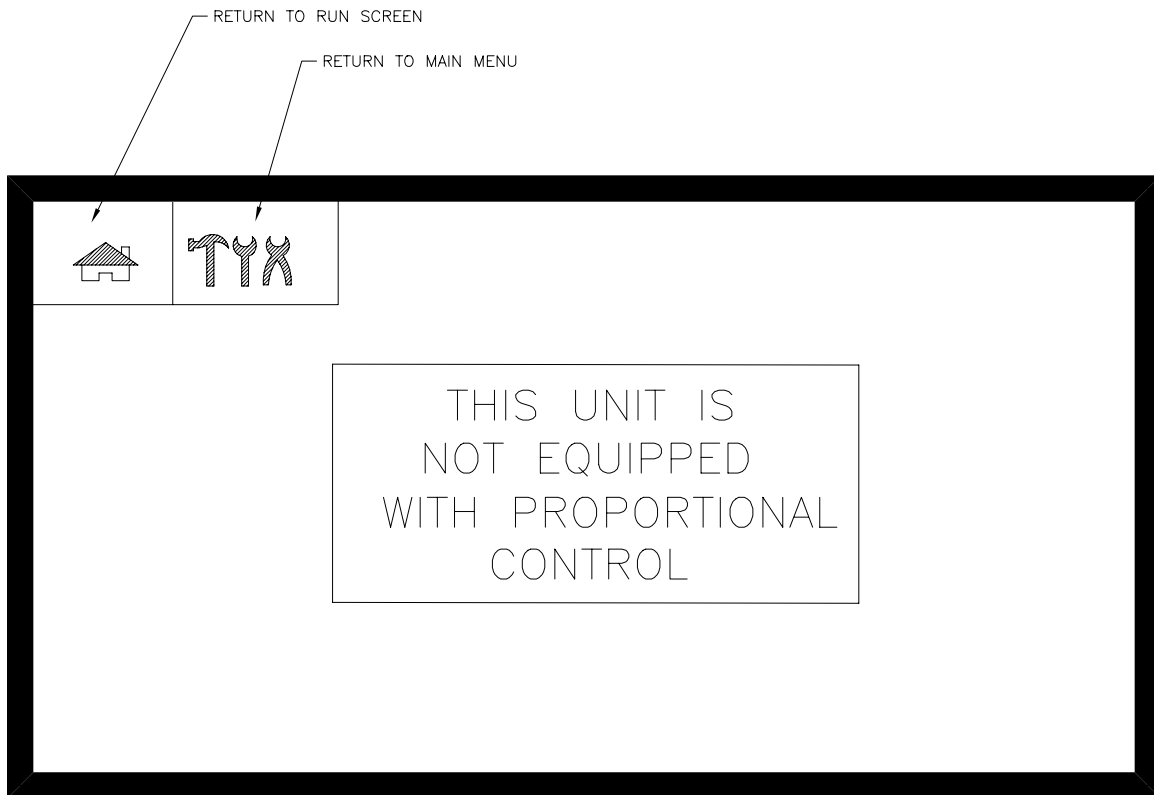
BOOSTER PRESS LOW Alarm indicates low booster pump output pressure. Low booster pressure will shut down the machine 40 seconds after alarm condition is detected.

HIGH BOOSTER TEMPERATURE Alarm indicates high booster pump temperature. The machine will shut down 30 seconds after this alarm condition is detected.

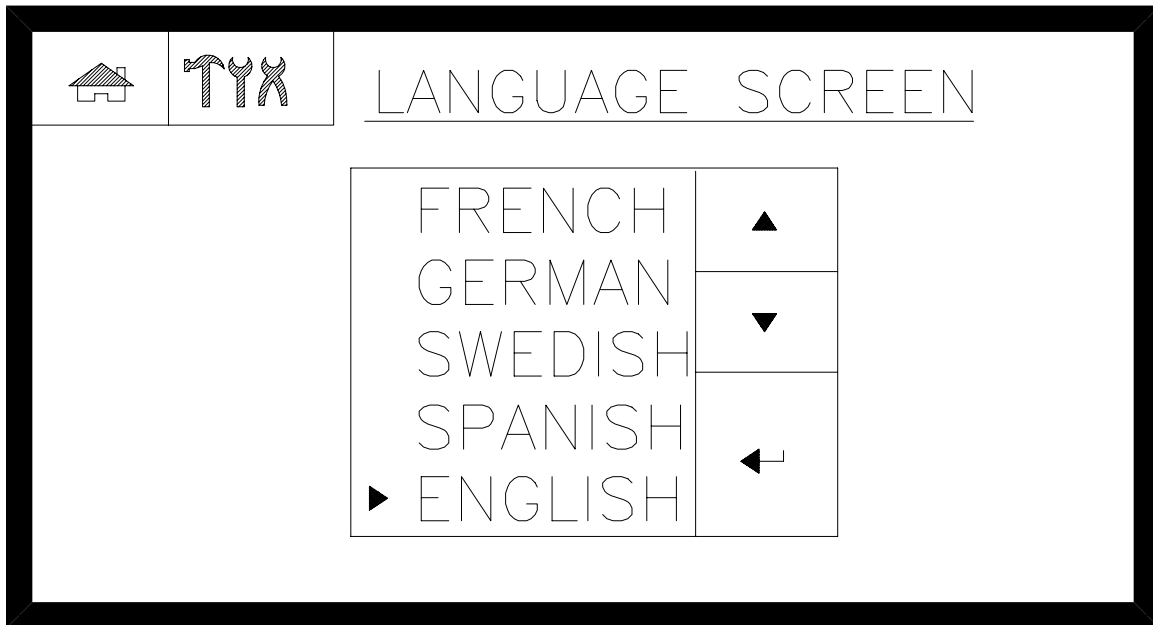
PRESSURE INLET LOW alarm indicates low booster outlet water pressure. The machine will be shut off if the condition persists for 30 seconds.

OUTLET HIGH alarm indicates excessively high discharge water pressure. This alarm is available only if a pressure transducer is installed on the machine.

OVERSTROKE Alarms indicate overstroke conditions. First a **WARNING**, then a **PENDING SHUTDOWN** alarm will occur. If condition persists the machine will SHUTDOWN due to overstroke. This shutdown condition is indicated on the **ALARM BANNER**.

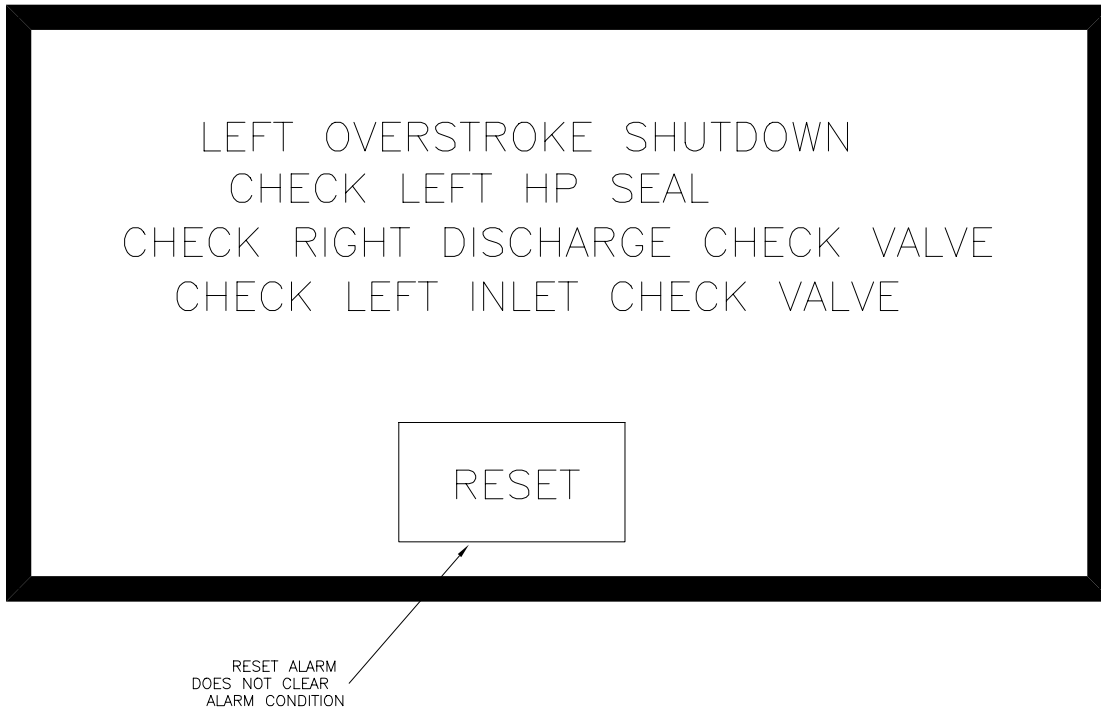
**NO PRESSURE CONTROL**

This screen will appear if the pressure control on main menu is selected and machine does not have PROPORTIONAL control.
The machine cannot be stopped from this screen.



LANGUAGE

Scroll up and down for desired language and press **ENTER** to select FRENCH, GERMAN, ITALIAN, SWEDISH, or ENGLISH.



**ALARM BANNER
(EXAMPLE)**

When a shut-down condition occurs, an ALARM BANNER will appear hiding the current screen. The ALARM BANNER will display the type of shutdown and remedy to clear the alarm.

Pressing the reset button will clear the ALARM BANNER but does not clear the alarm. The banner will continue to appear until the alarm condition is cleared. Shutdowns will appear on ALARM HISTORY SCREEN.

The ALARM BANNER shutdowns are:

Motor Overload – check incoming voltage, check overload relay setting.

Motor Feedback Failure – Check motor starter relay.

Oil Level Low – Check the oil level gauge on the reservoir, check for leaks.

Oil Temp High – Check cooling water flow with a flow meter.

Low Booster Pressure – Check the booster pressure adjustment and check booster condition

Low Inlet Water Pressure - Check water supply pressure at maximum flow rate.

Long Idle Time Shutdown – May be selected for energy saving.

Overstroke Shutdown – Check plumbing for leaks, check HP orifice, check for leaking HP check valves.

Booster Temp High – Check incoming water temperature, check for long idle time.

Left Overstroke Shutdown - Check left high-pressure seal, check right discharge check valve and check left inlet check valve.

Right Overstroke Shutdown - Check right high-pressure seal, check left discharge check valve and check right inlet check valve.

T/W Overstroke Shutdown – Check plumbing for leaks, check for long idle time.

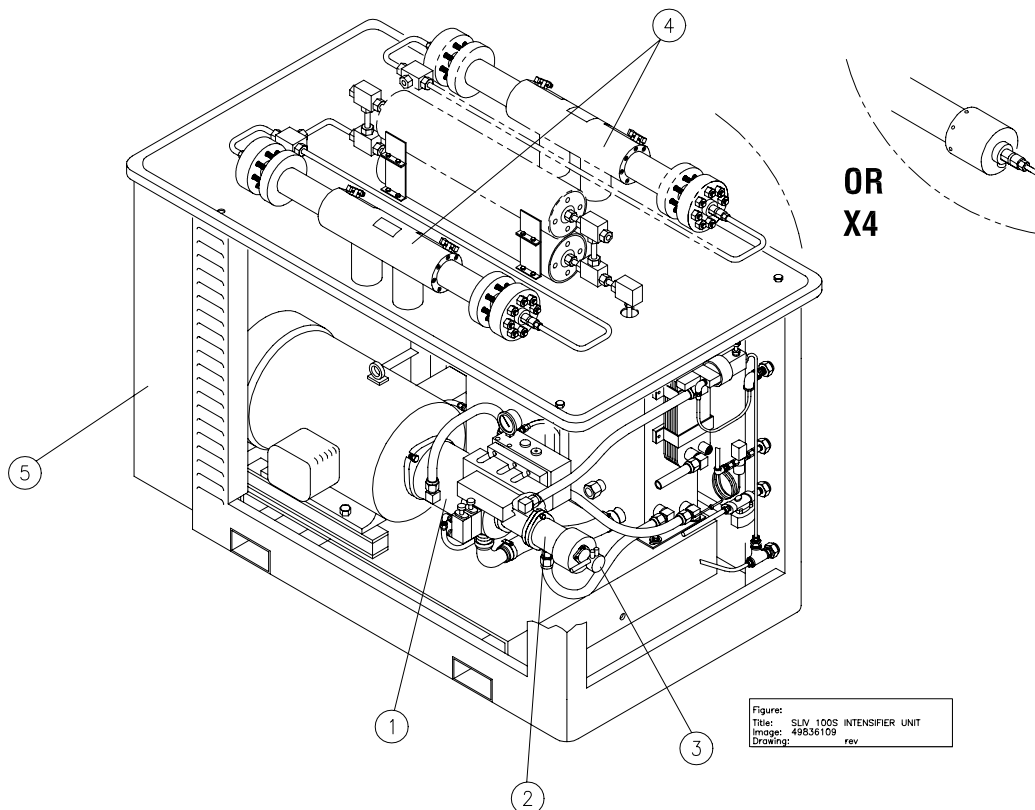
4 Maintenance

This section provides an overview of “Scheduled Maintenance” and “Preventive Maintenance”. In addition, maintenance of the five systems is necessary and is described in their respective sections. Refer to the following sections for detailed information on the operator console and systems maintenance:

- Operator Console, Section 3
- Low Pressure Water, Section 6
- High Pressure Water, Section 7
- Electrical System, Section 8
- Hydraulic System, Section 9
- Recirculation System, Section 10

The following is an overview of the primary components and their location.

- **Hydraulic Pump** – including electric motor, and hydraulic valve manifold block. The pump is a variable displacement, axial piston and pressure compensated type.
- **Recirculation Pump** – including a fixed displacement gear – type pump, oil to water heat exchanger, hydraulic return line – type filter, and related hydraulic hoses and fittings. The gear pump mounts to the back of the variable piston pump, which has a through shaft.
- **Booster Pump** – includes a stainless steel vane – type pump with pressure adjustment and high temperature switch, low pressure water filter, bypass relief valve, and associated water tubing and fittings. The booster pump is mounted to the back of the hydraulic gear pump, which has a through shaft.
- **Intensifier Assembly** – includes one high pressure (HP) attenuator, one hydraulic intensifier assembly, a HP dump valve and associated HP piping with fittings. An additional attenuator and intensifier are optional.



Item Description

- | | | |
|--------------------------|------------------------|------------------|
| (1) Hydraulic Pump | (2) Recirculation Pump | (3) Booster Pump |
| (4) Intensifier Assembly | (5) Control Panel | |

4.1 Scheduled Maintenance

Check Description	Item to be Checked	Major Component	As Req'd	Per Shift	Weekly	Monthly	3-Month	6-Month	Yearly ¹
Fluid Level & Leak Checks	Oil Level	Hydraulic Oil Tank		X					R
	Oil Sample	Hydraulic System				F			
	Hydraulic Cartridge Seals	Hydraulic Cylinder	X	X					
	Plunger Seals	HP Cylinder	X	X					
	Sealing Head	HP Cylinder	X	X					
Pressure & Flow Checks	Water Supply Pressure	Low Pressure Filter Assembly	X	X					
	Intensifier Discharge Pressure	HP Piping	X						
	Hydraulic Pump Pressure	Hydraulic Pump		X					
Temperature Checks	Plunger Seal	HP Cylinder	X	X					
	HP Check Valve	Port Sealing Head	X	X					
	Cooling Water Inlet/Outlet	Oil/Water Heat Exchanger	X			F			
Lubrication & Filter Checks	Motor Bearings Lube	Hydraulic Power Unit	X					R	
	Hydraulic Filter	Hydraulic Oil Tank	X	X				R	
Vibrations-Rotating Equip.	Electric Motor					F			L
	Hydraulic Pump					F			
Splined Shaft Service	Motor/Pump Connection	Motor-Female Spline Piston Pump-Male Spline							L ²
System Cleaning & Inspections	Hydraulic Pump					F			
	HP Tubing, Valves, & Fittings					F			
	Hydraulic Manifolds	Hydraulic Intensifier				F			
	Control Panel	Electrical Enclosure				F			
	Gage Calibration	Hydraulic Pump & HP Piping				F			
Control Lights			X						

Key:

- F:** Information
- X:** To be observed
- R:** To be replaced
- L:** To be lubricated

¹Yearly or 4,000 hours, whichever comes first.

²See Section 9.3.3 concerning spline lubrication recommendations.

4.2 General Maintenance

Proper maintenance is important for reliable and consistent performance. Preventive maintenance reduces unscheduled downtime, and extends component life.



High pressure water will cut almost anything it contacts. Any leaks must be repaired immediately to prevent damage or serious personal injury.

Maintenance Guidelines

- Regular inspection of equipment is recommended.
- Keep equipment and surrounding areas clean.
- Check pressures, temperatures, and look for leaks.
- Make repairs immediately.
- A maintenance record should be kept.

Work Area

- Maintain a clean work area for repair and maintenance of the waterjet pump.
- Use a clean work bench in a dust and dirt free work area.
- Use lint-free material for wipe cloths.
- When blowing off parts with compressed air, use only clean, dry air. When flushing parts with a solvent, use only clean, filtered fluid.
- Always use original KMT Waterjet replacement parts, for consistent performance, reliability, safety, and to protect equipment warranty.

Safety Recommendations

- Carefully read the Safety Guidelines in Section 1, of this manual.
- Lock out all electrical power.
- Close all incoming supply valves and open all drain valves.
- Close the nozzle valves and manifold valves. When the power is shut off, the safety dump valve will open and bleed off high pressure water stored in the discharge piping.
- Provide suitable receptacles, pans, trays, etc. to catch and retain fluids to avoid a hazardous work area.
- **DOUBLE CHECK** to insure that all pressure is relieved from the system before proceeding.

Binding and Interference

When assembling close tolerance machine parts, use extreme care in aligning them for assembly. Do not force the parts together. If parts bind during assembly, separate them and try again until they are successfully mated.

NOTE

It should never be necessary to force an assembly together.

Plunger material is strong, but brittle. Avoid dropping, sharp blows, or heavy bending loads when working with these expensive parts.

Make sure all parts are clean, free of burrs, metal particles, dirt, dust, etc. Use High Purity Goop (KMT Waterjet Part 10084440), when assembling any high pressure fitting.

After servicing any high pressure components, flush the high pressure water system by operating the waterjet pump for a short period with the nozzle valve open and no orifice in place. Next, shut down the waterjet pump, install an orifice, and slowly increase the discharge water pressure in stages. Check all high pressure connections for leaks.

Unusual requirements should be referred to the Customer Services group at KMT Waterjet.

To contact the KMT Waterjet Spare Parts Department:

USA: Customer Service Manager
KTM Waterjet Systems
P.O. Box 231
635 West 12th Street
Baxter Springs, KS 66713 USA
Phone: (620)856-2151
Fax: (620)856-5050
Email:
wj_service@kmtwaterjet.com

Europe: Technical Manager
KMT Waterjet Systems GmbH
Wasserstrahl-Schneidetechnik
Auf der Laukert 11
D-61231 Bad Nauheim Germany
Phone: 49-(0)6032-997-115
Fax: 49-(0)6032-997-271
Email:
order.service@kmt-waterjet.com

4.3 Service Log Data

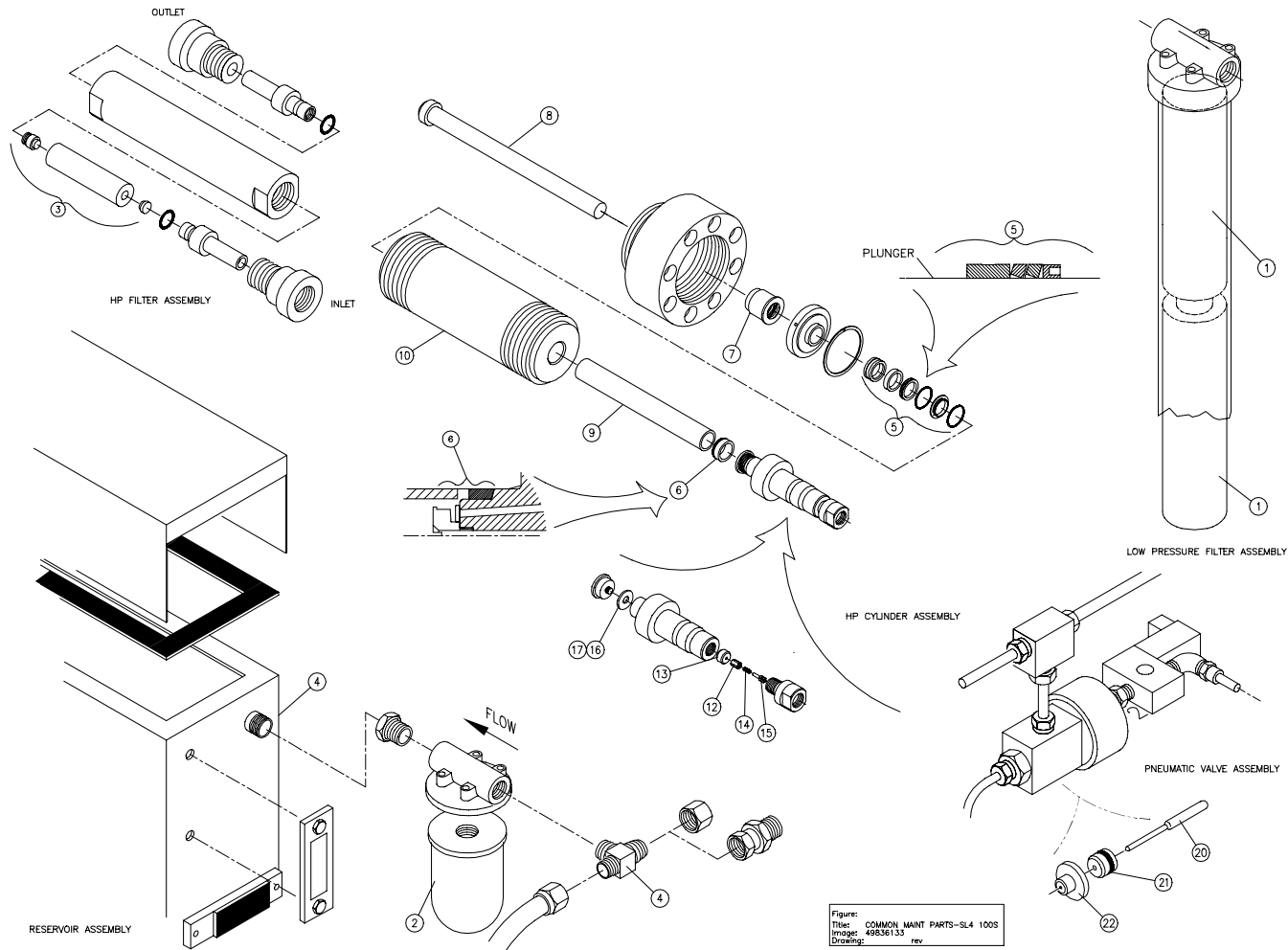
Maintaining a book of Service Log Sheets such as shown in the following pages can be a useful method for ordering spare parts, and for tracking maintenance trends on the SL-IV high pressure intensifier pump. Each part replaced should be noted with the following information: date, person, operating hours, and parts replaced. The Service Log data sheet and part identification illustrations provide a simple means of noting the part(s) service/ replaced. Identify the part(s) serviced or replaced in the accompanying figure and parts list then mark the box under the number corresponding to that part's balloon number in the figure. If there are special conditions that might relate to that part's service history, write comments to the side or add to the bottom or separate sheets of paper. Note that if there are two intensifiers on the pump (redundant option) then indicate which intensifier (I or II) in the column labeled "Intensifier". Note that intensifier I is located to the front when standing such that the control panel is to one's left and the plumbing connections are to the right rear of the pump. Also note which HP cylinder is being serviced: Cylinder A is closest to the electrical control panel.

Service life of certain HP components can be analyzed using the Service Log sheets. Subtracting operating hours between part changes provides service life information. If questions arise concerning service history, then the Service Log sheets can be faxed to the KMT Waterjet service office. Having a mutually – understood form of recording service history (that is, the Service Log sheets) is an advantage when drawing the attention of KMT Waterjet service personnel to the particular service problem.

Note: SLIV 100D intensifiers with flanged ends do not have item (6) sealing head HP seal.

Cutting Conditions (Circle One): Pure water / Abrasive		Operating Pressure: _____ bar/psi					No. of Orifices & Orifice Size: _____ each x _____ mm/inch										SL-IV Service Log Page _____										
Date/Person	Hours	1	2	3	4	TW	CYL	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Remarks	
							A																				
							B																				
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Ref. No.	Part No. (CCN)	PART DESCRIPTION
1	10106722	Filter Element, Low Pressure Water, 2 each x 10 microns
2	05104187	Filter Element, Hydraulic Oil
3		Filter Element, High Pressure Water, ¼ HP, 3/8 HP, or 9/16 HP
4	05071063	Hydraulic Oil Change
5	49834294	Seal, HP Plunger, U-cup
6	05144597	Ring Spacer
7	05009030	Seal, Hydraulic, Plunger Cartridge
8	05144506	Plunger, Ceramic
9	05144555	Liner, HP Cylinder
10	05059712	Cylinder, HP
12	05116579	Seat, HP Check Valve (Wear out first side, then reverse and use opposite side)
13	05116579	Seat, HP Check Valve (Wear out second side, then replace)
14	05147863	Spring, HP Check Valve
15	05119839	Pin
16	05119680	Poppet, LP Water Inlet Check Valve (Wear out first side, then reverse to use opposite side)
17	05119680	Poppet, LP Water Inlet Check Valve (Wear out second side, then replace poppet)
20	BV901184	Stem, HP Dump Valve
21	10178978	Seal Assy, HP Dump Valve
22	10178697	Seat, Replaceable, HP Dump Valve



Section 5 TROUBLESHOOTING**5.1 TROUBLESHOOTING - ELECTRICAL****5.1.1 Pump Will Not Start**

E-STOP Button Depressed	Pull out E-STOP button. Check all remote E-STOP pushbuttons. Push CONTROL POWER ON button – white light on CONTROL POWER ON button should illuminate.
Power Disconnected	Check that main power is present. Check that main power disconnect is ON.
Control Power Interrupted	Check power supply circuit protection (tripped breaker). Check power supply (24vdc) input and output.
Protection Fault Activated	Check LOW OIL LEVEL , HIGH OIL TEMPERATURE , OVERSTROKE CONDITION , or HIGH TEMPERATURE BOOSTER PUMP (bold letters indicate display messages)
Motor Overload Relay Tripped	Find reason for overload. Reset overload relay.
Inlet Water Valve Turned Off	Reset water valve by pressing RESET on Run menu.

5.1.2 Console Display and Lights Fail to Illuminate

E-STOP Button Depressed	Pull out E-STOP button. Check all remote E-STOP pushbuttons. Push CONTROL POWER ON button - white light on CONTROL POWER ON button should illuminate.
Main Power Disconnected	Check main power.
Door Unlatched (locked out)	Check that the door disconnect switch is properly engaged.
Control Power Not Available	Check power supply circuit protection (tripped breaker). Check power supply (24vdc) input and output.

5.1.3 Pump Quit Running

Unsafe Operation Detected	Check fault indication on operator's console and correct: LOW OIL LEVEL , HIGH OIL TEMPERATURE , OVERSTROKE CONDITION , or HIGH TEMPERATURE BOOSTER PUMP .
Electrical Power Interruption	Check power supply circuit protection (tripped breaker). Check power supply (24vdc) input and output. Check that main power is available.
Motor Overload Relay Tripped	Find reason for overload. Reset overload relay.

5.1.4 No Control Power (24vdc)

Circuit Breaker Tripped	Check input circuit breaker of power supply. Check output circuit breaker (24vdc) of power supply.
Power Supply Fault	Check power supply input and output voltages.
E-stop Button Depressed	Pull out E-stop button. Check all remote E-stop pushbuttons
Control Power On Button	Check for voltage through switch when button is pushed.
MCR Relay Not Energized	Check to see if coil is pulling in on the master control relay (MCR)
MCR Contact Set Failure	Check to see if contact sets on MCR are changing state when MCR is energized.

5.1.5 Red Light, Message On Operator's Console

Left Overstroke	Check left HP seal Check right discharge check valve Check left inlet check valve
Right Overstroke	Check right HP seal Check left discharge check valve Check right inlet check valve
T/W Overstroke	Check plumbing for leaks Check HP orifice Check HP dump valve
Booster Pump Pressure	Check booster adjustment Check booster condition
Inlet Water Pressure	Check water supply Check water filter
Oil Temp	Verify hydraulic oil tank temperature is above 62°C (144°F). Check output pressure of oil recirculation pump. Check cooling water flow to heat exchanger. Adjust water modulating valve.
Oil Level	Check hydraulic oil level on the reservoir sight glass. Check for and correct hydraulic oil leak, add oil to tank. If reservoir is full, check oil level switch.
Booster Pump Hot	Check if booster pump temperature is above 53°C (128°F). Check cutting water flow to/from booster pump. Check water bypass orifice. Check excessive time in deadheaded condition. Check booster pump temperature switch.

5.2 TROUBLESHOOTING – HP WATER**5.2.1 HP Water Signal Abnormal Fluctuation**

Orifice Large/ Worn/ Damaged	Check that orifices in use do not exceed capacity of pump. Check that orifices are in good working order. Verify that a jewel is not missing from the orifice mount.
Check Piping Leaks	Check system components for leaks including dump valve condition.
Check Valve Leakage	Inspect pump discharge HP check valves. Inspect pump inlet low-pressure (LP) check valves.
Check Seal Leakage	Inspect plunger seals and sealing heads.
Hydraulic Control Malfunction	Check hydraulic valve operation. Verify proper shifting of 4-way directional control valve. Verify proper proximity switch operation.

5.2.2 Hot Surfaces On HP Cylinder Components

HP Discharge Check Leaking	Inspect check valve seat, poppet, spring, and spring guide condition and sealing head.
LP Inlet Check Valve Leaking	Inspect check valve poppet, spring, o-ring, poppet retaining screw, and sealing head.
Sealing Head or Plunger	Check plunger and sealing head for erosion scratches or mechanical damage and replace if necessary.
Damaged HP Cylinder	Check cylinder bore for damage. Polish if required.

5.2.3 Oil or Water Leaks from HP Cylinder Weep Holes

Oil Leak HP Intensifier	Check hydraulic cylinder O-ring and back-up ring for leakage. Check proximity switch and spacer O-ring area for oil leakage. Replace hydraulic seal (cartridge) and clean holes in hydraulic seal retaining flange.
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Water Leak at HP Plunger Seal	<p>Replace seal assembly if leak exceeds one drop in 10 strokes.</p> <p>Check plunger surface and cylinder bore for build-up of seal material and polish off with 600 emery cloth, polishing the cylinder circumferential and plunger any direction</p> <p>Check Plunger surface and cylinder bore for scratches circumferential and longitudinal, if any are found, contact IR for possible rework and polishing.</p> <p>Check plunger for dull finish, contact IR for polishing.</p>
Water Leak at Sealing Head	<p>Check torque of sealing head screws.</p> <p>Check for scratches on inside diameter of HP cylinder. Polish if required with 600 emery cloth.</p> <p>Check for scratches in area of sealing head seal. Polish if required with 600 emery cloth.</p>

5.2.4 HP Check Valve Leak

If there are no visible HP water leaks, but there are higher temperatures on HP cylinder or sealing head, this indicates a HP or LP check valve leak. Use corrective action listed in **5.5** for both discharge and inlet checks:

5.2.5 Normal Temperature, but Check Valve Problem

Follow the instructions for HP check valve leak described in **5.5**.

5.2.6 HP Cutting Water Too Low

Low Hydraulic Pressure Setting	If in LO, turn pressure switch to HI. Check hydraulic pump pressure setting.
HP Water Filter Clogged	Clean or replace filter.
Worn HP Orifice	Replace orifice.

5.3 TROUBLESHOOTING – LP WATER

5.3.1 Low Booster Pump Pressure

Booster pump pressure below 60 psi	<p>If at anytime the pump is running and the booster pump pressure falls below 60 psi, adjust the relief valve clockwise to increase the pressure above 60 psi.</p> <p>If the booster pump pressure cannot be adjusted above 60 psi, replace the booster pump.</p>
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Booster pump pressure above 125 psi If at anytime the pump is running and the booster pump pressure is above 125 psi, the relief valve is opening up and sending water to the drain.

5.4 TROUBLESHOOTING – HYDRAULIC

5.4.1 Hot Hydraulic Oil

Restricted or No Cooling Flow Check cooling water flow to and from heat exchanger.
The water pressure differential across the heat exchanger, 2.75 bar (40 psi) minimum required for flow through the exchanger.
Check operation and setting of water modulating valve.

Water Modulating Valve Setting Check and adjust setting of water modulating valve.
Compressing spring (clockwise) slows water flow and increases temp; reducing spring tension (counterclockwise) increases water flow and lowers oil temp.

Heat Exchanger Clogged Flush heat exchanger, improve flow of cooling water or replace heat exchanger.

Recirculation Pump Hydraulic Pressure below 20psi Replace hydraulic oil filter.
If filter is new, replace recirculation pump.

5.4.2 Hydraulic Pressure but no High Pressure Water Pressure

Proximity switch failure Verify left hand and right hand LED lights on DC alternately illuminate ON/OFF. If so, both proximity switches are properly functioning.
If both the green and red LED lights are on at the same time on one proximity switch, replace the proximity switch.
Flag the proximity switches one at a time, checking to see if it is sending a signal to the PLC.

I/O relay failure Check if PLC output is shifting the I/O output relays and allowing power to go to the coils on the directional valve.

Directional valve coil failure Check coils on the directional valve with a volt meter to verify good or bad

PLC failure If there are inputs from the proximity switches but no outputs, contact IR service for a logic review and verification of PLC failure.

5.5 SPECIAL PROCEDURE—HP WATER CHECK VALVE TROUBLESHOOTING**5.5.1 HP Check Valve Troubleshooting**

A leaking HP check valve is suspected if either HP cylinder or sealing head is unusually hot. Compare temperatures of opposing sealing heads or HP cylinders to decide location of hot spot. Note any heat in LP water.

The display will tell you which direction is pumping faster. If the leak is bad enough, the intensifier will shut down and the display will tell you where to look for the problem. For instance, if the display indicates a Left Stroke Warning or Shutdown, the probable problem is either at Left Inlet Valve or Right Discharge Valve. You can usually confirm which it is by feeling heat on one side or another.

NOTE: The bolted flange / metal-to-metal seal arrangement of the SL-IV Plus sealing head make the INLET check valves much more difficult to access for maintenance than the HP OUTLET check valves. Therefore one should generally rule out problems with the OUTLET HP check valves prior to disassembling the INLET check valves.

6 Low Pressure Water System

The SL-IV Waterjet Pump is equipped with two low pressure circuits:

- Cutting water supply for HP intensifier assembly
- Cooling water supply for the oil-to-water heat exchanger

The low pressure water system supplies the pump with the following:

- Water of sufficient cleanliness and pressure to the inlets of the HP cylinders.
- Cooling water of sufficient flow rate and low temperature to the oil-to-water heat exchanger.

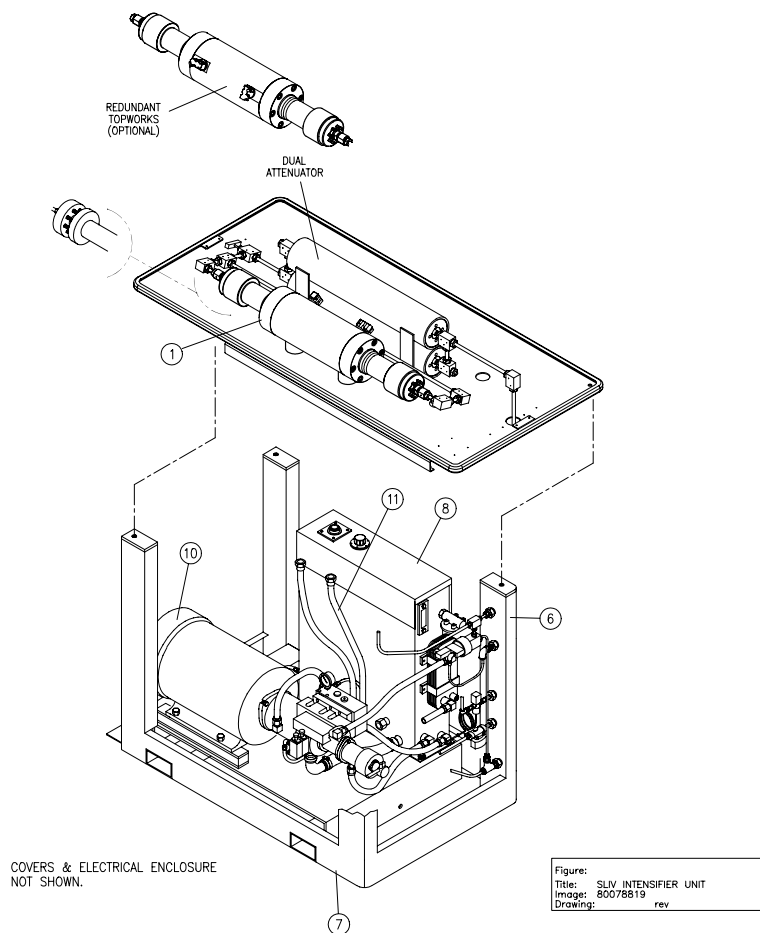


Figure 6.1 SLIV Waterjet Pump

Item Description

- | | | |
|-------------------|-----------------------|----------------------|
| (1) Intensifier | (6) Bulkhead/Frame | (7) Drip Pan/Frame |
| (8) Hyd Reservoir | (10) Motor/Pump Ass'y | (11) Hydraulic Hoses |

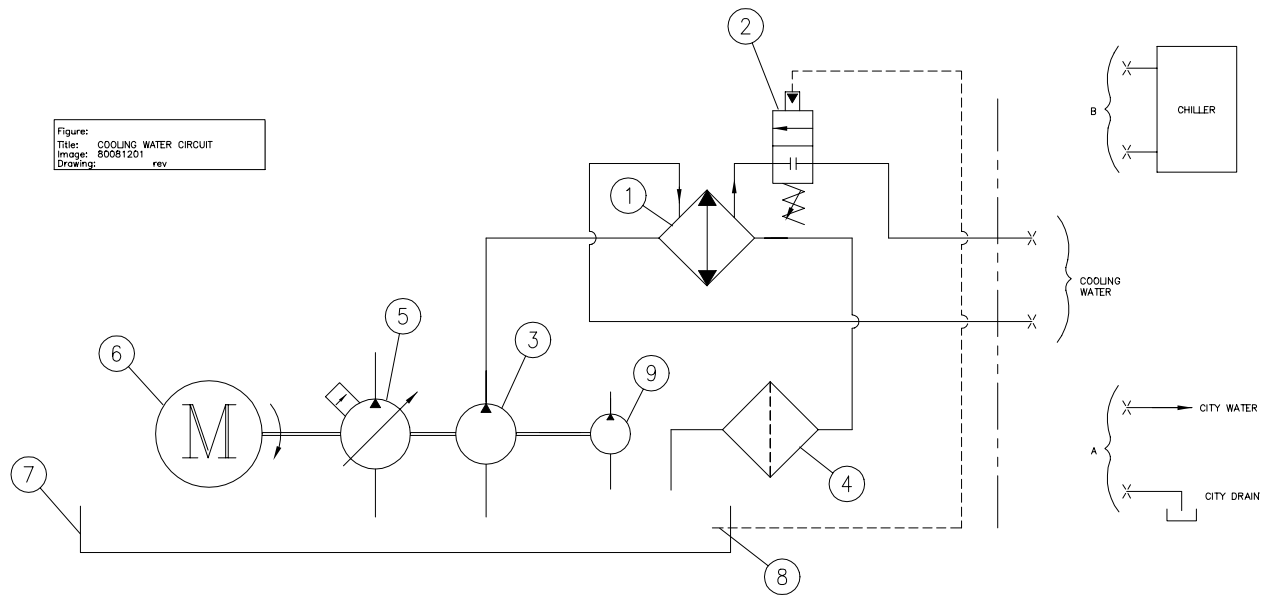


Figure 6.2 Cooling Water Circuit-SLIV Waterjet Pumps

- | | |
|---|-------------------------------------|
| (1) Heat Exchanger, Oil to Water Cooler | (2) Water Modulating Valve |
| (3) Hydraulic Pump, Gear Type Recirculating | (4) Hydraulic Filter, Return Line |
| (5) Main Hydraulic Pump | (6) Electric Motor |
| (7) Hydraulic Reservoir (Tank) | (8) Temperature Bulb/Reservoir Well |
| (9) Cutting Water Booster Pump | |

6.1 Oil Cooling Water Supply (See Figure 6.2)

The hydraulic oil cooling water circuit includes an oil- to- water heat exchanger (1), an automatic water modulating valve (2), and associated bulkhead fittings to connect inlet and outlet water to source/ drain piping/ hoses as appropriate. The water modulating valve provides accurate and reliable regulation of oil temperature in the hydraulic reservoir (8).

Cooling water is provided by the SL-IV Waterjet Pump user, and can be either tap water (A) or built into a chiller circuit (B) that re-circulates cooling water, reducing water consumption. See Table 6.3 for estimated water flow requirements. Note that actual water flow will vary due to open/close cycling of the water modulating valve, as well as variations in operating pressure, and pump duty cycle.

**Table 6.3. Cooling Water Requirements
—SL-IV Waterjet Pumps**

Hp (Kw)	Gpm (liters/ min)	At Temp.
30 (22)		70 deg F
50 (37)		
60 (44)		
75		
100 (75)	4.5	

Sometimes Waterjet customers pipe cooling water from a cooling manifold or series circuit. Issues with low supply pressure or high supply temperature may arise in connection with this cooling system.

To raise or lower hydraulic oil operating temperature, an adjustment on the water modulating valve (2) increases or decreases force on a spring. Turning the screw counterclockwise causes increased water flow while DECREASING oil temperature. Likewise turning the screw clockwise INCREASES oil temperature. The water modulating valve includes a sensor bulb (8) that mounts into a thermal well built into the hydraulic reservoir.

The heat exchanger (“cooler”) (1) is a flat plate design, providing efficient transfer of heat from hydraulic oil to cooling water in a compact, reliable package. Two each hydraulic hoses and two each water hoses connect to the flat plate heat exchanger. Cooling water IN connects to the port nearest hydraulic oil OUT, hence the term “counter flow” is used to describe this arrangement. On occasion the water passages in the heat exchanger (1) can become partially blocked by rust or solids buildup in the water. Back flushing may correct this problem.

For a more complete discussion of the hydraulic side of the cooling circuit, refer to Section 10.

6.2 Cutting Water Supply (See Figure 6.4)

The cutting water supply includes the following:

- Low pressure water filter (2)
- Inlet water shutoff valve (solenoid operated) (3)
- Booster pump (1) along with sensors and pressure controls

The low pressure water fittings are stainless steel with rubber hoses connecting the low pressure water components. The booster pump (1) housing is also stainless steel and is protected by the low pressure water filter (2).

The low pressure cutting water circuit allows the water to pass through the low pressure filter (2) prior to entering the booster pump (1) to prevent debris from damaging the pump. However, when the low pressure water filter gets loaded up with dirt/contaminants, the water pressure exiting this filter may be too low to supply the booster pump.

The cutting water supply circuit is automatically shut off after the motor has been off for 2 minutes. To reset the water supply valve, press F6.

6.2.1 Normal Operating Condition

During normal operation, the low pressure water system maintains the following conditions:

- Filter pressure drop (gage reading 4 minus 6) not more than 1 bar (15 psi)
- Booster pump discharge pressure gage reading 8.0-8.3 bar (115-120 psi)

NOTE

While the intensifier assembly reverses direction, the booster pressure will fluctuate slightly above and below the normal setting. Pressure fluctuation greater than 2 bar (30 psi) may indicate inadequate water supply to unit, or poor booster pump performance.

6.2.2 Operation (See Figure 6.4)

The cutting water enters the pump through port “B”. When the CONTROL POWER ON button on the operator control panel is activated, solenoid valve (3) opens allowing water to flow through the filter (2) to the inlet of the booster pump (1). The booster pump increases the inlet pressure to 8 bar (120 psi) to assure proper supply to both intensifier assemblies. If the motor does not run for 2 minutes, the solenoid valve (3) will shut off. To re-open the valve, press F6.

NOTE

The booster pump (1) is factory set to deliver 8 bar (120 psi) with an inlet pressure at port “B” of 4 bar (58 psi). The pump may require adjustment if local inlet pressure is different, because discharge pressure depends on inlet pressure. Inlet pressure is affected by filter condition, as well as local water supply conditions.

The water flows through the low pressure water supply filter (2) and then enters the booster pump.

Booster pump (1) inlet water is monitored by pressure switch (6). Water pressure less than 30 psig (2 bar) will signal either low supply pressure at port “B” or a clogged filter element (2). The booster pump is connected with hoses to the inlet of both hydraulic intensifiers. Water pressure at intensifier sealing heads (13) is monitored automatically by pressure switch (7) and manually by gage (9). If sealing head pressure drops below 60psi (4 bar) then the intensifier will automatically shut down.

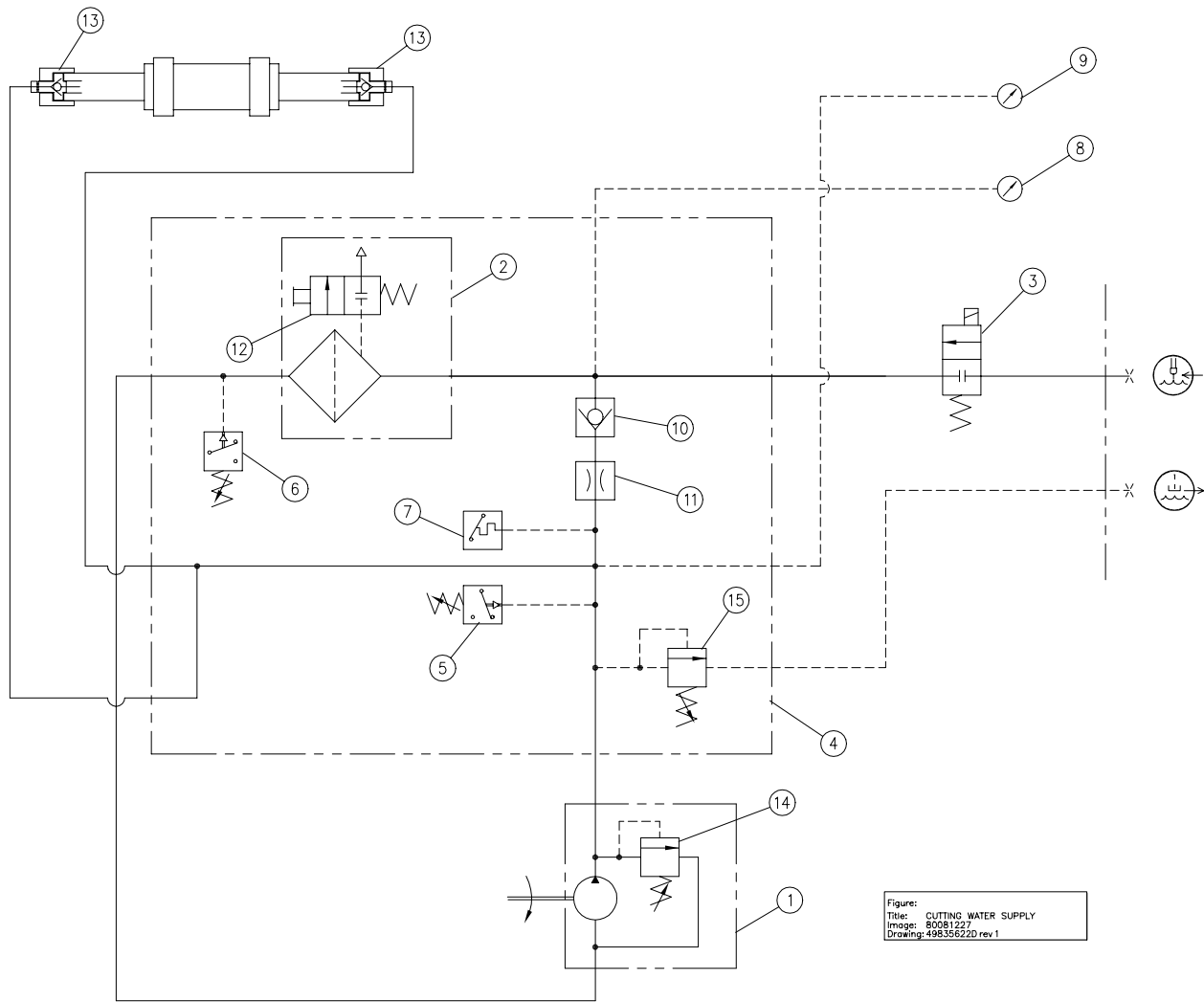


Figure:
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Figure 6.4 Cutting Water Supply System

- | | |
|--|--|
| (1) Booster Pump, Cutting Water Supply | (2) Filter, Cutting Water Supply |
| (3) Solenoid Shutoff Valve, Cutting Water Supply | (4) Filter Assembly, LP Water |
| (5) Pressure Switch, 60psig, Low Booster Pump Pressure | (6) Pressure Switch, 30psig, Low Supply Water Pressure |
| (7) Temperature Switch, High Booster Pump Out | (8) Pressure Gage, Cutting Water Supply Pressure |
| (9) Pressure Gage, Booster Pump Output Pressure | (10) Check Valve |
| (11) Orifice | (12) Air Bleed Valve |
| (13) Sealing Head Assembly, Intensifier | (14) Relief Valve, Built-in |
| (15) Relief Valve, Circuit | |

6.2.3 Booster Pump Pressure Adjustment

Adjustment must be made with the pump turned off and the inlet water turned off.

The booster pump pressure relief valve (14) is adjusted by turning with a flat blade screwdriver. Turn clockwise to increase pressure or counterclockwise to decrease pressure. The relief valve adjusting screw is accessed by removing the acorn nut on the side of the pump. Note that replacing the acorn nut after adjusting outlet pressure may change relief valve pressure.

6.2.4 Low Pressure System Protection

System pressurization over 8.6 bar (125 psi) is prevented by the relief valve (15). Note that a leaking check valve in a sealing head (13) could cause relief valve (15) to open. Booster pump overheating due to lack of water, or long deadheaded conditions, is prevented by the temperature switch (7), which turns the waterjet pump off. To reduce booster pump overheating while deadheaded, water is recirculated through orifice (11) and backflow check valve (10) to the booster pump inlet.

Control	Item No.	Pressure Adjustment		Pressure Settings Bar (psi)	
		Increase	Decrease	Maximum	Minimum
Booster Pressure	14	Clockwise	Counterclockwise	8.3 (120)	8.0 (115)
Booster Relief	15	Fixed	Fixed	9.0 (130)	8.6 (125)

6.3 Maintenance Overview

In order to maintain necessary fluid pressure for the pump and to keep the water clean for proper operation it is necessary to replace the water filter and/or adjust the booster pump. The guidelines for servicing these parts are described below.

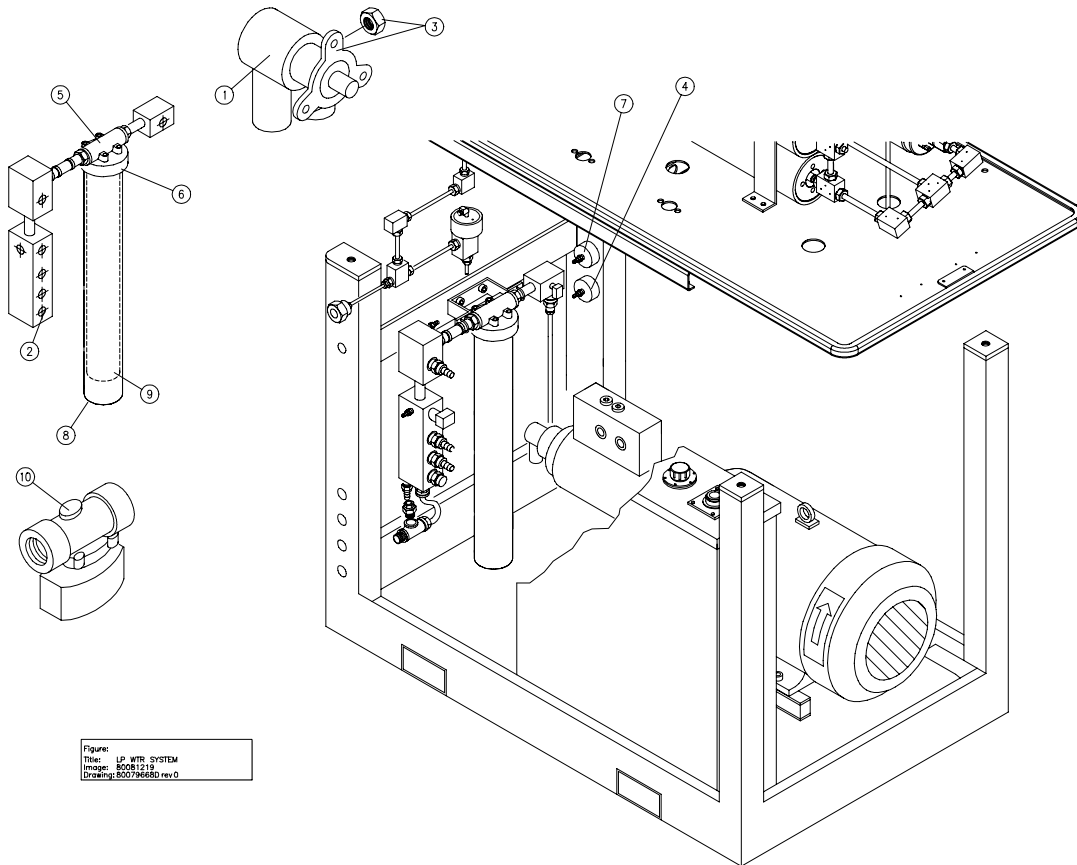


Figure:
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Figure 6-5

Item Description

- | | | |
|-----------------------------------|------------------------|----------------------------|
| (1) Booster Pump | (2) Temperature Sensor | (3) Relief Valve/Acorn Nut |
| (4) Pressure Gage | (5) Bleed Valve | (6) Filter Head |
| (7) Pressure Gage | (8) Filter Housing | (9) Filter Element |
| (10) Shut-off Valve
(Solenoid) | | |

6.3.1 Water Filter Service

Replace water filter when booster pump inlet pressure drops below 30 psig pressure switch (6), Figure 6-4 with 30 psig or greater on gage (8) Figure 6-4.

Components:	Bleed Valve Element Head Housing
Recommended Tools:	Supplied filter thread/unthread tool (to turn housing) Container (to capture some water spill) Rags
Parts:	Elements for water: 10 micron (quantity 2) Polymer mixer: 40 micron (quantity 2)

Water Filter Element Replacement Procedure

1. Turn off cutting water supply
2. Press bleed valve to relieve trapped pressure
3. Unscrew housing from head. Remove element.
4. Install new elements in housing. Screw housing into head.
5. Open cutting water supply.
6. Press bleed valve to remove trapped air.
7. Start waterjet pump. Verify satisfactory pressure readings.

6.3.2 Booster Pump

If booster pressure, as read on the booster pump discharge pressure gage is not 8.0-8.3 bar (115-120 psi), the booster pump needs to be adjusted.

Components: (1) Booster pump
(3) Relief valve set screw

Recommended Tools: Flat screwdriver (To turn pressure control knob)
Container (To capture some water spill)
Rags

Parts: None required

Booster Pump Adjustment Procedure

1. Turn on cutting water supply
2. Start waterjet pump and observe booster discharge pressure
3. Stop waterjet pump and press E-Stop button.
4. Remove acorn nut from the side of the booster pump and turn screw clockwise to increase pressure or counter-clockwise to decrease pressure.
5. Replace acorn nut, restart waterjet pump and observe booster discharge pressure.
6. Repeat steps 4 and 5 if necessary.

Section 7 HIGH PRESSURE WATER

7 High Pressure Water

The high pressure (HP) water system takes the relatively low pressure water inlet to up to maximum pressure in excess of 3,400 bar (50,000 psi) supplying orifice diameters appropriate to the waterjet pump's operating power (See Specifications, Section 11).

7.1 Components

The HP water components include the hydraulic intensifier, HP attenuator(s), HP dump valve, HP pressure indicator (optional), and HP piping. Maintenance on the intensifier is discussed in detail in this section. In addition to HP components and assemblies, the hydraulic cylinder features of the intensifier are discussed in this section.

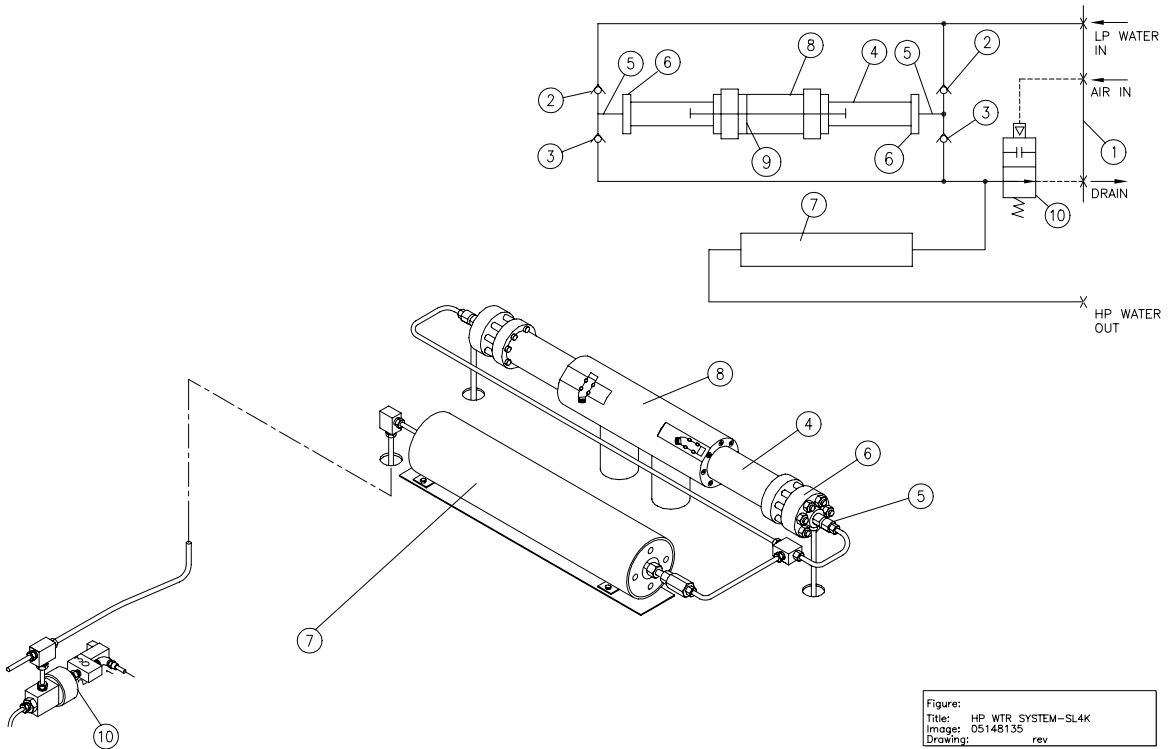


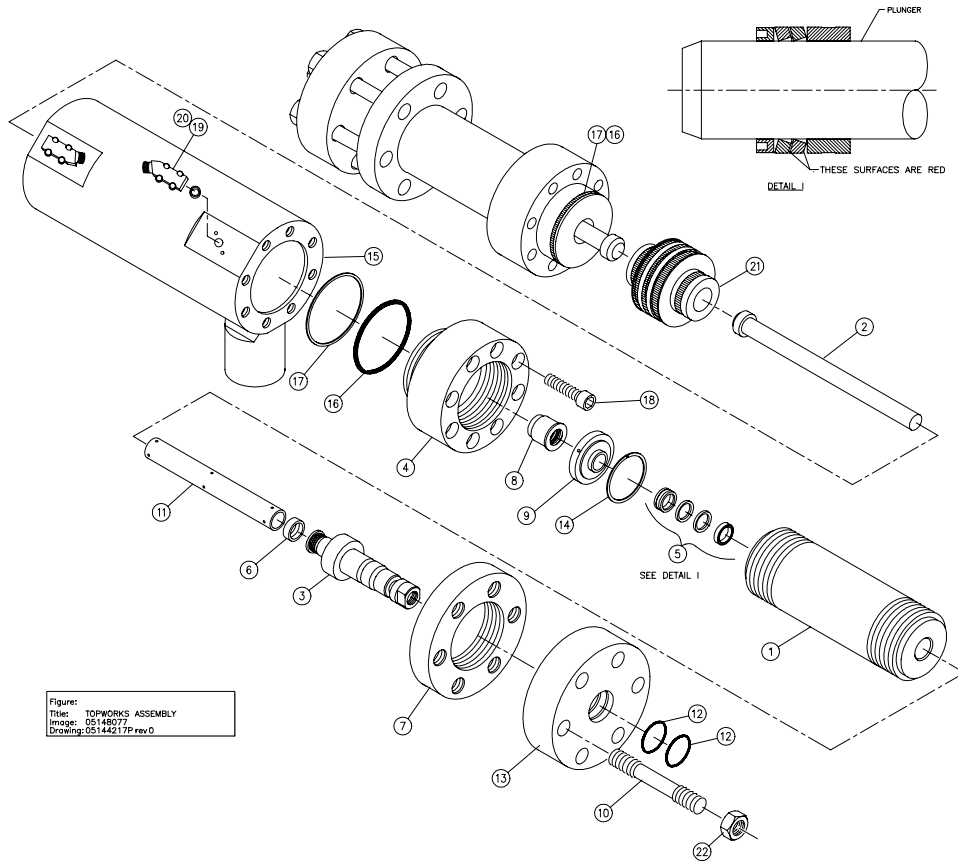
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Item Description

- | | | |
|--------------------------|---------------------|-----------------------|
| 1. Bulkhead Fittings | 4. HP Cylinder | 8. Hydraulic Cylinder |
| 2. Inlet Check Valve | 5. Sealing Head | 9. Hydraulic Piston |
| 3. Discharge Check Valve | 6. Sealing Head Nut | 10. HP Dump Valve |
| | 7. HP Attenuator | |

7.2 Intensifier Disassembly and Reassembly

Detailed instructions are provided on disassembly and reassembly of the hydraulic intensifier, including HP seal maintenance. A discussion of detailed inspection and repair for individual HP components and subassemblies is also provided. The HP attenuator is discussed but no disassembly procedures are included. Note that HP attenuators are not considered to be serviceable by the customer.



Item Description

(1) HP Cylinder	(2) Plunger	(3) Sealing Head
(4) Hydraulic Cylinder Head	(5) HP Seal	(6) Ring
(7) Ring Flange	(8) Hydr Seal Cartridge	(9) Retaining Flange
(10) Stud Bolt	(11) Cylinder Liner	(12) O-ring
(13) End Flange	(14) Retainer Ring	(15) Hydraulic Cylinder
(16) Back-up Ring	(17) O-ring	(18) Cap Screw
(19) Proximity Switch	(20) Cap Screw	(21) Piston Assembly
(22) Hex Nut		

Standard HP gland nut hex sizes for HP piping is as follows:

- 3/8" HP fittings: 13/16" (open end) wrench.
- 9/16" HP fittings: 30mm (1-3/13") wrench.
- Tie bolts nuts: 1-7/16" socket (7/8" and 1-1/8" plunger models)

**7.2.1 HP & LP Water Piping
Disconnect from/Reconnect to Waterjet Pump****WARNING**

Before performing maintenance on the waterjet pump observe electrical LOCK OUT/TAG OUT procedures.

1. Loosen and remove HP Piping attached to the discharge HP check valve. Move tubing to clear work area.
2. For servicing the discharge HP check valve on the intensifier assembly, refer to section 7.3.1. "Discharge HP Check Valve". Note that the sealing head can be removed with the discharge HP check valve attached.
3. Disconnect LP water at end flange. Note that to service the sealing head, including the inlet HP check valve, the tie bolts must be loosened allowing removal of the end flange.
4. With the HP piping and the LP cutting water plumbing disconnected, the following operations can be performed:
 - HP cylinder can be removed from hydraulic cylinder head
 - HP plunger seal can be serviced

After the pump has been reassembled, then the HP water piping and LP water disconnect are reinstalled as follows:

5. Slide inlet water collar over sealing head until it rests against the head nut. Connect LP inlet water quick disconnect to collar.
6. Install the HP water piping to the intensifier. Check HP fittings for proper collar position (1 to 1-1/2 threads exposed) and for adequate thread lubricant (High Purity Goop). Turn on cutting water supply and check for low-pressure leaks.

**CAUTION**

Check that all proximity switches are properly installed and secured prior to starting the motor. Failure to tighten proximity switch hold down screws (2 each per proximity switch) will result in hydraulic oil spraying in general directions.

7. Start the waterjet pump. Operate at low pressure (without a cutting orifice) to flush the HP passages, then operate at high pressure with orifice installed to check for leaks.

**7.2.2 HP Cylinder “Jug” (HP Cyl., Sealing Head, Flanges, & Studs)—
Disassembly / Re-assembly**

NOTE—KMT Waterjet recommends removing the HP cylinder/ sealing head/ flanges AS AN ASSEMBLY for servicing the plunger HP seals, plunger, hydraulic seals, etc. KMT Waterjet DOES NOT recommend loosening stud nuts except to service the sealing head inlet HP check valve, cone seat, etc. Refer to Table 7.1 for recommended disassembly / re-assembly practices.

Due to the weight (approx. 70 lbs) of the HP cylinder jug, adequate support should be provided to prevent damage to the plunger or seals during disassembly/ re-assembly. See Figure 7.2 for suggested special tools to support the HP cylinder jug for this procedure.

**HP Cylinder Jug Removal**

1. Prior to removing electrical power from the pump, extend plunger on end to be serviced. Remove connector from proximity switch on end of hydraulic cylinder closest to HP cylinder jug to be removed. Start the pump in LOW pressure mode, allow approximately 20 seconds for appropriate startup and cycling of intensifier to extend and stop toward the disconnected proximity switch. Shut off the pump, shut off LP water supply, observe LOCK-OUT/ TAG-OUT safety rules.



Before performing maintenance on the waterjet pump observe electrical LOCK OUT/TAG OUT procedures.

2. Disconnect HP and LP piping / hoses per paragraph 7.2.1 above.
3. With support cradle tool located under HP cylinder jug, unthread and remove jug from plunger and hydraulic cylinder head.

NOTE: several methods for rotating the HP cylinder jug are available. The cylinder wrench is available, or the jug can be rotated by hand with the help of the studs and stud nuts. A slight lift force applied to the HP gland nut of the outlet HP check valve can help ease the effort of rotating the HP cylinder jug.

HP Cylinder Jug Re-Installation

1. Verify that HP cylinder threads are adequately lubed with High Purity Goop and that the threads have been sanded/ dressed if galling was encountered during HP cylinder jug removal.
2. Verify that the HP plunger seals, packing follower, and plastic cylinder liner tube are correctly installed. Align HP cylinder jug with plunger using cradle tool to support weight and provide approximate alignment. Carefully push/ lift jug into place until threads are ready to engage.

3. While lifting upward on the outlet HP check valve gland nut, push upward on a stud nut, rotating the jug CW, while pushing inboard and upward until thread engagement is accomplished. Continue to thread HP cylinder into hydraulic cylinder head until hand tight.
4. Re-connect HP and LP piping / hoses per paragraph 7.2.1 above.

**CAUTION**

Check that all proximity switches are properly installed and secured prior to starting the motor. Failure to tighten proximity switch hold down screws (2 each per proximity switch) will result in hydraulic oil spraying in general directions.

5. Restart the pump, first operating in LOW pressure mode to flush out air in HP components and also to check for obvious leaks. Switch to HIGH pressure after 5-10 minutes of LOW pressure operation, watching for obvious leaks. Be ready to shut off the pump if leaks appear. Remedy leaks then repeat start procedure, moving from LOW pressure to HIGH pressure soon after intensifier starts pumping water (no further need to flush air from lines).

7.2.3 Stud Nuts and End Flange, Sealing Head—Disassembly / Re-assembly

NOTE—KMT Waterjet recommends removing the HP cylinder/ sealing head/ flanges AS AN ASSEMBLY for servicing the plunger HP seals, plunger, hydraulic seals, etc. KMT Waterjet DOES NOT recommend loosening stud nuts except to service the sealing head inlet HP check valve, cone seat, etc. Refer to Table 7.1 for recommended disassembly / re-assembly practices.

End Flange and Sealing Head Removal

1. Prior to removing electrical power from the pump, extend plunger at intensifier end to be serviced. Remove connector from proximity switch on end of hydraulic cylinder closest to HP cylinder jug to be removed. Start the pump in LOW pressure mode, allow approximately 20 seconds for appropriate startup and cycling of intensifier to extend and stop toward the disconnected proximity switch. Shut off the pump, shut off LP water supply, observe LOCK-OUT/ TAG-OUT safety rules.

**CAUTION**

Before performing maintenance on the waterjet pump observe electrical LOCK OUT/TAG OUT procedures.

2. Disconnect HP and LP piping / hoses per paragraph 7.2.1 above.
3. Loosen stud nuts, then remove nuts.
4. Remove end flange. Note that sealing head may be removed with end flange.

5. Remove sealing head. Note that a white plastic ring used to position the sealing head relative to the HP cylinder bore may not have been removed with the sealing head. This ring should be removed prior to re-installing a sealing head to avoid pushing the ring further into the HP cylinder bore. Note that a fully- assembled spare sealing head greatly reduces pump downtime.

Re-Assemble Sealing Head and End Flange to HP Cylinder

1. Verify that sealing head cone surface is smooth. Perform any necessary maintenance on inlet check valve. (Refer to paragraph 7.3.2) Verify that a white plastic alignment ring is installed on the 'nose' of the sealing head. Verify O-rings (2 ea) properly installed in ID grooves of end flange. Check HP cylinder bore to verify presence of plastic tubular cylinder liner and to verify that no white plastic alignment ring remains in end of HP cylinder bore. Feel sealing edge of HP cylinder bore to verify that no unusual blemishes are present that might hinder proper cone ring seal.
2. Install sealing head into end flange. Install sealing head and end flange over stud bolts and into cylinder bore. Note that end flange should be oriented with the LP water fitting oriented near the 9 o'clock or 3 o'clock positions for ease of making the LP water connection.
3. Thread nuts onto studs to hand-tightness. Apply molygrease to stud threads (Table 7-2 item 3). Verify end flange and ring flange are parallel to within 0.070-inch.
4. Tighten stud nuts (using a torque wrench) in a crossing pattern in several stages to reach maximum torque. See Table 7.1 for suggested nut tightening sequence. Verify flange parallelism at completion of tightening sequence.
5. Re-connect HP and LP piping / hoses per paragraph 7.2.1 above.

**CAUTION**

Verify that proximity switches (2 ea) are properly installed. Failure to tighten proximity switch hold down screws will result in hydraulic oil spraying in general directions.

6. Restart the pump, first operating in LOW pressure mode to flush out air in HP components and also to check for obvious leaks. Switch to HIGH pressure after 5-10 minutes of LOW pressure operation, watching for obvious leaks. Be ready to shut off the pump if leaks appear. Remedy leaks then repeat start procedure, moving from LOW pressure to HIGH pressure soon after intensifier starts pumping water (no further need to flush air from lines).

7.2.4 HP Plunger Seal Service-- Disassembly / Re-assembly

1. Remove HP and LP piping/ hose, then remove HP cylinder jug following procedure 7.2.2, above.
2. Thread HP plug and gland fitting (items C1 & C2, Special Tools, Table 7.3) into HP check valve gland nut. Hand tight is sufficient.
3. Stand HP cylinder jug upright with stud nuts resting on platform of wood blocks or stand tool item (B), Table 7.3.

DANGER: HP cylinder jug is heavy and if it is stood on top pan of the pump, will present a falling object hazard. Take care to properly support jug so that it will not fall.

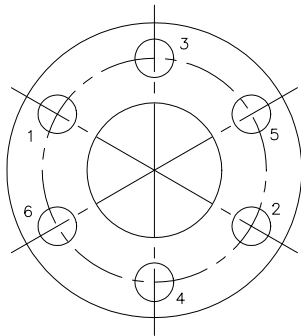
4. Fill HP cylinder bore with water, then fit a used plunger or seal removal tool (item (E), Table 7.3) into bronze packing follower. Note that wrapping a shop rag around the plunger at the packing follower avoids splash-back. Use a dead blow hammer to strike the button end of the plunger as though attempting to drive the plunger into the HP cylinder. This technique should 'hydraulic' the HP seal components upward onto the plunger/ tool shaft and out of the HP cylinder.
5. Slip plastic liner tube from bore of HP cylinder, inspect for possible heat or wear damage or for possible debris. Feel ID of HP cylinder for approximately 1-inch into bore. Sand any obvious ridges or grooves with 600-grit wet/dry sandpaper. Note that grooves or ridges are typically caused by seal debris buildup rather than by marks in ID wall of HP cylinder.
6. Inspect plunger surface for flaws. Rotate plunger 360- degrees by hand while viewing light reflection on plunger surface to note any dullness, streaks, pits or other defects. Run fingernail perpendicular to direction of suspected surface flaws to gage severity of defects. Depending on seal life achieved with removed HP plunger seal, make judgment regarding whether to replace plunger. Refer to Paragraph 7.2.6 for procedure regarding plunger removal/ installation.
7. Lightly coat seal components with FML grease refer to Table 7-2 item 1 prior to installing seal parts on plunger. Install new HP plunger seal assembly onto plunger, refer to Figure, Detail I, (paragraph 7.2) for proper seal component orientation. Note that steel spring inside U-cup (if so equipped) can be easily distorted. Verify that U-cup spring, lips and cavity appear uniform prior to installation.

NOTE: Bronze packing follower intended to fit tightly on plunger. If follower is too tight to slip onto plunger, try heating follower in hot water. Then attempt to slip follower over plunger.

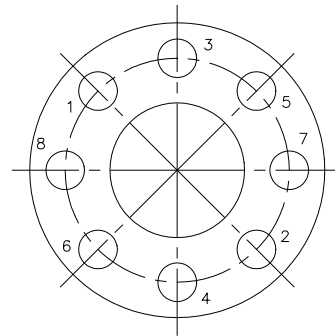
8. Slip plastic cylinder liner tube over plunger.
9. Install HP cylinder jug to hydraulic cylinder head per paragraph 7.2.2.

TABLE 7.1 FLANGE NUT TORQUE SPECIFICATIONS

Plunger Diameter	7/8" Diameter Plunger (SL-IV Plus)		1-1/8" Diameter Plunger (SL-IV 100S)	
No. of Studs, Tightening Sequence	6 each (Fig A)		8 each (Fig B)	
Units	N-m	Ft-Lb.	N-m	Ft-Lb.
1 st Stage	Hand Tight	Hand Tight	Hand Tight	Hand Tight
2 nd Stage	135	100	135	100
3 rd Stage	200	150	200	150
4 th Stage	257-285	190-210	257-285	190-210
Max Out-of Parallel	1.8mm	0.070"	1.8mm	0.070"
Socket Wrench Size	1-7/16"		1-7/16"	



6-BOLT CROSSING PATTERN
FIG. A



8-BOLT CROSSING PATTERN
FIG. B

Table 7-2. Lube Specs KMT Intensifier Pumps

Item No.	IR P/N	Description	Applications
1	10087385	FML Grease, White	Lube Parts, HP Cylinder
2	10084440	High Purity Goop-SS Thds	SS Threads
3	49832199	Moly Disulfide Grease	Non-SS Thds

Table 7.2 HP INTENSIFIER SERVICE TEARDOWN SEQUENCE

		Disassemble/Re-assemble						
Intensifier Component Maintenance	Related Component Assembly	HP Piping	LP Water Plumbing	HP Cylinder Sealing Head, Flanges & Studs [1]	Stud Nuts & End Flange	Retainer Flanges & Hydraulic Cartridge	Hydraulic Cylinder Head	
Ref Part No.→	--	7.2.1	7.2.1	7.2.2	7.2.3	7.2.5	7.2.6	
1	Outlet HP Check Valve	Sealing Head	Yes	No	No	No	No	No
2	Inlet HP Check Valve	Sealing Head	Yes	Yes	No	Yes	No	No
3	HP Plunger Seal	HP Cylinder	Yes	Yes	Yes	No	No	No
4	Hydraulic Seal Cartridge-Plunger	Hydraulic Cylinder Head	Yes	Yes	Yes	No	Yes	No
5	Sealing Head Cone Seal	Sealing Head	Yes	Yes	No	Yes	No	No
6	HP Cylinder	--	Yes	Yes	No	Yes	No	No
7	Plunger	--	Yes	Yes	Yes	No	Yes	No
8	Hydraulic Piston	--	Yes	Yes	Yes	No	No	Yes

Note [1]:Remove/installed as a unit (HP Cylinder “Jug”)

7.2.5 Plunger and Hydraulic Cartridge Removal and Installation

1. Remove HP and LP piping/ hose, then remove HP cylinder jug following procedure 7.2.2 above.
2. Remove the proximity switch on the intensifier side nearest HP cylinder to be serviced. This procedure will allow hydraulic oil to drain to tank and will minimize oil spillage. Draining takes about 5 minutes. Remove cartridge retainer flange from hydraulic cylinder head by first removing retaining ring using a flat blade screwdriver. Wipe and clean surfaces, weep holes, and grooves in cartridge retainer flange. Check retainer flange for cracks.
3. Using cartridge/plunger removal tool threaded to the seal cartridge, pull the cartridge outward over the plunger. Seals in the hydraulic cartridge can be removed and replaced, or the entire cartridge can be replaced. It is recommended that at least one spare cartridge be kept on hand, ready to install. See Section 7.3.6 for servicing hydraulic seal cartridge.
4. With the cartridge removed, the plunger can be removed with the cylinder head in place. Slide the cartridge/plunger removal tool over the plunger, with the hex-shaped smaller end toward the plunger button. Note orientation of plunger button retainer pins (6 each), then align hex flats of tool with pins. Force tool by hand under pins, then rotate tool slightly to cause pins to retract enough to release plunger. Plunger can now be extracted from hydraulic piston. See Section 7.3.5 for servicing the plunger.
5. To install new plunger, slip cartridge/plunger removal tool over plunger, hex end toward plunger button, to help center plunger in cylinder head. Position plunger in mating pocket of piston, then force into place by hand. Using a flashlight, verify that all 6 pins are equally extended to grip plunger button.
6. Lubricate exposed surfaces of seals in hydraulic seal cartridge with food grade grease and slide cartridge over plunger into cylinder head cavity.
7. Thoroughly clean cartridge retainer flange, including cross-drilled weep holes. Install flange and internal retaining ring, making sure that the retaining ring seats fully inside its groove. Note that hydraulic cartridge O-rings may take up clearance. To install retaining ring, first tap lightly on retainer flange using plunger removal tool. This will compress cartridge O-rings enough to get retaining ring started in groove. Push on outer edge of retainer flange with a flat bladed screwdriver while working one end of retaining ring into groove. Retainer flange should tilt or tip enough to allow retaining ring to move into its groove. Continue working ring into groove while tilting flange until retaining ring is fully installed.
8. Install HP cylinder jug to hydraulic cylinder head per paragraph 7.2.2.

7.2.6 Hydraulic Cylinder Head and Piston—Removal / Re-Installation

1. Remove HP and LP piping/ hose, then remove HP cylinder jug following procedure 7.2.2 above.
2. Remove proximity switch (19) at cylinder end to be serviced. Loosen the remaining proximity switch to drain hydraulic oil in tank.
3. Remove hydraulic seal cartridge (8). Seal cartridge (8) removal is recommended to avoid sliding cylinder head (4) over plunger (2). The plunger need not be removed at this stage.
4. Loosen and remove 8 each socket head cap screws (18) retaining cylinder head (4) to hydraulic cylinder (15). The cylinder head and its O-ring (16) can be removed. The proximity switch mounting flats provide a small lip for loosening the cylinder head.
5. To remove the hydraulic piston (21) from the hydraulic cylinder (15), remove one cylinder head, remove the proximity switch toward that end. On the opposite end remove the HP cylinder and end cap, then remove the retainer flange and hydraulic cartridge. The piston must be driven from the cylinder bore due to the seal squeeze and friction. Use a plastic head hammer to avoid striking the assembly with a metal object. See Section 7.3.7 for servicing the hydraulic piston.
6. Reassemble the hydraulic cylinder by reversing the above steps.
Tighten 12M socket head capscrews (8 per cylinder head) in a crossing pattern to 190-210 N-m (140- 155 ft-lbs).

CAUTION--Remember to install and tighten proximity switches. Failure to do so will result in considerable spraying of hydraulic oil.

7. Install HP cylinder jug to hydraulic cylinder head per paragraph 7.2.2.

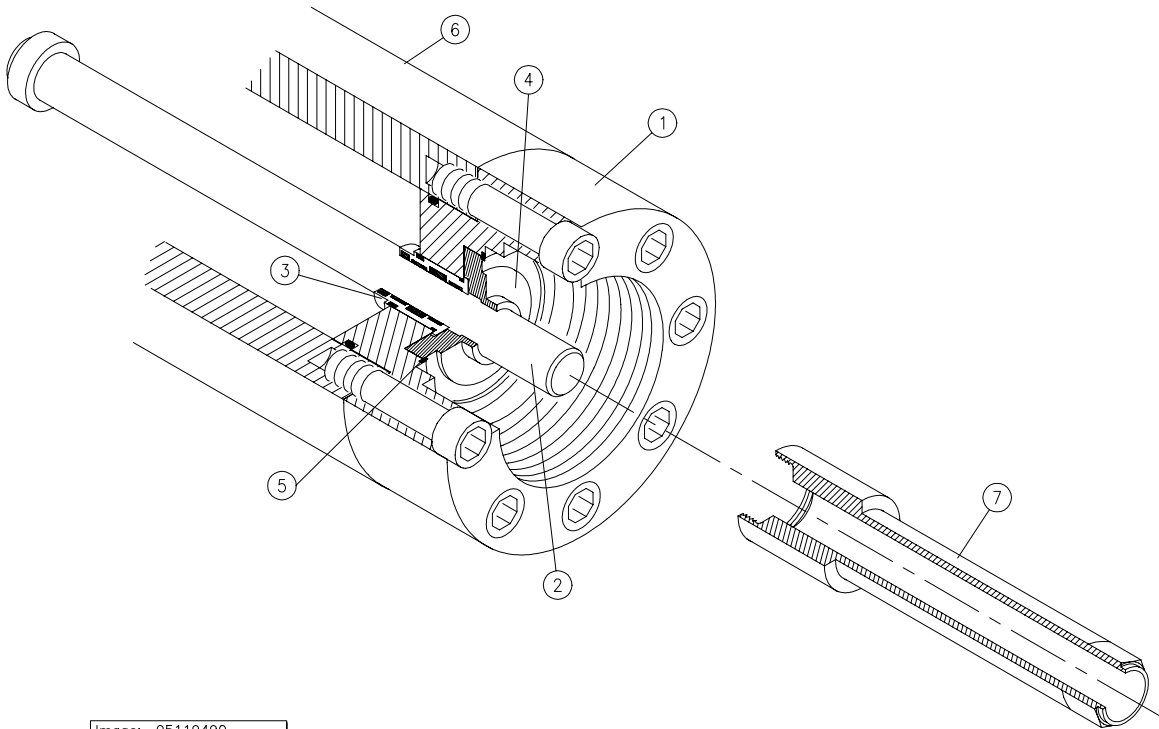


Image: 05119490
Drawing: 05113030 rev

Item Description

- | | |
|--------------------------------------|----------------------------|
| 1. Cylinder Head | 4. Bushing Retainer Flange |
| 2. Plunger | 5. Retaining Ring |
| 3. Hydraulic Cartridge, Plunger Seal | 6. Hydraulic Cylinder |
| | 7. Plunger Removal Tool |

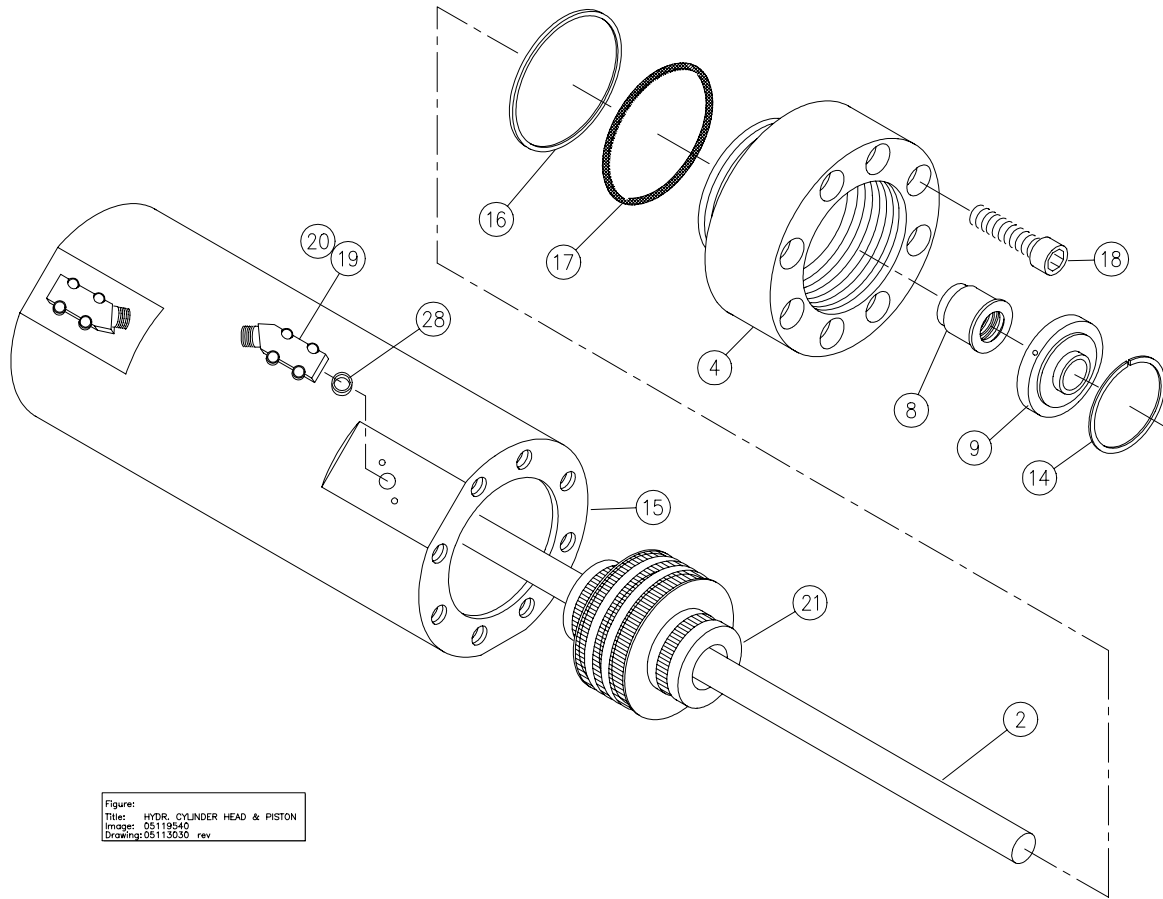


Figure:
Title: HYDR. CYLINDER HEAD & PISTON
Image: 05119540
Drawing: 05113030_rev

Item Description

2.	Plunger	9.	Bushing Retainer Flange	18.	Cap Screw
4.	Cylinder Head	15.	Hydraulic Cylinder	19.	Proximity Switch
8.	Hyd Cartridge, Plunger Seal Assy	16.	O-ring	20.	Cap Screw
		17.	Backup Ring	21.	Hyd Piston Assy
				28.	Spacer

7.3 Intensifier Subassemblies Inspection and Repair

The inspection and repair of the following subassemblies will be discussed:

- Discharge HP Check Valve, Section 7.3.1
- Inlet Check Valve, Section 7.3.2
- Sealing Head, Section 7.3.3
- HP Cylinder, Section 7.3.4
- Plunger, Section 7.3.5
- Hydraulic Seal Cartridge, Section 7.3.6
- Hydraulic Piston, Section 7.3.7
- Hydraulic Cylinder, Section 7.3.8

7.3.1 Discharge HP Check Valve

The HP discharge check valve can be serviced with the sealing head either installed in or removed from its intensifier HP cylinder.

1. Remove the gland nut from the sealing head using a pair of wrenches.
2. When the gland nut is removed, the spring guide and spring will normally stay in the gland nut. The seat is removed with a magnet. Inspect the seat for damage or cracking. A cracked seat should be replaced. The seat is symmetrical, and can be installed with either face toward the poppet. Note that a slight burr at the hole edge identifies the used side of the poppet seat. When reinstalling the seat, apply a thin film of High Purity Goop to both faces. Install the seat into the sealing head with the best surface facing the check poppet.

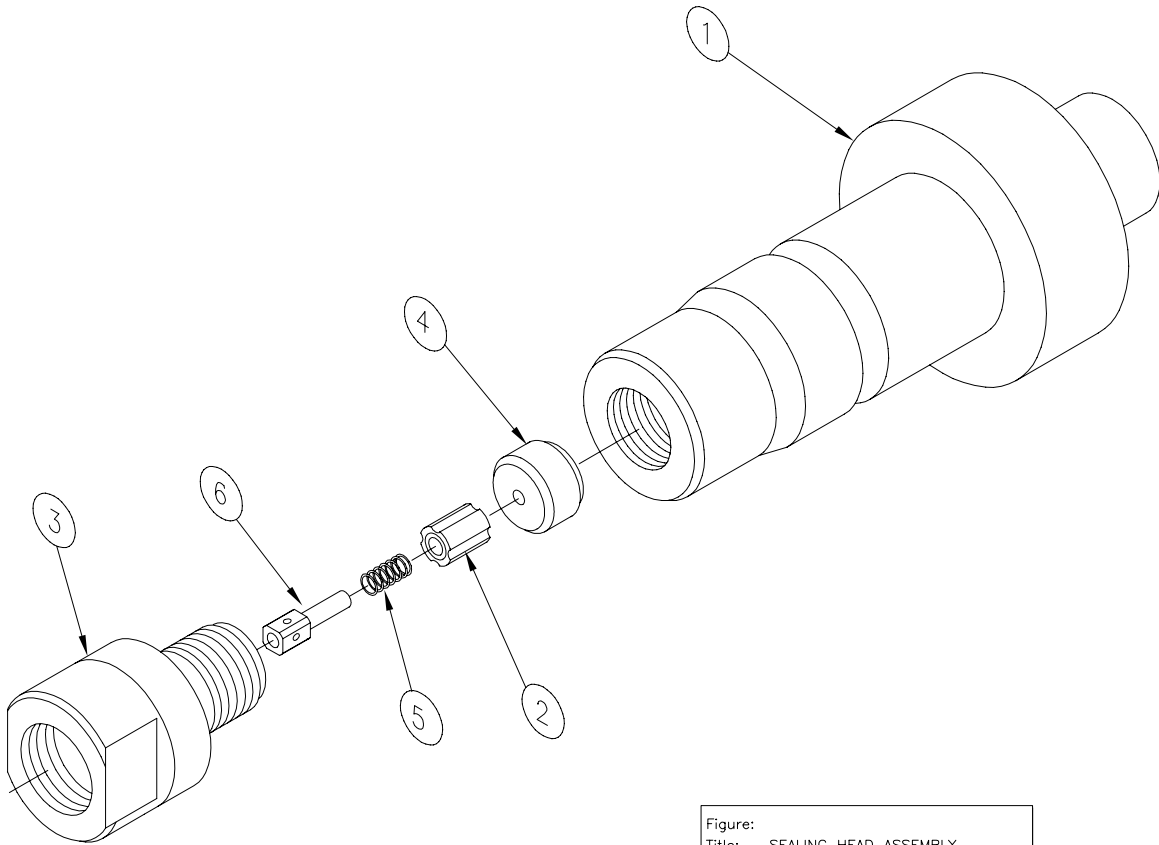


Figure:
Title: SEALING HEAD ASSEMBLY
Image: 05114798
Drawing: 05116769P rev 4

Item Description

- | | | |
|------------------|------------|---------------|
| (1) Sealing Head | (2) Poppet | (3) Gland Nut |
| (4) Poppet Seat | (5) Spring | (6) Guide Pin |

3. Inspect the poppet, spring, and guide for wear. Replace the spring and guide if worn.
4. Apply a thin film of High Purity Goop to the sealing face of the gland nut. Install the guide, spring, and poppet into the gland nut.
5. Apply High Purity Goop to the gland nut threads. Install the gland nut into the sealing head. The gland nut should be hand tightened until there is a gap of 5mm (0.20") between the gland nut and sealing head. No threads should show. If the gap exceeds 5mm (0.20"), then one of the parts has slipped out of place, and they must be removed, inspected and reassembled.
6. Using a crowfoot/torque wrench combination, torque the gland nut to 176 Nm (130 ft-lbs.).
7. Reconnect high pressure and low pressure piping, per Section 7.2.1. Operate waterjet pump to verify HP fittings do not leak, and that the HP water signal is normal (indicative of normal check valve operation).

7.3.2 Inlet Check Valve

1. Use a ½” flat bladed screwdriver to unscrew the poppet retainer from the sealing head. The inlet check valve is disassembled.
2. Inspect and refinish the sealing head face seal surface per instructions in Section 7.3.3.
3. Inspect both surfaces of the flat washer shaped poppet. If one surface is marred, and the opposite surface is not, the poppet may be reversed with the best surface facing the sealing head. If both sides are worn, replace poppet.
4. Assemble poppet (2) and spring (7) on poppet retainer (11). Apply small amount of Loctite 222 thread locker to thread of poppet retainer, taking care not to get Loctite on poppet or other inlet check valve sealing surfaces.
5. Tighten poppet retainer (11) using 1/2-in. flat blade screwdriver taking care not to twist off poppet retainer. If torque wrench tools are available, tighten to 25-30 in-lbs.
6. Inspect the assembled unit to insure the following:
 - The poppet moves freely.
 - The spring is fully guided on the poppet retainer.
 - The spring end is 90° from the retainer’s screwdriver slot.
 - The poppet retainer is shouldered against the sealing head.

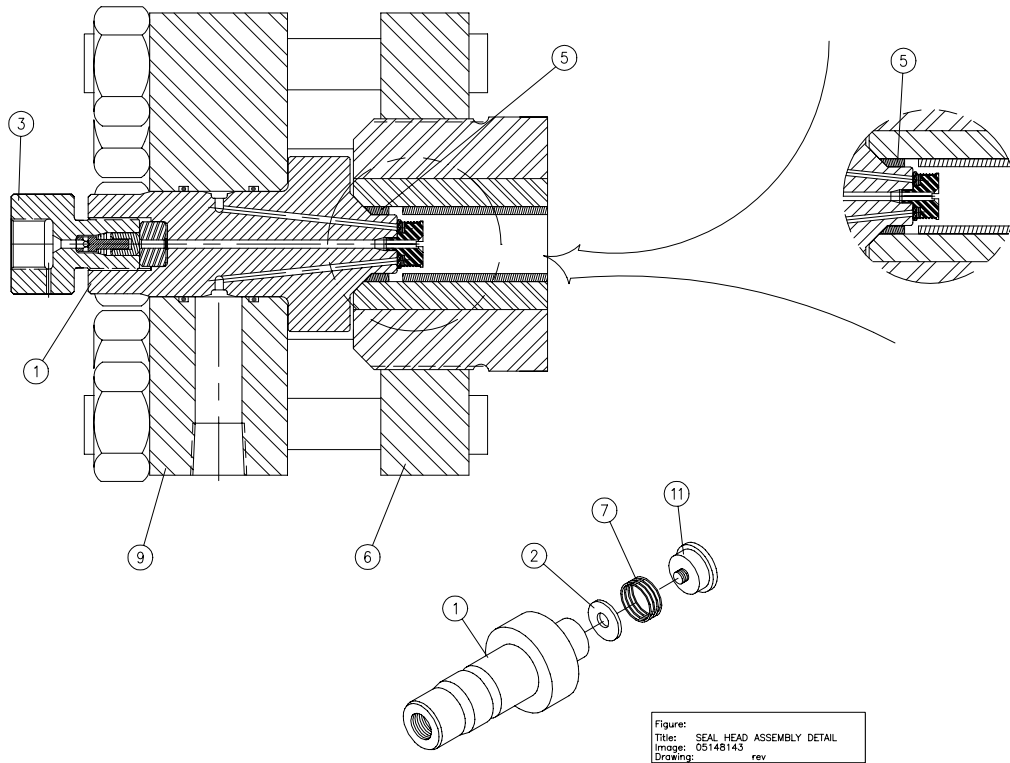


Figure:
Title: SEAL HEAD ASSEMBLY DETAIL
Image: CS148143
Drawing: rev

Item Description

- | | | |
|----------------------|-----------------|--------------------|
| (1) Sealing Head | (2) Poppet | (3) Gland Nut |
| (5) Seal Head Spacer | (6) Flange Ring | (7) Suction Spring |
| (9) End Flange | (11) Retainer | |

7.3.3 Sealing Head

The sealing head should be inspected for scratches and wear on two surfaces:

- HP cone ring seal contact surface
 - Inlet HP check valve poppet contact surface
1. Polish the cone ring 45 degree surface to achieve a smooth finish. Grooves or machine tool marks should be barely discernable by fingernail test.
 2. Inspect the inlet poppet sealing surface of the sealing head for pits, scratches, or jetting erosion. Refinishing the seal head inlet poppet face is mandatory when rebuilding the sealing head. Using a piece of plate glass (not window glass) on a sturdy table, place a piece of 400 grit wet/dry sandpaper atop the plate of glass which provides the absolutely flat surface necessary for the polishing process. Using even, deliberate strokes, polish the sealing head until smooth. Rotate the head about 10-15 degrees every stroke. Be careful not to tilt or tip the head while polishing it as to not scrape the part.
 3. When the sealing head is flat and smooth, perform a final polish with 600 grit wet/dry sandpaper. A mirror finish is required. Ingersoll-Rand offers a refinishing service.

7.3.4 HP Cylinder

1. At a workbench, use the seal removal tool to prevent scratching the cylinder bore sealing surface. Use a pulling action to remove the sealing head HP seal.
2. Remove the bore liner. Use a plastic-faced hammer and the seal removal tool to drive out the plunger HP seal and follower. Be careful not to scratch the bore of the cylinder or damage the cylinder threads.
3. Clean sealing areas of HP cylinder inside diameter and inspect cylinder for rings, scratches, pits, residue build-up and other potential leak paths. Seal material or residue can build up forming a ring, and running a fingernail across it, will cause it to appear as a surface flaw. It is usually necessary to clean the area before performing an inspection.
4. Use 600 grit wet/dry sandpaper to polish HP cylinder inside diameter where the seal will locate. Polish only in a circumferential motion. Do not polish or drag the sandpaper along the length of the cylinder. Hold the sandpaper on the end of your finger, and move in a cylindrical wiping motion in the bore of the HP cylinder. Wipe residue from cylinder inside diameter and re-inspect for surface defects.

NOTE

The HP cylinder ends often show a “step” between inner and outer sleeves where the inner sleeve extends beyond the outer by a small amount. This is normal and does not indicate a flaw in the cylinder.

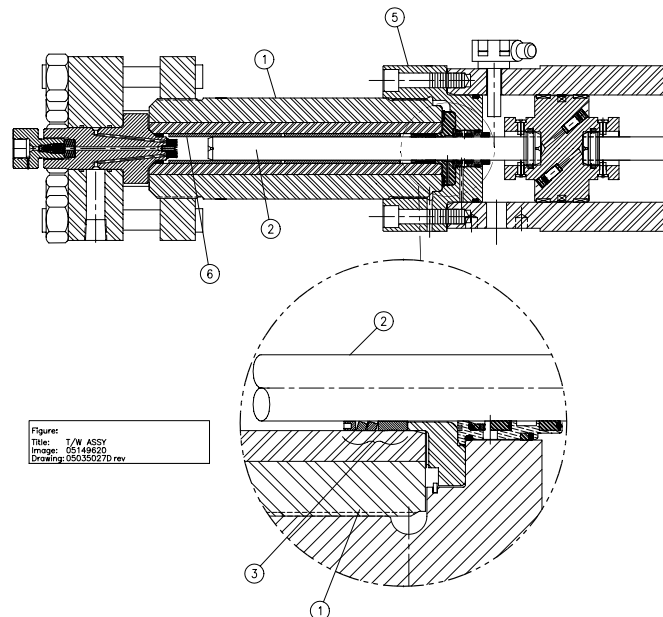


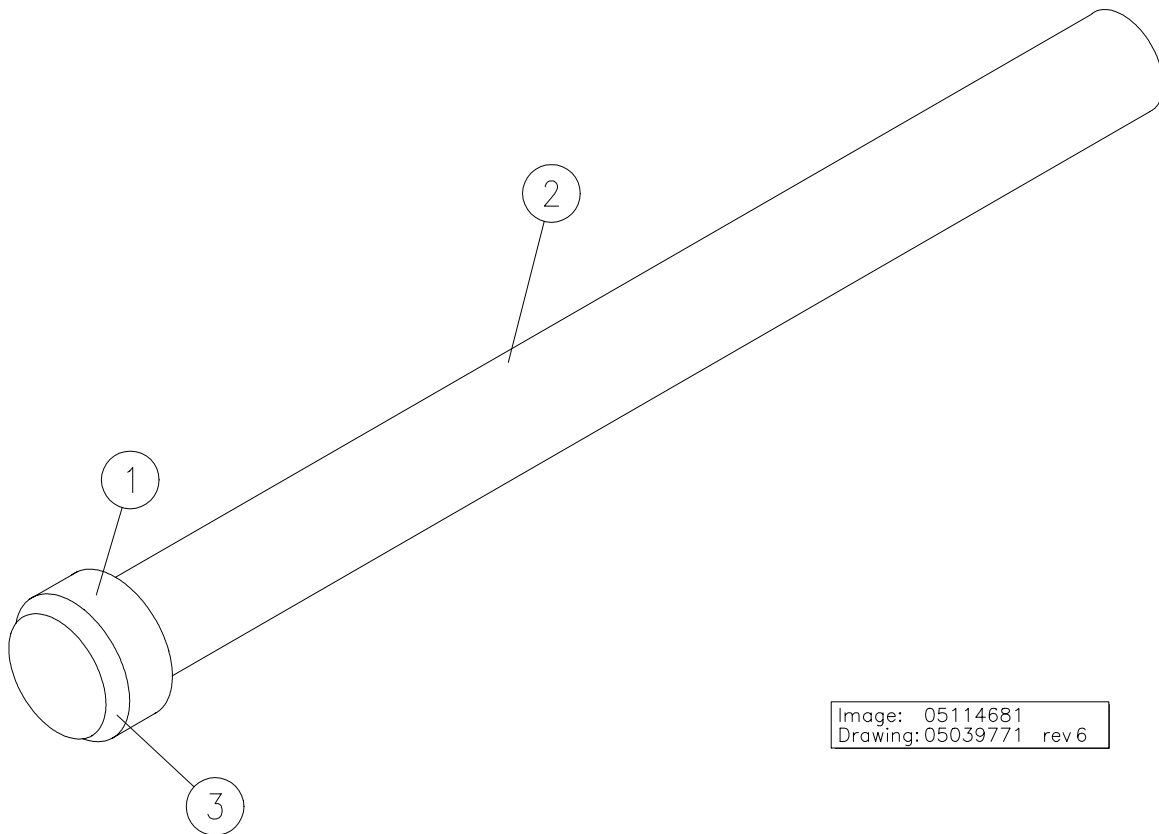
Figure:
Title: T/W ASSY
Image: 05148629
Drawing: 0503027D rev

Item Description

- | | |
|---------------------------|-------------------|
| (1) Cylinder Body | (5) Cylinder Head |
| (2) Plunger | (6) Liner |
| (3) Plunger Seal Follower | |

7.3.5 Plunger

Plunger surfaces can become streaked with longitudinal scratches or flaws, the surface can become discolored or dull in appearance, or the outboard end can become smeared with stainless steel due to contact with the bore liner. If any of these conditions become severe, the plunger HP seal and possibly the hydraulic seals will leak excessively. Repair of plunger surface flaws usually cannot be accomplished on site. KMT Waterjet offers a plunger reconditioning service.

**Item Description**

(1) Plunger Button

(2) Plunger

(3) Button Chamfer

7.3.6 Hydraulic Seal Cartridge

Carefully remove worn seals and O-rings from cartridge by pushing them with a dowel or similar object. Remove seals positioned close to the open ends first, working toward the interior. Examine seals for unusual wear, deformation or cuts. Note any unusual buildups of solid material or debris causing possible leak paths.

Examine the cartridge body (1) surfaces for scratches, signs of metal-to-metal contact, deformation or other unusual wear.

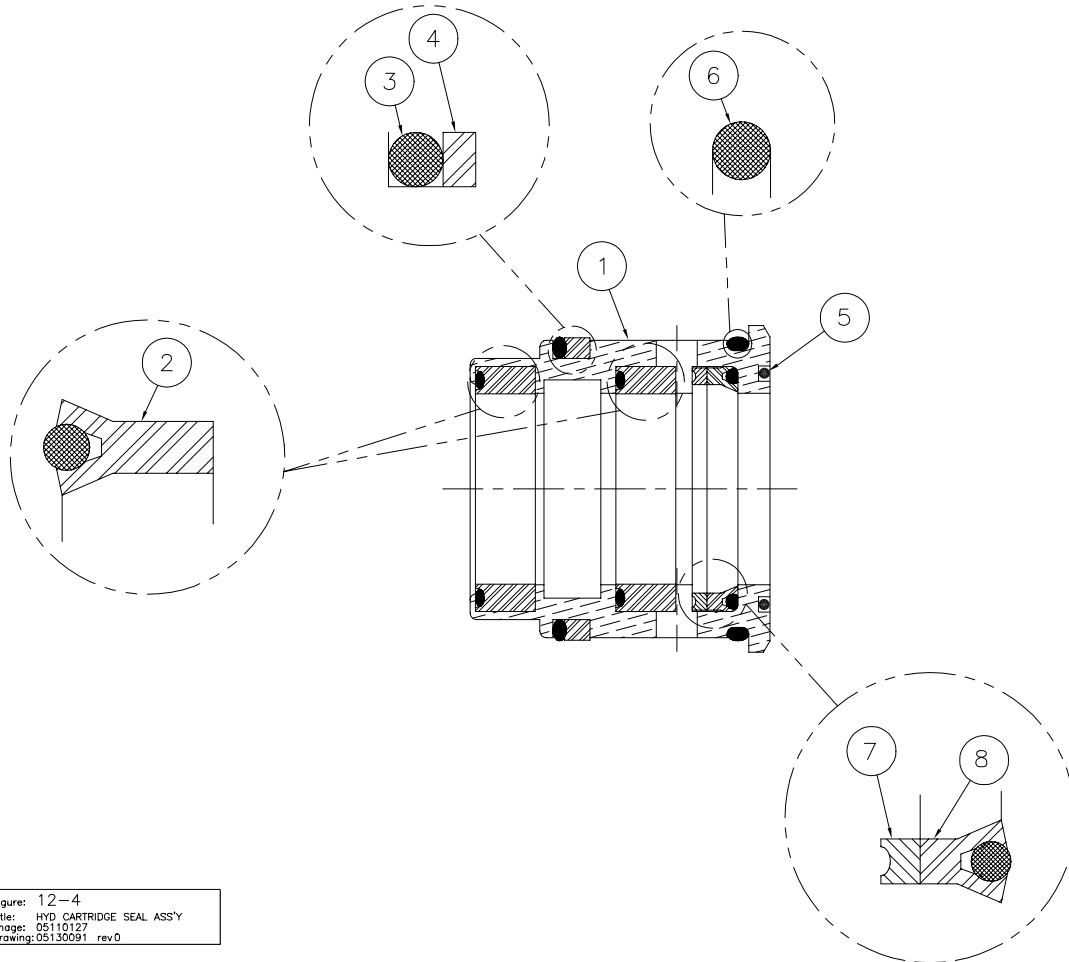


Figure: 12-4
Title: HYD CARTRIDGE SEAL ASS'Y
Image: 05110127
Drawing: 05130091 rev 0

Item Description

- | | | |
|--------------------|----------------|------------|
| (1) Cartridge Body | (2) U-cup Seal | (3) O-Ring |
| (4) Back-Up Ring | (5) O-ring | (6) O-Ring |
| (7) Back-Up Ring | (8) U-cup Seal | |

NOTE

It is important to examine the inside diameter surfaces of cartridge seal grooves for scratches, especially any scratches in the axial direction that might offer a leak path. Use caution during seal removal and installation to avoid scratching these surfaces. Do not use metal screwdrivers, wires, etc. to remove inside diameter seals. Plastic or wood should be used for seal removal and installation.

1. During seal installation, orient U-cup packing seals (2) (8) so that they match figure above.
2. Apply food grade grease to seals and cartridge seal components to aid in installation and seal seating. Use installation tool, if available, for installation of U-cup seals (2) (8). Verify that U-cup O-rings are in place in their respective U-cup seals after installation.

7.3.7 Hydraulic Piston

The hydraulic piston contains a seal assembly, bearing rings, pins and flat spring bands, and check valves. Bearing rings (10) provide wear contact between piston and cylinder ID. Plungers (12) are held in place by 6 each pins (2) per plunger. Pins (2) are maintained in place by flat steel band (6). Check valves (4) are mounted internal to the piston to vent unwanted hydraulic pressure to the piston opposite side. These check valves prevent hydraulic pressure from building behind the plunger button

Replace Piston Seal

1. Remove bearing rings (10) and worn seal ring assembly (9).
Do not scratch bottom surface of piston seal groove. Scratches to the seal groove sides and/or bottom can result in a hydraulic leak.

NOTE: Use a smooth, dull-edged blade made from brass or similar soft (relative to steel) material to remove and install seal assemblies.

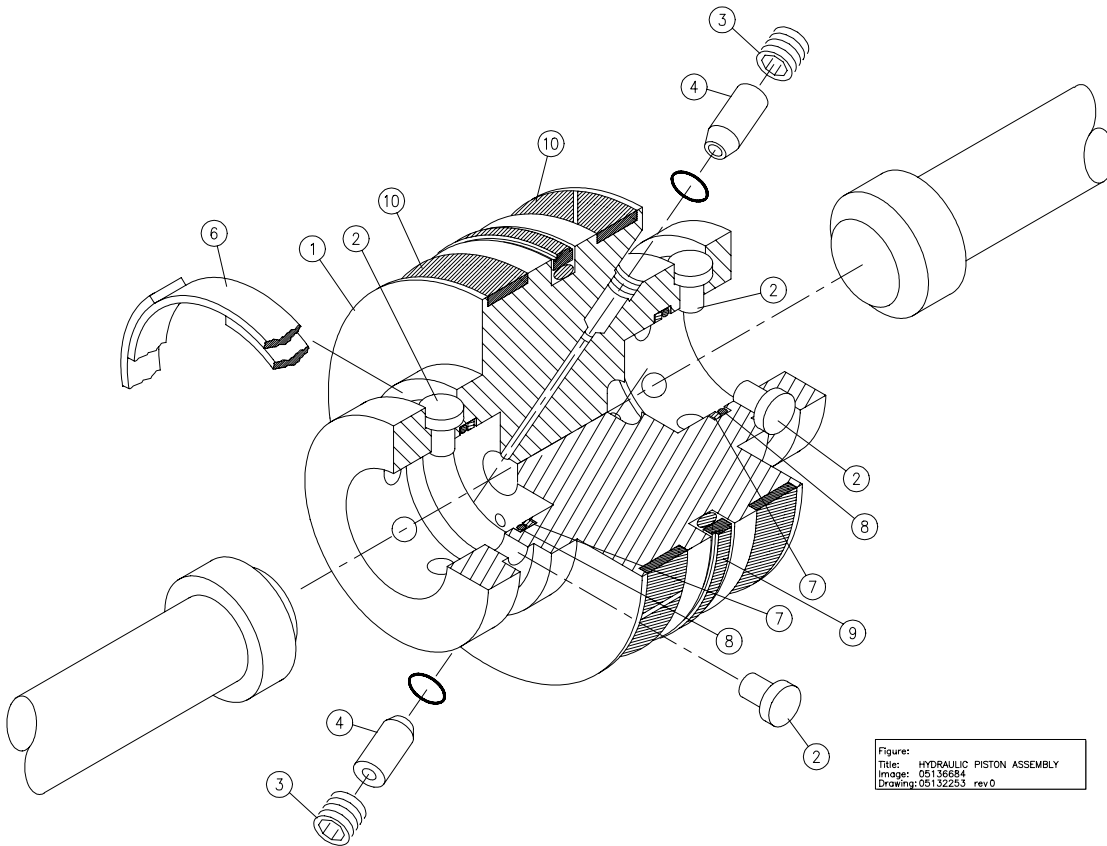


Figure:
Title: HYDRAULIC PISTON ASSEMBLY
Image: 05136584
Drawing: 05132253 rev 0

Item Description

1. Piston	5. Threadlocking Adhesive	7. Backup Ring (2 ea.)
2. Pin (12 Each)	6. Flat Wire Snap Ring (2 ea.)	8. O-ring
3. Set Screw (2 ea.)		9. Seal Assy
4. Check Valve (2 ea.)		10. Bearing Ring (2 ea.)

2. With seal and bearings removed, inspect seal groove bottom for marks or scratches and residue buildup. Clean and /or repair groove surfaces as required.
3. Install replacement bearing rings (10).
4. Install replacement piston seal assembly (9). First install inner ring, taking care that this ring is not twisted after installation. Slide outer seal ring over metal edges, easing seal into place over inner ring.

NOTE: Heating the piston seal ring in hot water (150 degree F for 3-5 minutes) increases seal flexibility.

Service Piston Plunger Sockets (2 each)

1. Remove flat spring bands (6) and remove plunger retainer pins (2). Inspect pins and spring band for deformation or unusual wear. Clean and inspect pin holes in piston for unusual wear or hole deformation/enlargement.
2. Remove plunger button O-ring (8) and backup ring (7) (2 places), taking care not to scratch or otherwise damage seal groove surfaces. Clean and inspect seal grooves for residue buildup or surface marks that might cause seal leaks.
3. Inspect plunger button sockets for unusual wear.

NOTE: Plungers may make an indentation in the bottom of the plunger socket. The bottom of this socket may show the impression of the plunger on it due to the high contact forces between piston and plunger. This compression mark is normal.

Service Piston Internal Check Valves

NOTE: Check valve (4) servicing is not necessary unless there is suspicion of a problem. If the check valves (2 each) or piston internal passages must be serviced, seal and pin servicing is also recommended.

1. Check valves (items (4), 2 each) or cross-drill plug (11) removal may be necessary. Re-install using thread locking compound applied sparingly on the plug threads.

Excess compound may clog a check valve or block a drilled passageway.

NOTE: To avoid excess compound, position the plug or retainer on its Allen wrench, apply thread locking compound, then hold the plug/retainer horizontal on a paper towel while rotating the plug/retainer to wipe off excess thread locking compound.

2. Install O-ring in check valve cavity, positioning in hole bottom with pencil-like blunt instrument. Install check valve with chamfered end toward O-ring. Coat retainer (3) with thread locking compound. Then thread retainer (3) over check valve cartridge (4). Allow 24 hours for thread locking compound to set.
3. Install plugs (11) in cross- drilled passages by applying thread locking compound to plug threads. Then thread plugs (2 each per hole), with the

second plug acting to lock in the first. Allow 24 hours for thread locking compound to set.

Install Plunger Button Seals and Retainer Pins in Hydraulic Piston

1. Install new backup ring (7) and O-ring (8) in each internal groove in each plunger pocket (2 places).

Failure to install backup ring can result in plunger being forced out of plunger pocket.

2. Reinstall pins in piston, verifying that each pin moves freely without excess side play in its cavity.
3. Reinstall band (6) over pins. Repeat this process for the opposite piston side. With piston on bench, install plunger in each end of piston, checking snap-in feature of plunger attachment. Use plunger removal tool to verify that pins retract (release plunger) and close (retain plunger) in a uniform manner.

Install Hydraulic Piston Assy into Hydraulic Cylinder

NOTE: Piston seal assembly must be compressed before the piston assembly will slide into the hydraulic cylinder. A ring compression tool such as shown in the figure below is recommended.

1. Check that hydraulic cylinder bore is free grit, or contamination, and that the proximity switches are removed to prevent interference. Lubricate piston bearing and seal surfaces with FML-2 grease. Lightly lubricate 2-3 inches of cylinder (15) bore with same grease.
2. Fit or drive piston assembly into ring compression tool (20). Position compression tool with piston assembly over end of hydraulic cylinder. Using a plastic-faced hammer so as not to damage piston surfaces, gently drive the piston assembly into the hydraulic cylinder.
3. Remove seal compression tool, continue driving piston assembly into hydraulic cylinder until it is between the proximity switch holes. Continue intensifier re-assembly by installing cylinder heads, plungers, hydraulic seal cartridges, and HP components.

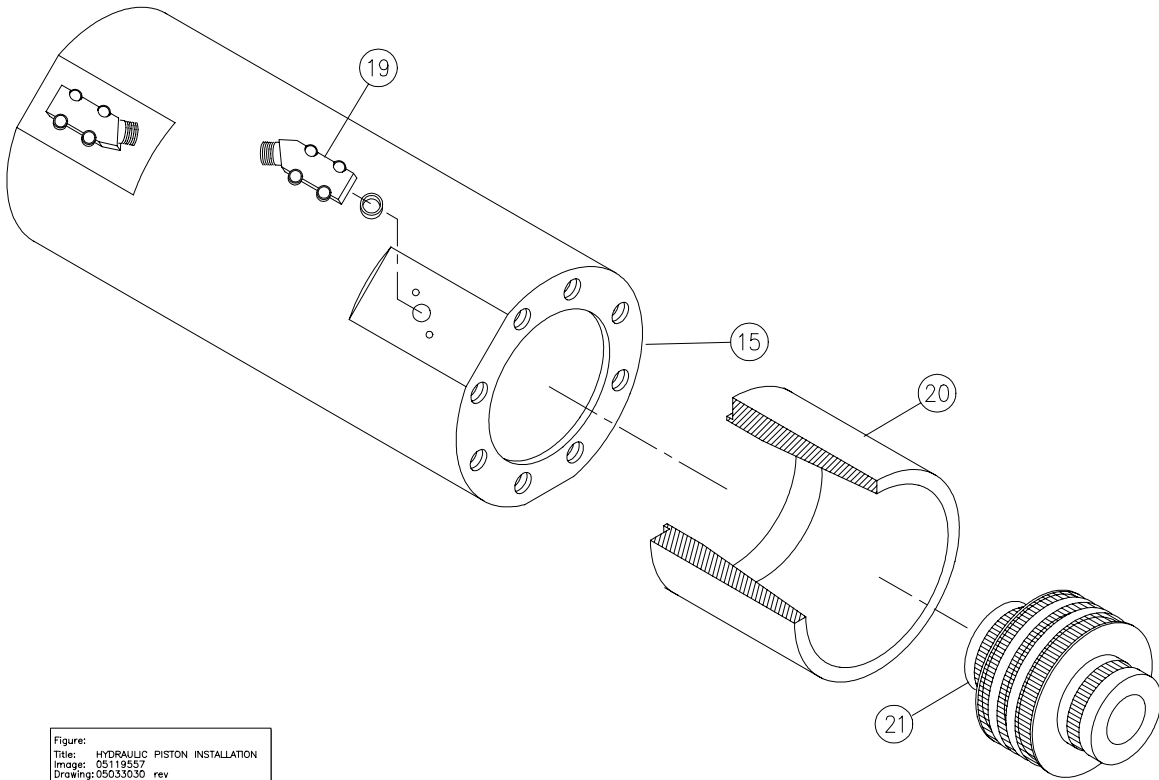


Figure:
Title: HYDRAULIC PISTON INSTALLATION
Image: 05119557
Drawing: 05033030 rev

Item Description

- | | |
|------------------------|---------------------------------------|
| 15. Hydraulic Cylinder | 20. Seal Ring Compression Tool (P460) |
| 19. Proximity Switch | 21. Hydraulic Piston Assy |

7.3.8 Hydraulic Cylinder

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 on this bore is indicative of piston seal wear.

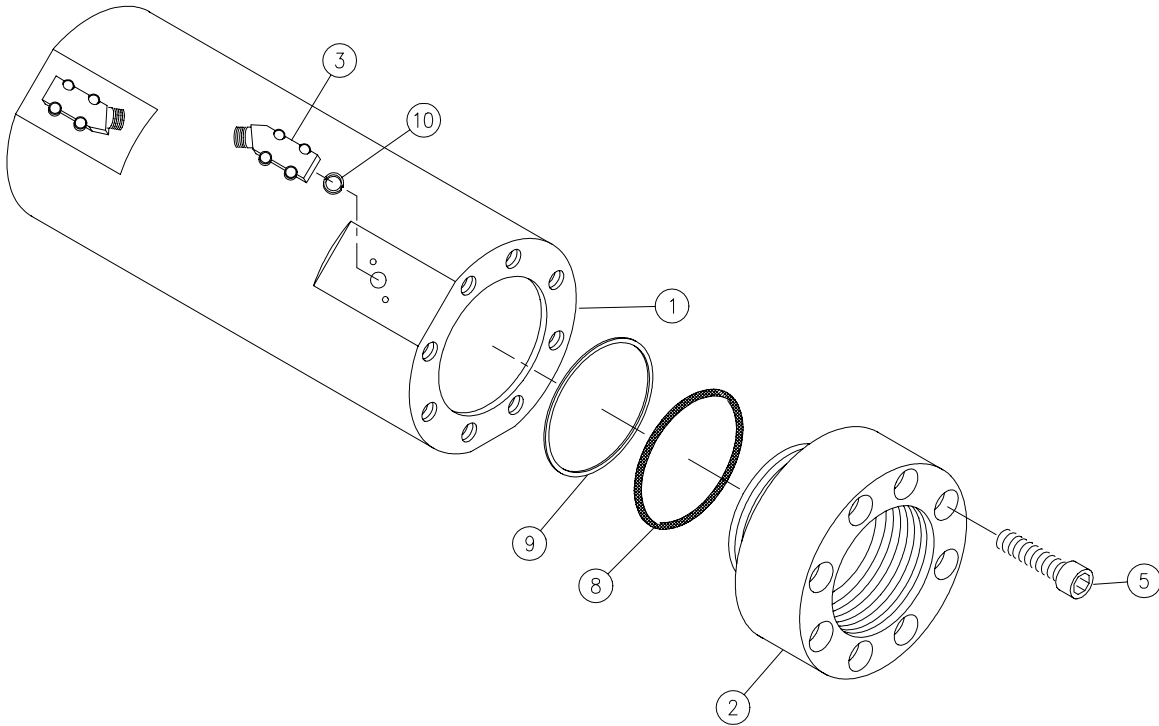


Image: 05114707
Drawing: 05113030 rev

Item Description

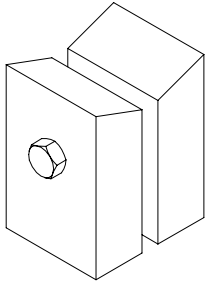
(1) Hydraulic Cylinder	(2) Cylinder Head	(3) Proximity Switch
(5) Cap Screw	(8) Back-up ring	(9) O-ring
(10) Spacer		

7.4 HP Dump Valve

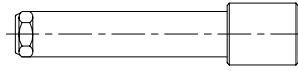
The dump valve assembly includes a normally open HP water valve, plus a solenoid operated air valve for the air actuator on the dump valve. Replacement parts for the HP valve are provided in the **Parts Lists** (Section 12, see Figure 12-7, “Bulkhead Piping Assy”).

7.5 HP Attenuator

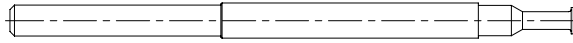
There is no servicing of the HP attenuator at the customer level. The seals in the HP attenuator are tested at Ingersoll-Rand to high pressure in excess of operating pressure making disassembly difficult. In the event of a HP water leak of a HP attenuator, the attenuator should be replaced. The defective attenuator should be returned to KMT Waterjet for replacement or servicing.



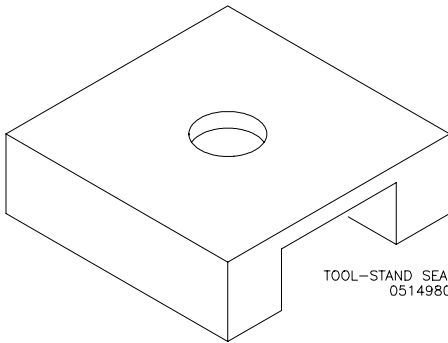
VEE BLOCK CRADLE
05149877



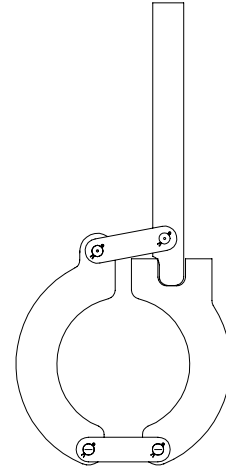
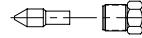
PLUNGER REMOVAL TOOL
05004924



SEAL REMOVAL TOOL
10148674



TOOL-STAND SEAL REMOVAL
05149802



CYLINDER WRENCH
05066139

Figure:
Title: S14 INTENSIFIER HP CYL TOOLS
Image: 49831951
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Section 8 ELECTRICAL SYSTEM**8 Electrical System**

The electrical system contains all functions necessary for turnkey operation. This includes the control and starter panel, intensifier reversal circuit, diagnostics, malfunction warning and protection.

The electrical enclosure and the display, buttons, lights, and electrical harnesses into and out of this enclosure can be exposed to occasional water spray and dust per NEMA-12 standards.

8.1 Electrical Overview

There is only one electric motor on the SL-IV Waterjet Pump. The control voltage of 24vdc is furnished by the built-in power supply drawing its power from the motor's AC circuit.

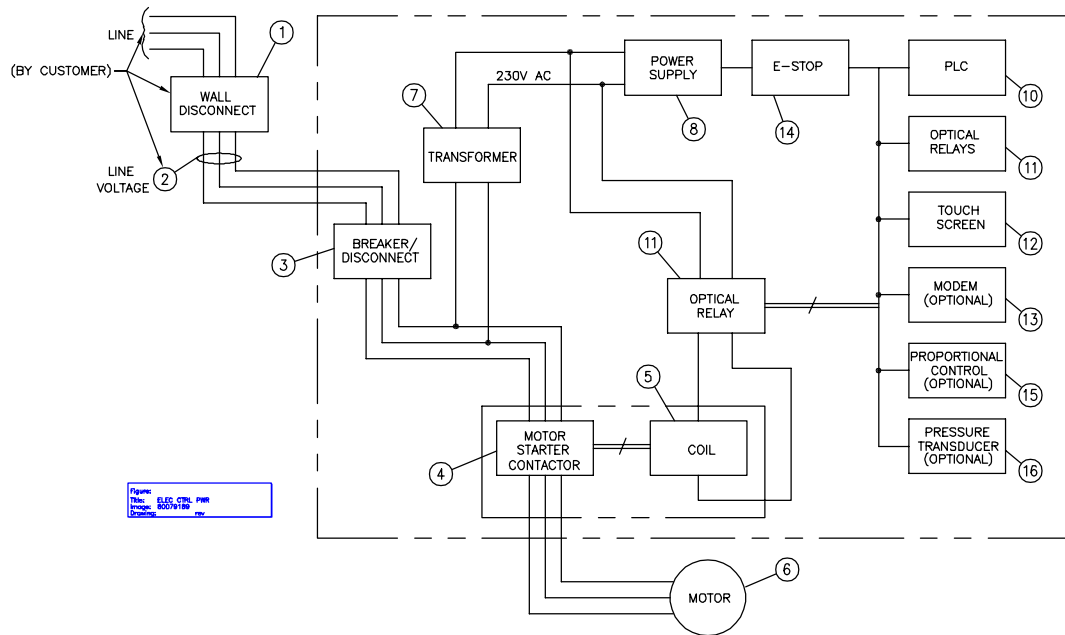


Figure 8-1 ELECTRICAL CONTROL POWER

Item Description

1	Wall Disconnect-Main Power	10	Programmable Logic Controller
2	3-Phase Line (Service Drop) Power	11	Optical Relays
3	Enclosure Door Disconnect/Circuit Breaker	12	Touch Screen Interface Panel
4	Motor Starter Contactor(s)	13	Modem (Optional)
5	Contractor Coil(s) (230V)	14	Emergency Stop Button
6	Electric Motor	15	Proportional Control (Optional)
7	Transformer (230V AC Out)	16	Pressure Transducer (Optional)
8	Power Supply (24V DC Out)		

8.1.1 Motor Starter Circuit

All horsepower levels of SL-IV Waterjet Pumps are available with built-in starter/ control panels . Two starter circuits are typically used:

- ◆ Wye-Delta for reduced voltage starting: Required in Europe and standard on the SL-IV for motors of 75 hp or greater. Three each 3-phase contactors are used to accomplish Wye- Delta starting.
- ◆ Across- the- Line, or Full- Voltage starting: Commonly used in North America, only a single 3-phase contactor is required.

Electrical power from the utility grid enters the SL-IV Intensifier Pump at the combination circuit breaker/ disconnect (3). Note that whenever the door to the electrical enclosure is opened, all electrical power is automatically disconnected from the intensifier pump. Be aware that 3-phase, medium voltage power is still present at the input side of the main circuit breaker/ door disconnect. To make the SL-IV Intensifier Pump electrically safe, one should switch the wall disconnect (1) OFF and observe LOCK-OUT/ TAG-OUT safety practices. Note that the wall disconnect (1) should have circuit breakers or fuses, but that this over current protection may be oversized for the current draw of the particular SL-IV Intensifier Pump. The primary over-current protection for the SL-IV Intensifier Pump is the main breaker/ door disconnect (3) built into the electrical enclosure. On the output side of the main breaker/ door disconnect (3) main power leads connect to the motor starter contactor(s) (4), then to the electric motor (6). Secondary power leads connect to two phases of the main breaker/ door disconnect output side to supply the control circuit.

Other features included in the motor starter circuits include:

- Manual disconnect with door handle interlock
- Overcurrent protection
- Hydraulic unloading during startup, allowing the motor to reach full speed.
- 9-post motor terminal block for European models.

8.1.2 Control Circuits and Logic

The operator controls the waterjet pump primarily through the digital display panel. The digital interface (display) communicates with the PLC controller located inside the electrical enclosure.

In order to avoid costly damage to the pump, automatic shutdown logic and diagnostic messages are displayed to the operator as to the cause of the impending shutdown. The inputs that trigger automatic shutdown are:

- Motor Overload
- Motor Feedback Failure
- Oil Level Low
- Oil Temp High
- Low Booster Pressure
- Low Inlet Water Pressure
- Long Idle Time Shutdown
- Booster Temp High
- Left Overstroke Shutdown
- Right Overstroke Shutdown
- Topworks Overstroke Shutdown

For more information on these conditions and recovery procedures, refer to **Section 3, Operation**, of this manual.

The functions listed below are available by connecting to terminal blocks in the starter/control enclosure. An optional 37-pin circular connection mounted in the side of electrical enclosure is available.

- Start
- Stop
- Emergency Stop (E-Stop)
- Pump RUN indicator light
- Pump malfunction light
- Remote 2-pressure
- Proportional Pressure (optional)

Table 8-2. SENSORS/SOLENOIDS - SLIV

No.	FUNCTION	COMPONENT DESCRIPTION	LOCATION
1	Intensifier shift sensors	Proximity switches	Hydraulic cylinder, intensifier assy
2	Cutting water supply	Solenoid shutoff valve, water	Bulkhead plumbing assembly
3	HP water dump valve	HP shutoff valve, pneumatically-operated, solenoid valve (pneu)	HP discharge piping, betw. HP atten. and bulkhead piping.
4	Intensifier Shift, A/B Port Shifting	Solenoid- operated, directional control valve (DCV), hydraulic pilot- operated spool	Hydr manifold assy, motor/ pump group
5	HI/LO Pressure Select	Solenoid shutoff valve, hydr cartridge style	Hydr manifold assy, motor/ pump group
6	Low oil level/ temperature	Combination level/ temp switch, immersed in hyd fluid	Hydraulic reservoir
7	High Booster Pump Temp	Temperature sensor	LP water filter assy, manifold block
8	Low cutting water supply pressure	Pressure switch, 30 psig	LP water filter assy, manifold block
9	Low booster pump pressure	Pressure switch, 60 psig	LP water filter assy, manifold block

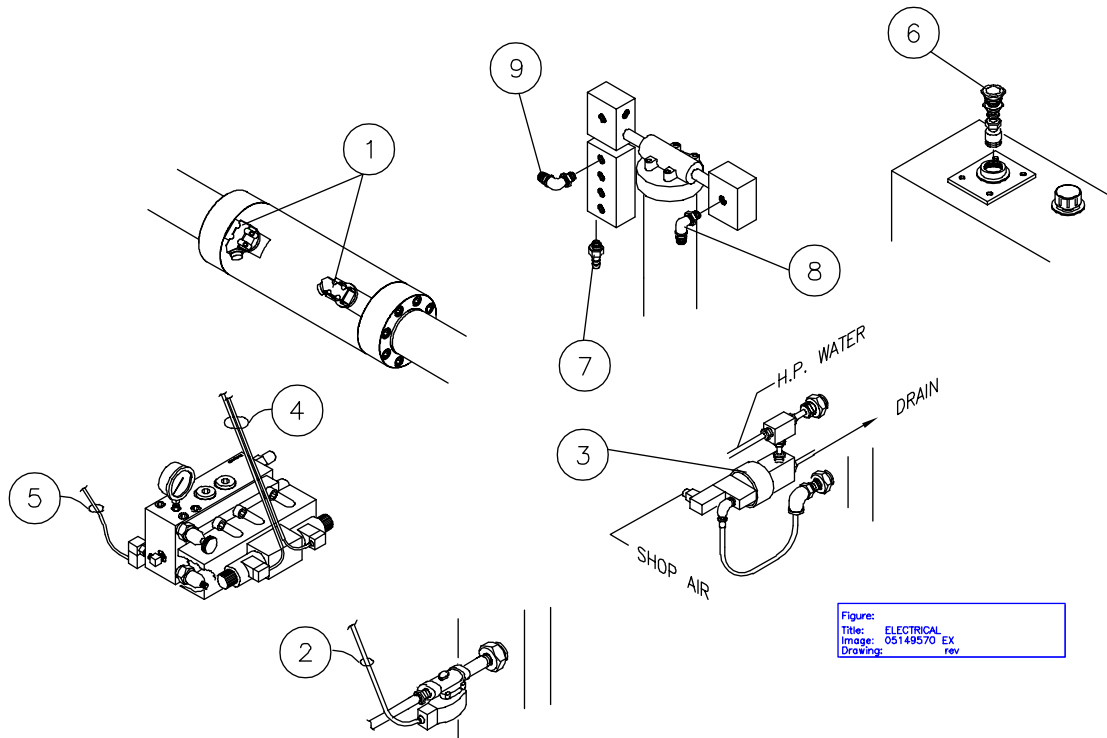


Figure:
Title: ELECTRICAL
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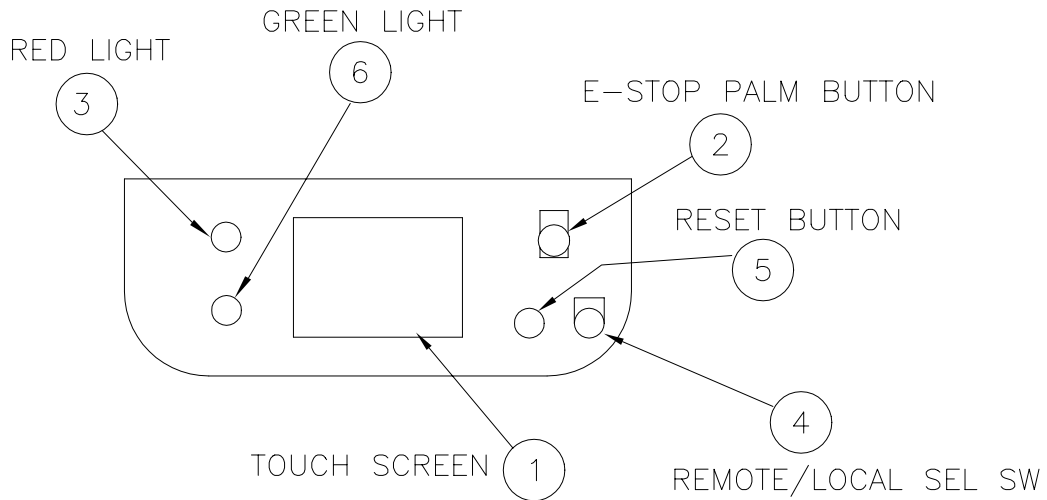


Figure:
Title: CONTROLS
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Figure 8-3 CONTROL PANEL/SCREEN, SLIV

8.1.3 Operation (See Figure 8-3)

To energize the Control Panel, pull the **EMERGENCY STOP** button, then press the **RESET** button. The Control Panel will display the **RUN** screen. After a five second delay, if all run conditions are met (no alarm conditions, and inlet water pressure above 30 psi) the **RUN BAR** will flash, indicating machine is ready to start.

Before starting intensifier insure all parameters are set to users specifications.

On **RUN** screen press **PRESSURE** button to set final pressure. An up/down arrow below the **PRESSURE** switch indicates high or low pressure setting. The pump will be held in low pressure for 20 seconds after motor is started, after which pressure will go to high if high is selected, otherwise the pump will stay in low pressure. The final pressure may also be set on the **PRESSURE CONTROL** screen if analog control is present.

On the **STROKE RATE** screen set the **STROKE RATE ALLOWED**. Because overstroke protection is related to stroke speed under actual pressure setting, this allows you to control sensitivity of the overstroke protection software for your particular operating pressure.

Return to the **MAIN MENU**. Scroll to **SET-UP** screen. There are two **SET-UP SCREENS** – If analog pressure control is not installed on the machine, a screen will appear that does not include the **TRANSDUCER** and **PROPORTIONAL SELECT** buttons. These buttons are used only if a pressure transducer and/or a proportional valve are installed on the machine. Set water reset function and idle shutdown function on or off.

WATER RESET FUNCTION

Press on **(I)** to shut water off five (5) minutes after machine shuts down. Selecting this function will insure that the inlet cutting water is shut off following a shutdown fault. This can prevent water from leaking past a damaged water seal following an overstroke shutdown caused by a seal failure.

IDLE SHUTDOWN FUNCTION

Set timer to stop machine after 5-30 minutes of inactivity (machine not stroking). This feature saves energy by automatically shutting down the intensifier if it is not being used.

For more information, refer to Section 3, **Operation**, of this manual.

(1) Standard machine, start-up after machine has been E-stopped:

Safety dump valve will be open. It will close 3 seconds after the T/W begins stroking. The pump will be held in low pressure for 20 seconds after motor is started after which pressure will go to high if high is selected, otherwise will stay in low.

The purpose for this is to allow entrapped air to be bled from any HP cylinder that has been maintained to avoid hot air burning the plunger seals.

(2) Standard machine, start up after normal stop: Safety dump valve will be closed, pump will be held in low pressure for 20 seconds after motor is started, after which the pressure will go to high if high is selected, otherwise will stay in low.**(3) Machine equipped with hp transducer, start up after E-stop:** same as (1) above.**(4) Machine equipped with hp transducer, start up after normal stop:** If pressure is allowed to bleed through orifice to below 1000 psi, dump valve will open and start up will be like (1) above, if pressure is not allowed to bleed, start up will be as (2) above.

- The display screen will always default to the **Run** screen after being on any other screen more than 5 minutes.

NOTE

The high-pressure dump valve will not close if the air supply is OFF.

After pressing the Start button:

- The motor starter in the control panel is activated and the motor starts.
- The intensifier assembly starts operating. Reversal position is sensed by proximity switches, which send signals to the PLC inside the control panel. The PLC activates the opposite solenoid on the pump reversing valve.

8.1.4 CONTROL POWER CIRCUITS (see Figure 8-1)

A control power transformer (7) with multiple input taps and 230 VAC output taps provides all control power to the SL-IV Intensifier Pump. A pair of leads from the main breaker/ door disconnect (3) are routed to the transformer (7) input side. Note that transformer (7) input voltage should match voltage at the wall disconnect (1). Hence, the 2 leads to the transformer (7) input are correct when L1 is 0 volts and L2 matches the wall disconnect (1) voltage (e.g., 460, 415, 757, 400, 208 volts-AC, etc.).

Transformer (7) output power is always 230 volts-AC. Note that if the Pump has a 230 volt AC motor (6) and starter (4) setup, no transformer (7) is necessary. (IR Waterjet does NOT recommend that Pumps be operated at 230 volts-AC for reasons of operating cost and energy savings, though sometimes running the intensifier at this and other low voltages is necessary.)

Wiring from the control power transformer (7) output (secondary windings) is directed to two places: 1) motor contactor(s) (5) and 2) 24 volt-DC power supply (8). To minimize the load requirement on the 24 volt-DC power supply, motor contactor coil(s) (5) use 230 volt-AC coil(s), while the relay logic (11) controlling the motor contactor(s) (4) is powered by 24 volts-DC.

The 24 volt DC power supply (8) receives 230 volts-AC input power and regulates it to 24 volts DC, 5 amps maximum output power. 24 volt-DC power from the power supply (8) first passes through a circuit breaker and the EMERGENCY STOP (E-Stop) (14) logic, then to the PLC (10), the touch screen display (12), the optical relays (11), and to other control functions.

8.1.5 (OPTIONAL) PROPORTIONAL PRESSURE CONTROL

Proportional pressure control (optional) allows the operator to change cutting water pressure using the touch screen. An electronically-controlled hydraulic cartridge relief valve mounted on the hydraulic manifold accomplishes this proportional control. The proportional relief valve receives its commands from a section of the PLC. An analog output module attachment with the PLC is required to operate the proportional pressure control.

8.1.6 (OPTIONAL) MODEM

Modem option available for remote maintenance, trouble-shooting and software updating.

8.2 Maintenance Overview

Electrical components require minimum attention and service. The components that require service are the proximity switches on the intensifier assembly, and the optical relay switch in the control panel.

8.2.1 Proximity Switch Service

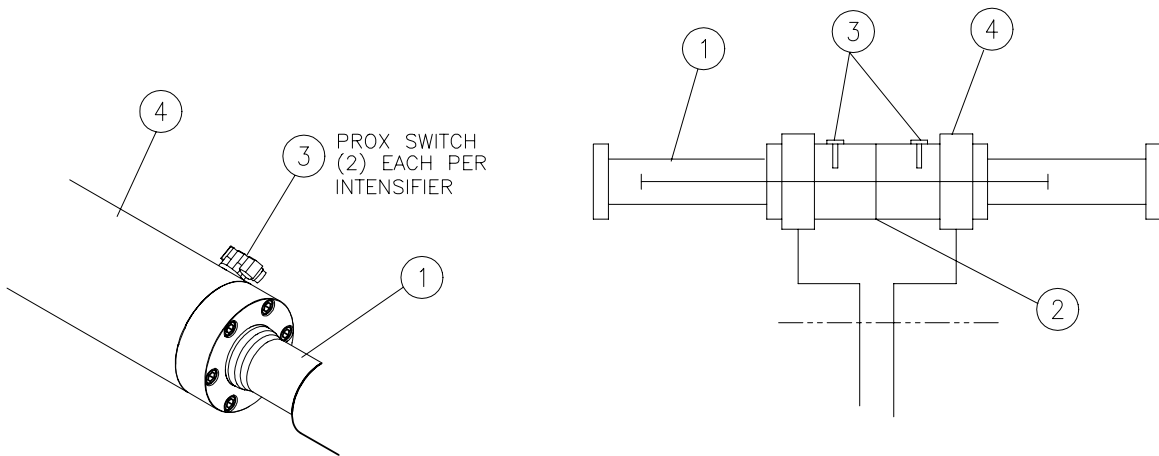
If the pump quits pumping water, the proximity switch may need to be replaced. Check the LED lights on the switch.

Symptoms of a failed proximity switch are (1) the LED lights do not change state (indicating not sensing the piston) or (2) the LED lights are continuously flashing. Replace the switch when failure occurs.

- | | |
|---------------------------|--|
| Components: | (1) Intensifier Assembly
(2) Piston
(3) Proximity Switch
(4) Hydraulic Cylinder |
| Recommended Tools: | Allen (hex) Wrench, M5
Torque Wrench
Rags |
| Parts: | Proximity Switch |

Replace Proximity Switch

1. Turn off waterjet pump, disconnect and LOCKOUT electric power.
2. Disconnect cable.
3. Unscrew bolts, remove proximity switch.
4. Install new switch. Install bolts.
5. Torque bolts to 16-18 Nm (140-160 in-lbs.).



PROX SWITCH
(2) EACH PER
INTENSIFIER

Figure:
Title: PROX SWITCHES
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8.2.2 Optical Relay Switch Service

Components:	Optical Relay Switch
Recommended Tools:	Flat screwdriver, 3mm (1/8 inch)
Parts:	Optical Relay

Replace Optical Relay Switch

1. Turn off waterjet pump, disconnect and LOCKOUT electric power.
2. Open control panel.
3. Unscrew optical relay switch mounting bolts, remove and replace.

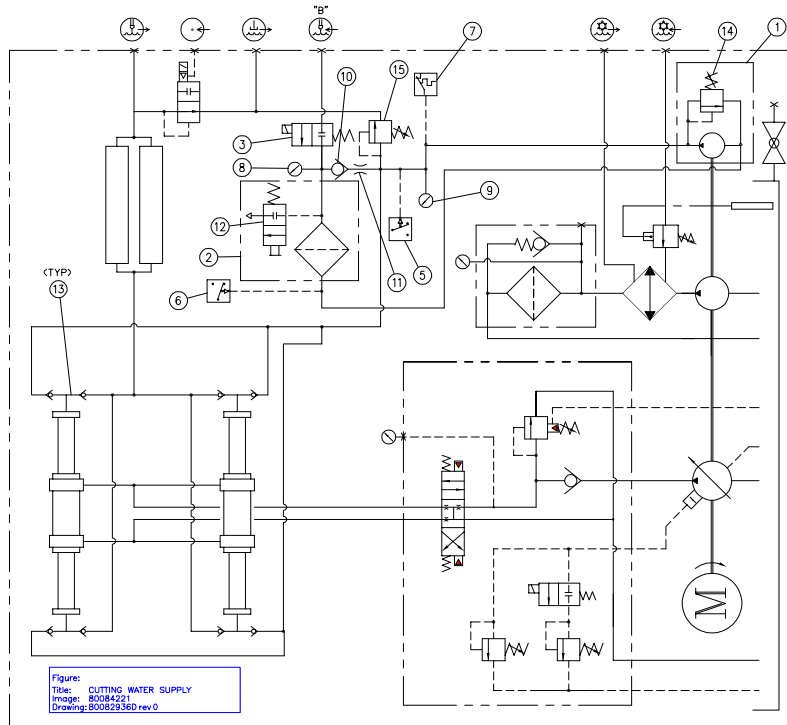
If the motor will not start and a “motor feedback” fault message appears, the optical relay which controls the motor starter may need replaced.

9. HYDRAULIC SYSTEM

9.1 Features

In addition to “slow start”, other features of the hydraulic system are listed below:

- **Hydraulic 4-way valve** – directional control valve (DCV)–solenoid–operated. Used for HP cylinder shifting.
- **Close - coupled motor/hydraulic pump** – pump mounts directly to the motor, saving approximately 8-10 inches of length on the overall pump/motor assembly, reducing footprint of the waterjet pump package. The pump is directly coupled to the motor rather than a conventional standalone housing and shaft coupling assembly.
- **Reference hydraulic gage** – used for adjusting pressures in the HI/LO relief valves. Displays hydraulic pressure, as well as water pressure in multiple units directly at the pressure adjustment knob.
- **Built in hydraulic oil drip pan** – allows for the spills to be contained within the machine
- **Remote dual pressure control** – allows for flexibility at the cutting nozzle in pressure adjustments for certain pure water/abrasive applications.
- **Pressure adjustment control** – allows for infinite pressure settings though out the entire pressure range for flexibility.



9.1.1 Components

Following are the hydraulic system components:

NOTE

The main pump is direct-mounted to the motor. The main pump control includes hi and lo preset pressures. The operator is able to switch between pressures at the operator's console.

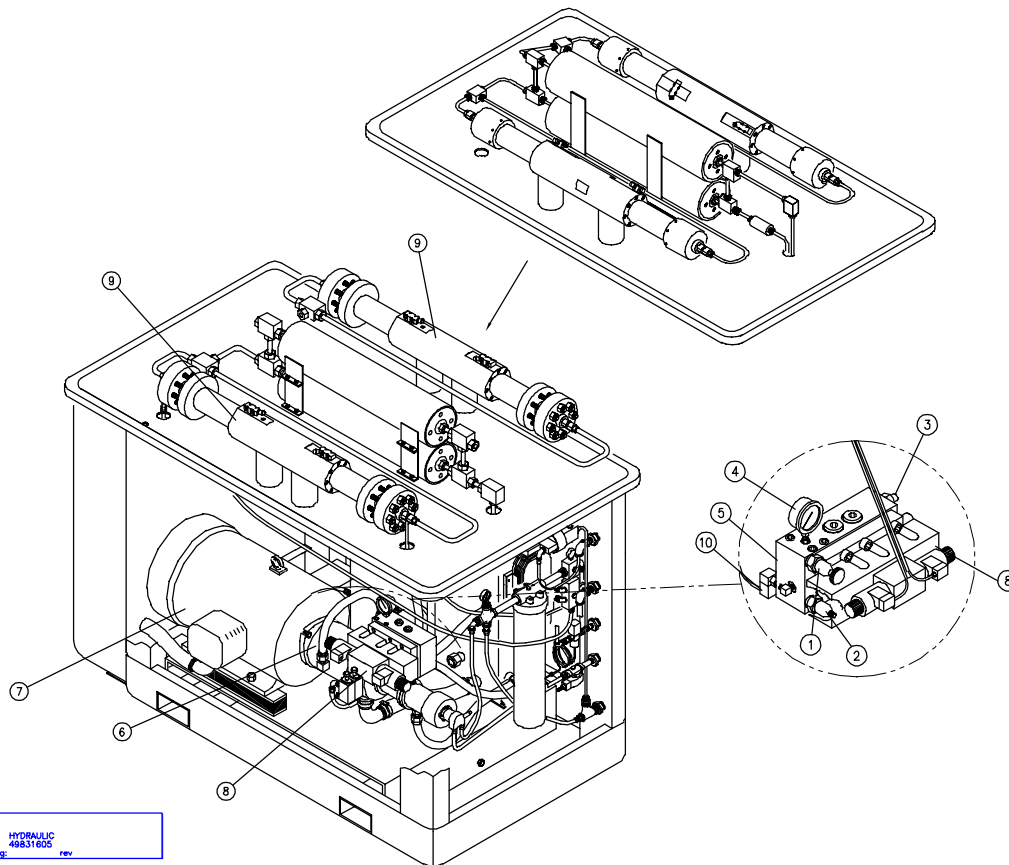


Figure:
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Item Description

- | | | |
|---------------------------|-------------------------------|------------------------|
| (1) HI pressure control | (2) LO pressure control | (3) Fixed relief valve |
| (4) Gage | (5) Manifold | (6) Pump |
| (7) Motor | (8) Directional Control Valve | (9) Hydraulic Cylinder |
| (10) Hi-Lo Solenoid Valve | | |

9.2 Operation

The hydraulic system operates at HI or LO pressure settings up to the maximum flow capacity of the variable displacement piston pump. Upon selecting HI or LO, the operator is able to adjust the HI or LO pressure controls within the respective adjustment ranges. Note that for SLIV pumps having proportional pressure control, the discussion of HI/LO controls does not apply. Instead the proportional pressure control is used to increase/decrease hydraulic pressure on the pump.

The electric motor (7) drives the variable displacement, pressure compensated pump (6). The hydraulic manifold (5) is mounted on the pump discharge. The flow from the pump passes through a check valve to the directional control valve (8), and the directional control valve sends the flow to the hydraulic cylinders (9) in one direction until the piston activates the proximity switch at the end of the stroke. The activated proximity switch sends an electrical signal to the programmable controller (PLC). This PLC in turn activates the directional control valve (8) to change flow and to reverse direction of movement of piston until activating the opposite end-of-stroke proximity switch.

Although one DCV supplies hydraulic power to two intensifier hydraulic cylinders arranged in parallel, these cylinders operate at approximately the same cycle rate due to logic built into the PLC (see Section 8, Electrical System).

9.2.1 Hydraulic Pressure Adjustment

A variable displacement pressure compensated feature maintains constant operating pressures even under variable flow demands. Dual pressure control is standard. Switching high to low pressure may be done at the control panel (or remotely) with the HI-LO switch that activates the solenoid valve (10). The HI pressure is set by adjusting the knob (1) and the LO pressure is adjusted using a wrench on that relief cartridge (2). Turning the knob/adjusting the screw clockwise increases pressure.

NOTE

In order to remote select the pressure, the remote/local switch should be set to the "REMOTE" position.

Proportional pressure controls are typically located at an operator's station that is remote from the SLIV intensifier pump.

9.2.2 Hydraulic System Pressure Protection

Besides the HI-LOW Pressure Control Valves, the hydraulic system pressure is limited by the main relief valve (3). The operating hydraulic pressure is indicated by hydraulic gage (4).

Control	Valve	Pressure Adjustment		Hyd. Pressure Bar (psi)	
		Increase	Decrease	Maximum	Minimum
High Pressure	1	Clockwise	Counterclockwise	207 (3,000)	1.7 (25)
Low Pressure	2	Clockwise	Counterclockwise	103 (1,500)	1.7 (25)
Main Relief	3	Fixed	Fixed	234 (3,400)	(Not applicable)

NOTE

Do not adjust the HI pressure control to pressures greater than 207 bar (3,000 psi). Doing so will cause the main relief to open limiting hydraulic pressure to 234 bar (3,400 psi). Excessive opening of the main relief valve will result in significant wasted heating of the hydraulic oil, and the decrease of water flow performance.

9.3 Motor/Hydraulic Service Maintenance

The hydraulic oil filter should be checked daily and replaced when the visual indicator is in the red zone. The hydraulic oil should be replaced every 3000 hours or yearly, whichever occurs first. For hydraulic oil and filter maintenance, see Section 10, **Recirculation System**.

The hydraulic system components that require periodic maintenance are the motor and the manifold. The motor needs to be serviced every 5000 hours of use. The operating pressure settings of the manifold needs to be checked daily and adjusted if necessary.

Recommended Tools: Manual Grease Gun
Open End Wrench 14mm (9/16")
Rags

Parts: Bearing Grease, SRI #2 or equivalent

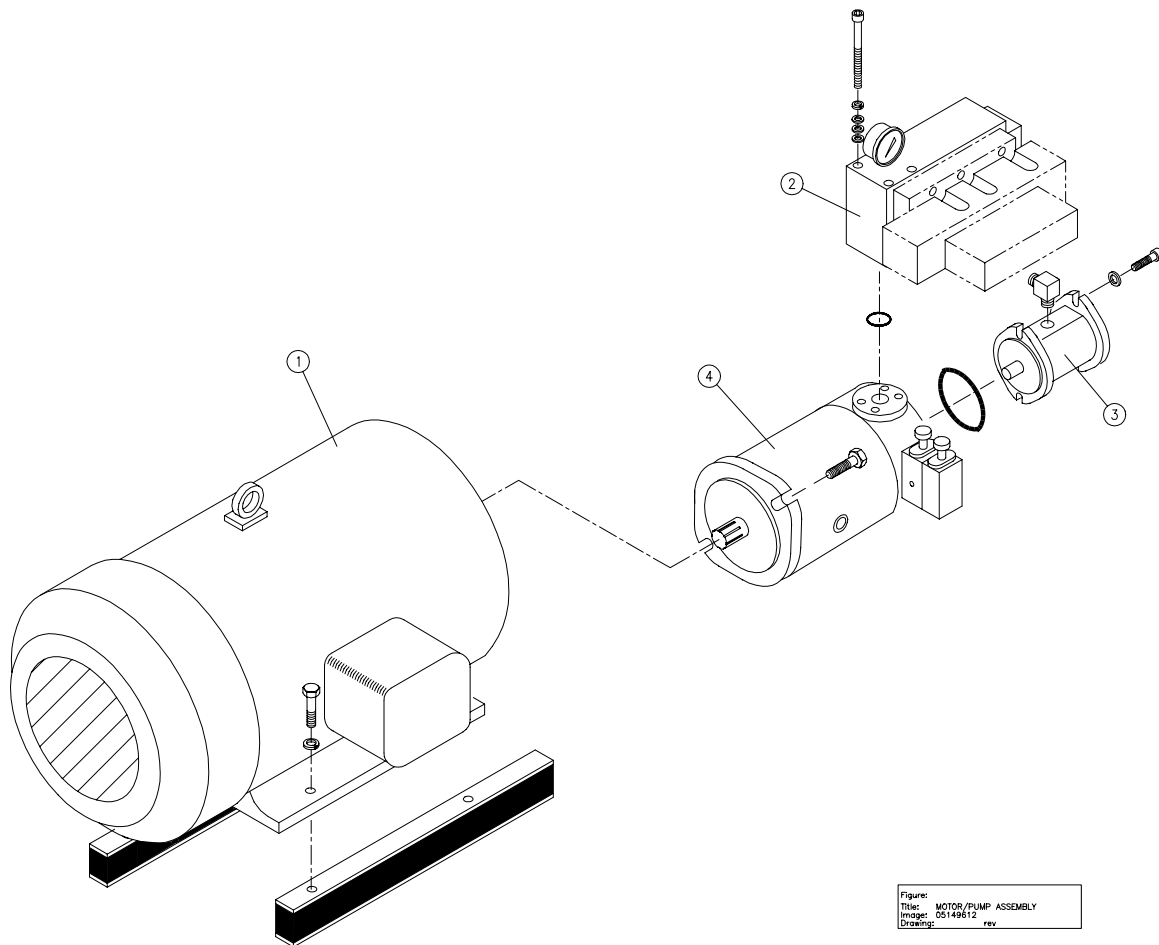


Figure:
Title: MOTOR/PUMP ASSEMBLY
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Item Description

(1) Motor	(2) Manifold	(3) Recirculation Pump
(4) Hydraulic Pump		

9.3.1 Motor Service

1. Locate the two zerk fittings, they are located at each end of the motor, remove their plastic caps.
2. Apply one or two strokes of grease. Replace caps on zerk fittings.
3. Run motor a few minutes.

9.3.2 Manifold Service

1. Check operating pressure.
2. If pressure adjustment is necessary:
3. Adjust high pressure control valve. Turn locking nut counterclockwise, then turn the knob clockwise to increase pressure, counterclockwise to decrease.
4. Adjust low pressure control valve. Turn locking nut counterclockwise with open end wrench. Turn the hex clockwise to increase pressure, and counterclockwise to decrease. Lock in place with nut.

10 Recirculation System

The recirculation system keeps the hydraulic oil at operating temperature while using the minimum amount of cooling water flow. The system also provides the necessary oil conditioning and filtration to maintain oil cleanliness. The conditioning of the hydraulic oil includes cooling it, cleaning it, and together with the hydraulic tank, removing air bubbles entrained in the oil due to agitation and turbulent flow in the main pump circuit.

10.1 Components

The cooling and filtration system (recirculation system) is equipped with the following:

- **Recirculation pump** (gear-type)–which receives oil from the oil tank
- **Heat exchanger** - cooling water is controlled by the water modulating valve
- **Oil filter assembly** - includes an indicator to show the filter element condition. It also includes a bypass or relief valve, should the filter element become entirely clogged with dirt/contaminants.

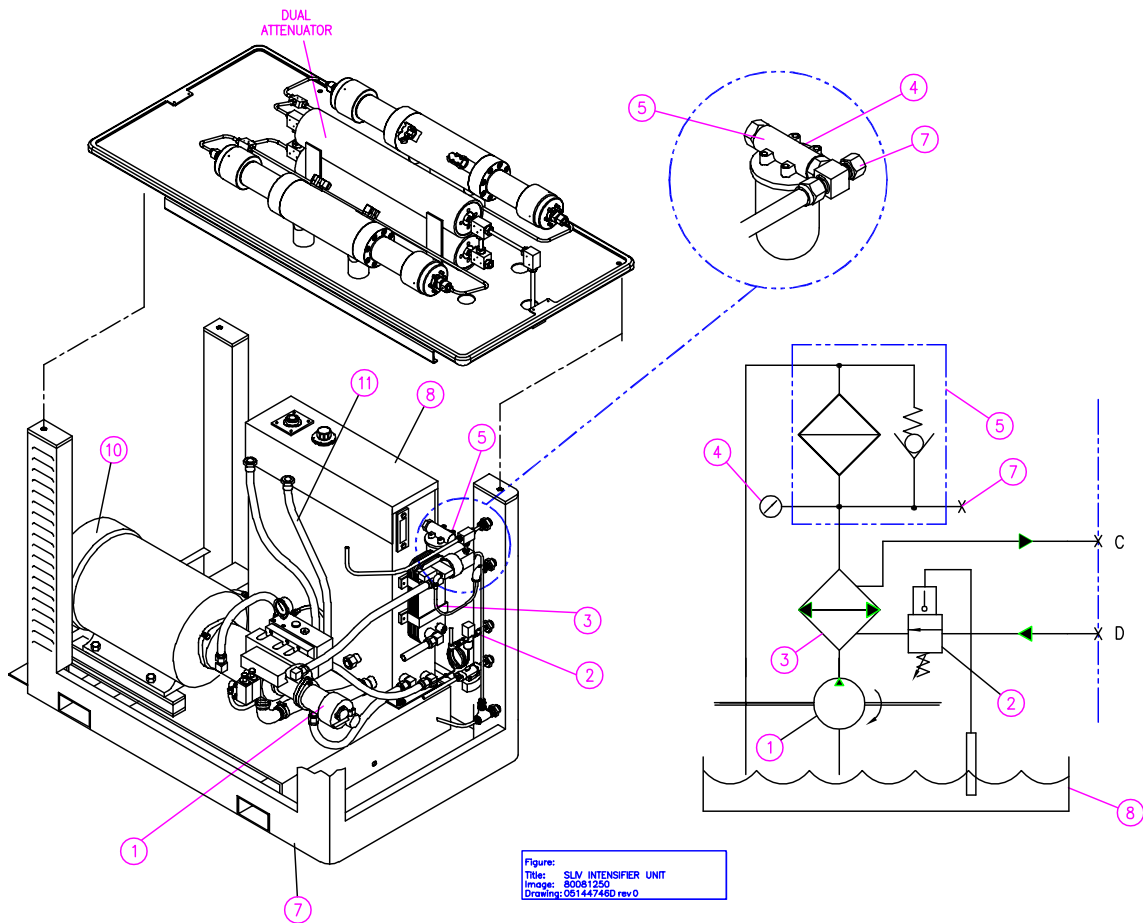


Figure 10-1 Recirculation System

Item Description

- | | | |
|------------------------|----------------------------|--------------------|
| (1) Recirculation Pump | (2) Water Modulating Valve | (3) Heat Exchanger |
| (4) Visual Indicator | (5) Oil Filter | |
| (7) Oil Fill Port | (8) Hydraulic Oil Tank | |

10.2 Operation

The recirculation pump (1) takes oil from the tank (8) and pumps it to the oil to water heat exchanger (3), then to the oil filter (5) and back to the tank.

The visual indicator (4) indicates when the filter element needs replacement. It should be read when both the water jet pump is running and the oil temperature is approximately 115°F.

Oil fill port must be used when pumping oil into tank to assure cleanliness. By filling at this point, the hydraulic oil must pass through the hydraulic filter to get to the hydraulic tank, guaranteeing that the oil into the tank gets passed through a filter.

Operating Temperature Adjustment

The operating temperature is adjusted by turning the water modulating valve (2) adjusting knob with a flat blade screwdriver. Clockwise increases the oil temperature.

The water modulating valve regulates the cooling flow that enters at port “D” to the heat exchanger (3) and then discharges through port “C” to the drain.

The operating oil temperature is factory set at 46°C (115°F) based on the temperature and flow of cooling water at the factory. Field adjustment may be necessary.

10.3 System Pressure Protection

System pressurization over 4.2 bar (60 psi) is prevented by relief valve located in filter housing (5).

Table 10-2 Re circulating Oil Temperature and Pressure Controls

Control	Valve	Adjustment		Setting	
		Increase	Decrease	Maximum	Minimum
Oil Temperature	2	Clockwise	Counter-clockwise	52°C (125° F)	41°C (110°F)
Oil Pressure	--	Fixed (Built into Hydraulic filter housing)		4.2 bar (60 psi)	3.8 bar (55 psi)

10.4 Maintenance Overview

During normal operating condition, the oil will be maintained at the correct operating temperature.

In order to get the best value from the hydraulic system (including the recirculation system) one should change the filter element when it indicates that it is time. The hydraulic oil should be changed after 3,000 hours or 1 year of service (whichever comes first) or whenever a fluid sample indicates that it is contaminated and beyond being fixed by simply operating the filter.

Parts: Hydraulic Oil:
 General service, use Mobil #DTE Heavy Medium, No. 021029 (KMT Waterjet part 05022702)
 Food service, use Conoco AA-20 (KMT Waterjet part 49835762)
 Oil with additives such as zinc diophosphate (ZDDP) for anti-wear are not recommended because of reaction with water.

Tools: Open End Wrench, 1-1/4"
 Rags
 Container to collect oil
 Oil transfer pump with 3/4" hoses. Inlet hose with 1/2" male pipe connector, and pump discharge hose with 3/4" female JIC connector.

TABLE 10-3. Hydr Oil Filter Change Criteria

SL-IV Pump Models	Type of Indicator	Interpretation of indicator reading
30 hp, 50 hp	Pressure Gage	Replace filter element when the pressure reading is 1.4 bar (20 psig) above normal when at operating temperature. Maximum normal pressure is 1.7 bar (25 psig). (Note [1])
60 hp, 75 hp, 100 hp	Differential pressure indicator	If the visual indicator (slide bar) is in the yellow zone or entering the red zone, this is an indication that the oil filter needs to be replaced. (Note [1])
Note [1]: Perform filter element condition check with SL-IV pump running at normal oil operating temperature (110-120 deg-F).		

Oil Filter

See Table 10-3 for oil filter change criteria.

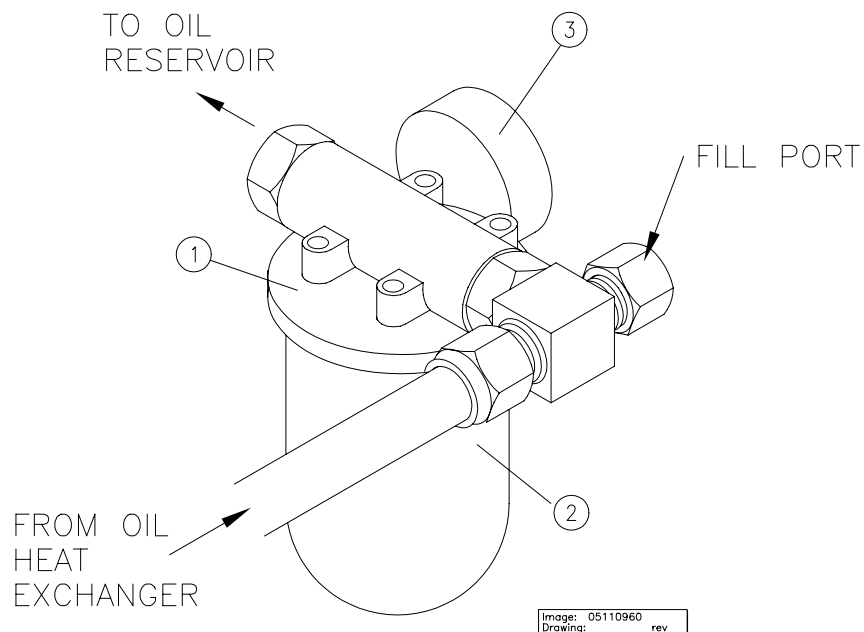
Components: (1) Oil Filter Head
(2) Element
(3) Visual Indicator

Parts: Element

Tools: Filter Wrench
Rags
Container to collect oil spills

Replace Oil Filter

1. Unscrew element from filter head with the filter wrench.
2. Oil gasket of new element.
3. Screw new element on head.
4. Start pump and check for leaks.



Oil Tank

The oil tank is equipped with the following:

- Visual temperature and level indicator
- Air breather and filter that prevents dirt from being sucked into the tank whenever the oil level drops, then allows air to escape when the level rises
- Drain valve, and
- Fill components.

The fill components consists of the Oil Filter Head, Fill Port, and the Fill Port Cap.



The breather is not a fill component, and must not be used as a fill point.

After 3,000 hours of operation, or yearly (whichever happens first), analyze the hydraulic oil and replace if necessary.

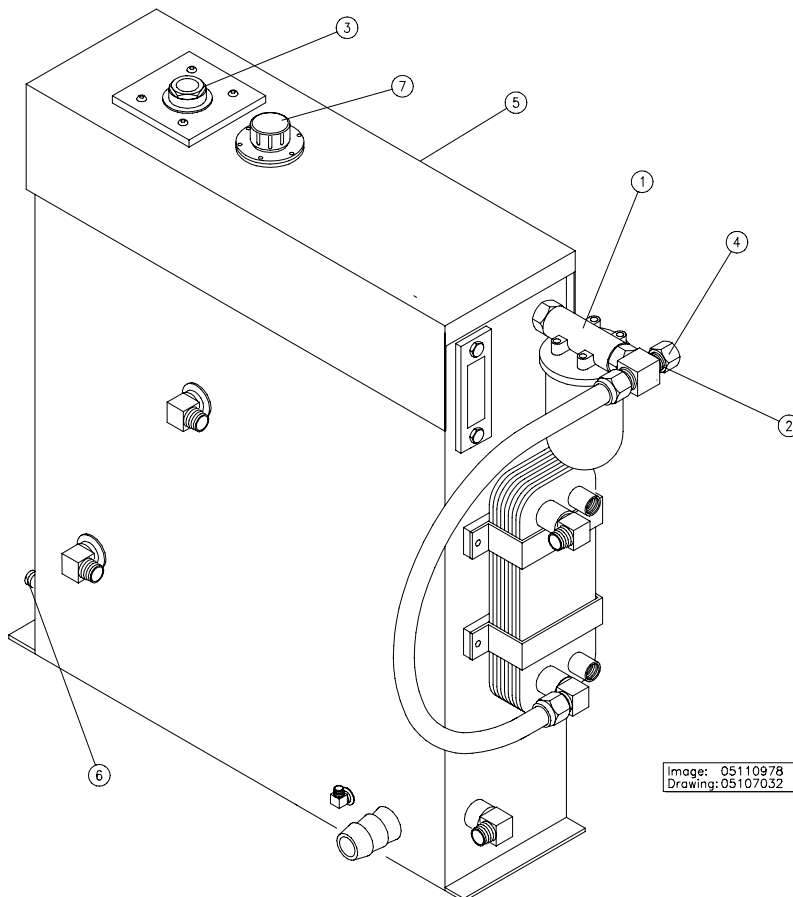


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Item Description

- (1) Filter Assembly
- (2) Oil Fill Port
- (3) Temperature Sensor
- (4) Oil Fill Port Cap
- (5) Oil Tank Cover
- (6) Shut-Off Valve
- (7) Breather

Replace Hydraulic Oil

1. Drain the tank, by connecting the inlet hose of the oil transfer pump to the drain valve. Open valve and pump oil to container.
2. Close hand valve, remove oil transfer pump inlet hose from hand valve.

NOTE

Never assume a new drum of oil is free of damaging contaminants. Typically, oil from a new drum does not meet the hydraulic system cleanliness requirements. For this reason it is important to use the oil transfer pump, which forces oil through the return filter into the tank.

3. Remove cap from fill port.
4. Connect oil transfer pump discharge to fill port. This will assure clean filtered oil is pumped into the tank.

**CAUTION**

Oil must be filtered through an equivalent filter such as a 10 micron filter element. Failure to do so will cause damage to the primary hydraulic components, voiding the warranty.

5. Check oil sight gage to assure proper fill level. Remove hose, cap fill port.
6. Remove the plug of the main hydraulic pump case and make sure the case fills with oil. With the plug removed, head pressure from the tank (reservoir) will force oil into the pump case.
7. Run pump following initial start-up procedure. This will assure the system is filled.
8. Check oil sight gage. Add oil if necessary.
9. Disconnect oil transfer pump discharge hose, install fill port cap.

**CAUTION**

Failure to fill the pump case with oil will damage the pump due to air becoming trapped inside.

11 Specifications

Following are the specifications for the SL-IV 100 Waterjet Pump. Included are the specifications for the equipment, torque, cutting water, cooling water, and the maximum quantity of orifices which can be supported.

11.1 Equipment Specifications

Installation location	Indoors	
-Air borne dust/contaminants	Min	
Ambient temperature		
-Minimum storage	2(36)	°C(°F)
-Minimum operating	5(40)	°C(°F)
-Maximum operating ¹	40(104)	°C(°F)
Maximum Relative Humidity ²		
-At Maximum Operating Temp.	95%	
Electrical ³ __ motor size	75 (100)	Kw (hp)
-Motor type ⁴	TEFC	
Voltage / Service Amps	400/3/50/175 415/3/50/175 480/3/60/175 575/3/60/150	Volts/Phase/Hertz/Amps
Controls		
-Voltage	24	volts, DC
-Power Supply	5	amps, DC
-Safety shutdown switch settings		
High oil temperature	62(144)	°C(°F)
Low inlet water pressure	2(30)	Bar (psig)
Low oil level	140(37)	l (gal).
Booster pump overheat	53(128)	°C(°F)
Low booster pressure	4 (60)	Bar (psig)
Hydraulic System		
-Oil tank capacity	170(45)	l (gal)
-Recommended oil type		
Regular applications	Mobil, DTE Heavy Medium,	
Food applications	# 021029 (# 05022702) AMOCO #FG68EL (# 49835762)	
-Hydraulic oil operation		
Minimum temperature	15(60)	°C(°F)
Maximum temperature	62(144)	°C(°F)
Optimum temperature	46(115)	°C(°F)

¹ Based on motor nameplate data, oil temperature must be maintained within operating specifications.

² When relative humidity is above 50%, frequently check oil in tank for water content. Installation of an air desiccant trap/filter on the oil tank breather is a good practice.

³ Totally enclosed fan cooled.

⁴ Not all motor voltages are readily available, check with factory for availability

Hot oil shutdown	62(144)	°C(°F)
Oil filtration	$\beta_{10} \geq 75$	
-Hydraulic Pump Type	Piston	
Displacement	Variable	
Pressure	Compensated	
Flow rate	203(53)	l/min(gpm)
-Hydraulic Hi-Lo Settings (factory)		
Lo pressure	34(500)	bar(psi)
Hi pressure	172(2500)	bar(psi)
-Hydraulic oil cooling		
Total heat rejection (max)	13(18)	kW(hp)
Cooling fluid requirements at inlet fluid temperature	18(65)	°C(°F)
Maximum cooling flow	17(4.5)	l/min(gpm)
Maximum inlet pressure	6.9(100)	bar(psi)
Pressure drop	30(2)	bar(psi)
Cutting Water "IN"		
-Minimum inlet pressure	2.4(35)	bar(psi)
-Maximum inlet pressure	7(100)	bar(psi)
-Maximum outlet pressure	8.3(120)	bar(psi)
-Maximum inlet temperature	29(85)	°C(°F)
-Optimum inlet temperature	18(65)	°C(°F)
-Factory Boost Pump Settings		
Inlet Pressure	4(58)	bar(psi)
Outlet Pressure Set at ⁵	8.3(120)	bar(psi)
Cutting Water Out		
-Maximum flow rate	7.6(2.0)	l/min(gpm)
-Minimum outlet pressure	345(5,000)	bar(psi)
-Maximum cont. outlet pressure	4135(60,000)	bar(psi)
Compressed Air		
-Flow rate maximum	0.028(1.0)	m ³ /min(cfm)
-Inlet pressure range	5-6(75-85)	bar(psi)
Service Connections		
-Cutting water in	1/2" NPT	60,000 psi HP fitting
-Cutting water out	9/16"	
-Cooling water in	1/2" NPT	
-Cooling water out	1/2" NPT	
-Plant air in	1/4" NPT	
-Cutting water drain	1/2" NPT	
-Oil tank drain valve	1/2" NPT	
-Oil tank fill port	3/4" male JIC	

⁵ Boost pump discharge pressure is dependent on inlet pressure.

11.2 Torque Specifications

Recommended Torque Values–Hydraulic Intensifier and HP Connections



Do not exceed torque values, excess torque can cause component damage or failure with potential hazards to equipment and personnel.

Item	Torque Nm(Ft-Lb)	Wrench mm(inch)
Hydraulic Intensifier		
Hydraulic Cylinder		
Cylinder Head [1]	102-110(75-80)	(M12) hex
Proximity switch	17(13)	(M5) hex
HSEC Jackbolts	44-48(32-35)	(3/8) socket [2]
Seal Head		
Gland Nut	176(130)	(1-3/16) Crowfoot
HP Tubing Nut	68(50)	(13/16) Crowfoot
Pneumatic Valve		
3/8" Inlet	68(50)	(13/16) Crowfoot
1/4" Outlet	34(25)	(5/8) Crowfoot
H P Fitting Gland Nuts		
1/4" Nut	34(25)	(5/8) Crowfoot
3/8" Nut	67(50)	(13/16) Crowfoot
9/16" Nut	102(75)	(1-3/16) Crowfoot

- [1] Socket Head Cap Screws (6 per cylinder head)
- [2] See section 7 for complete tightening procedure.

NOTE

Measurements are made with lubricated components and a calibrated torque wrench. Inconsistencies in wrench settings, lubrication, and technique, may not produce a leak tight seal. If leakage persists, increase the torque until the components seal, do not exceed a value 15% greater than shown. If leakage persists there is a component problem. **EXCESSIVE TORQUE MAY DAMAGE OR REDUCE THE LIFE OF COMPONENTS.**

Use of an antiseize thread lubricant, like High Purity Goop (KMT Waterjet P/N 10084440) is highly recommended for tightening of stainless steel HP water fittings.

A torque wrench kit is available from (KMT Waterjet P/N 49895436).

11.3 Cutting Water Specifications

The cutting water supply to the waterjet pump must meet the following specifications. High concentration of dissolved solids, especially calcium, silica, and chlorides, will affect high pressure component life. A water analysis will indicate the type of water treatment necessary.

Water Quality Parameters	Minimum Requirement	Better	Best
Alkalinity (mg/l)	50	25	10
Calcium (mg/l)	25	5	0.5
Carbon Dioxide (mg/l)	0	0	0
Chloride as Cl (mg/l)	100	15	1
Free Chlorine (mg/l)	1	1	0.05
Iron as Fe (mg/l)	0.2	0.1	0.01
Magnesium as Mg (mg/l)	0.5	0.1	0.1
Manganese as Mn (mg/l)	0.1	0.1	0.1
Nitrate (mg/l)	25	25	10
Oxygen (mg/l)	2	1	0.1
pH Value	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
Silica (mg/l)	15	10	1
Sodium (mg/l)	50	10	1
Sulfate (mg/l)	25	25	1
Total Dissolved Solids (mg/l)	200	100	5*
Total Hardness as CaCO ₃ (mg/l)	25	10	1
Turbidity (NTU)	5	6	1

* Do not reduce beyond this amount or the water will become too aggressive.

11.4 Cooling Water Specifications

Depending on the type of cooling system (closed recirculation, once through, etc.), the following common problems can be experienced:

Closed recirculation:

- Corrosion
- Fouling

Once through:

- Corrosion
- Fouling
- Scale
- Microbiological

Scale control is the most common problem, and is the result of insoluble matter deposited on the heat transfer surface. Calcium carbonate is the primary cause of scale when calcium bicarbonate breaks down. As the temperature of the water increases it becomes less able to hold carbonates in suspension.

To predict the tendency of scale formation, the Langelier's saturation index can be used as a guide.

Saturation Index = pH-pHs where pHs is calculated at saturation with calcium carbonate.

A positive index indicates a tendency to deposit calcium carbonate, the higher the positive value, the higher the scale formation. A zero index corresponds to water that is in equilibrium with respect to calcium carbonate.

11.5 Orifice Support Capacity

The SL-IV100hp Waterjet Pump supplies high pressure (HP) water up to 4,137 bar (60,000 psi). The following table shows size, ratings, and maximum quantity of orifices that can be supported.

Rated power kW(hp)	Pressure Bar (Psi)	Flow lpm (gpm)	Qty	Orifice Diameter mm (inch)
75(100)	3,800 (55,000)	7.6 (2.0)	1	0.51 (0.020)
60(80)	3,800 (55,000)	6.1 (1.6)	1	0.46 (0.018)
75(100)	3,800 (55,000)	7.6 (2.0)	2	0.36 (0.014)
53(70)	3,800 (55,000)	5.3 (1.4)	2	0.30 (0.012)
75(100)	3,800 (55,000)	7.6 (2.0)	4	0.25 (0.010)
75(100)	3,800 (55,000)	7.6 (2.0)	8	0.18 (0.007)
75(100)	3,800 (55,000)	7.6 (2.0)	16	0.13 (0.005)
75(100)	4,137 (60,000)	7.2 (1.9)	1	0.48 (0.019)
45(60)	4,137 (60,000)	3.8 (1.0)	1	0.36 (0.014)
75(100)	4,137 (60,000)	6.8 (1.8)	2	0.33 (0.013)

67(90)	4,137 (60,000)	6.1 (1.6)	3	0.25 (0.010)
75(100)	4,137 (60,000)	6.8 (1.8)	7	0.18 (0.007)
75(100)	4,137 (60,000)	6.8 (1.8)	14	0.13 (0.005)

PARTS LISTS

For:

**SL-IV PLUS
100S**

High Pressure Waterjet Pump

To contact the KMT Waterjet Systems Spare Parts Department:

USA Parts Department
KMT Waterjet Systems
Production Equipment Group
635 West 12th Street / POB 231
Baxter Springs, KS 66713-0231
USA
Phone: (800) 826-9274
Fax: (620) 856-5050
E-mail: wj_service@kmtwaterjet.com

Europe: Spare Parts Manager
KMT Waterjet Systems GmbH
Wasserstrahl-Schneidetechnik
Auf der Laukert 11
D-61231 Bad Nauheim
Germany
Phone: 49-(0)6032-997-115
Fax: 49-(0)6032-997-271
E-mail: Info.waterjet@kmtwaterjet.de

SECTION 12 PARTS LISTS

12.1 General

This section contains parts lists for service procedures and part identification, along with electrical and plumbing schematics of the SL-IV 50 hp HP Waterjet Pump. The reader can use these parts lists to identify the part on a drawing, then find the part number and part description corresponding to the drawing balloon number. Replacement parts can be ordered with this part number information.

12.2 Part Nomenclature

The following abbreviations and numerical sizes are used for part descriptions in these parts lists:

Table 12-1 Part Description Abbreviations and Nominal Size Guide

Item	Description	Item	Description
Assy	Assembly	mm sq.	Square millimeters
1/4, 9/16, 3/4	Nominal sizes in fractions of an inch, eg, 1/2 NPT ~ 0.50-inch national pipe thread, or 9/16 HP tube ~ 0.56-inch OD HP tubing or tube fitting	JIC	37-degree flared, threaded Hydraulic fitting, JIC standard, typically used on Hydraulic hose end connections.
Hydraulic ID or OD	Hydraulic Inside diameter or outside diameter	Dia	Diameter
psi or ksi	Pounds per square inch or thousands of pounds per square inch	Deg	Degree
HP and hp	HP: High Pressure, hp: horsepower	-4,-8,-12	Hydraulic fitting nominal size, in 1/16 th's of an inch, eg, 1/2 OD tube ~ -8
SAE O-ring	O-ring threaded port style, SAE standard	NO or NC	Normally open or normally closed

Fig #	Figure Title	Part Number	Page #
	Waterjet Pump, 400V	49833155	
12-1	Waterjet Pump, 400V Redundant	80079395	12-5
	Waterjet Pump, 460V, Yellow	49838394	
12-2	Intensifier Assembly	05144407	12-7
12-3	Seal Head Assembly	05119672	12-9
12-4	Hydraulic Piston	05146576	12-11
12-5	Hydraulic Cartridge	05144563	12-13
12-6	Hydraulic Hose Connections	05142351	12-15
12-7	High Pressure Piping	05142427	12-17
12-8	Hydraulic Manifold Assembly	49835796	12-19
12-9	Bulkhead Piping	05142344	12-21
12-10	Pneumatic Valve Assembly	10184760	12-23
12-11	Low Pressure Filter Assembly	49838378	12-25
12-12	Hydraulic Power Unit	49835846	12-27
12-13	Motor/Pump Assembly	49835812	12-29
12-14	Reservoir Assembly	05104153	12-31
12-15	Top cover Assembly	80074768	12-33
	Electrical Assembly 400V	80077910	
12-16	Electrical Assembly 460V	49838600	12-35
	Control Panel Configuration 400v	80077928	
12-17	Control Panel Configuration 460v	49838618	12-37
	Controls Subassembly 400v	80077845	
12-18	Controls Subassembly 460v	49834658	12-39
12-19	Redundant Kit (Option)	80079429	12-41
	Electrical Schematic	49836604	
	Electrical Schematic, Y-Delta	05148549	
	Hydraulic Schematic	49835622	

Figure 12-1. WATERJET PUMP, 400v-49833155, 400v Redundant-80079395, 460v -49838394

ITEM No.	QTY.	PART No.	DESCRIPTION
1	1	80077910 49838600	Electrical Assembly
2	1	05142344	Bulkhead Assembly
3	1	--	Frame Assembly
4	1	05104153	Reservoir Assembly
5	1	05142427	HP Water Assembly
6	1	49835846	Hydraulic Power Package
7	1	05142351	Hose Connections
8	-	05022702	Hydraulic Fluid
9	1	--	Decal Pkg
16	192"	--	Stripping
17	192"	--	Stripping
18	1	80074768	Cover Assembly
29	1	05128087	Start-Up Tag

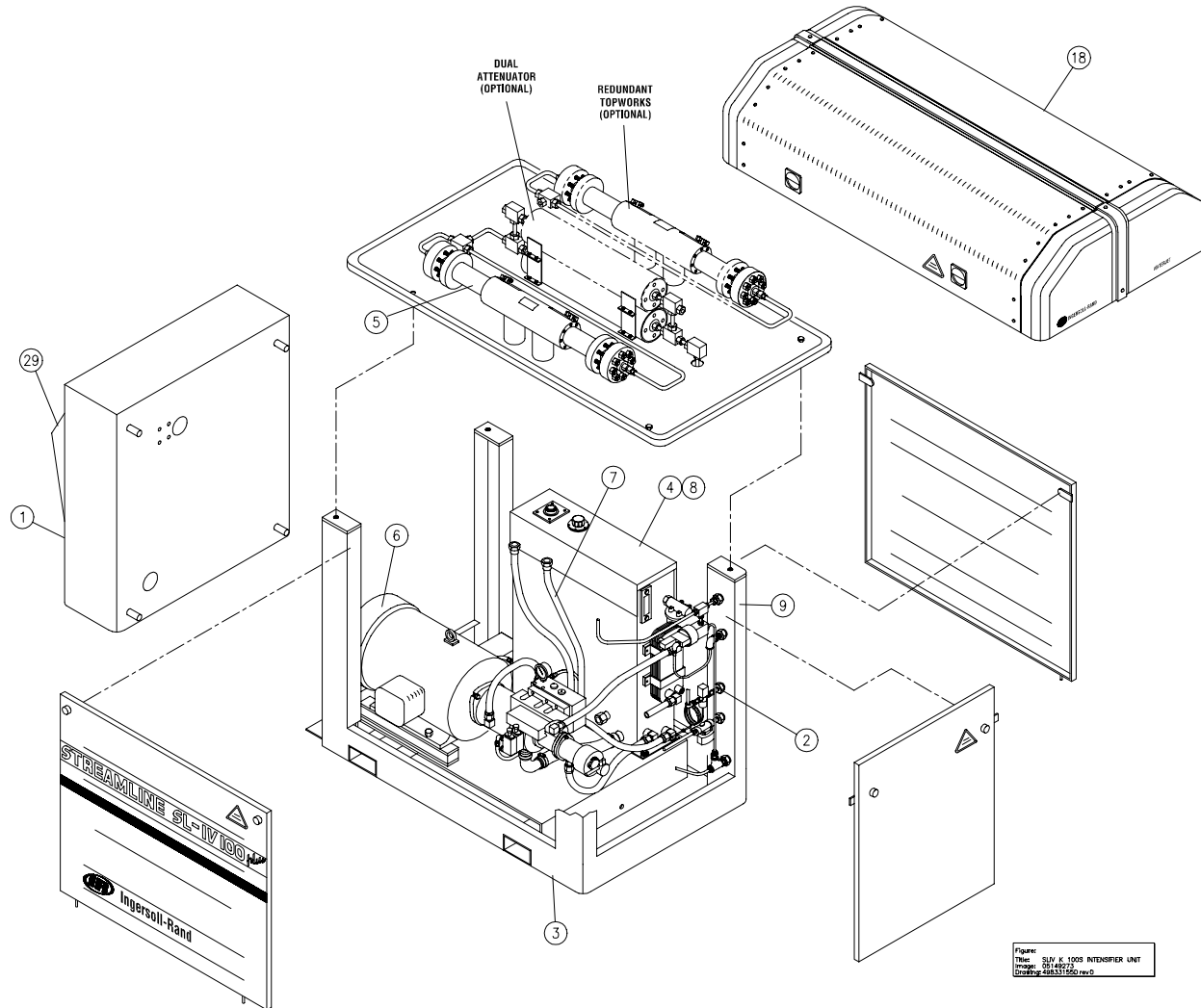


Figure 12-2. INTENSIFIER ASSEMBLY 05144407			
ITEM No.	QTY.	PART No.	DESCRIPTION
1	2	80076797	HP Cylinder Body, 1.13-in. ID
2	2	05144506	Plunger, Ceramic
3	2	05119672	Sealing Head Assembly
4	2	80076805	Cylinder Head,
5	2	05149711	HP Seal Assembly
6	2	05144597	Ring Spacer
7	2	05144498	Ring Flange
8	2	05146584	Seal Assembly, Low Pressure
9	2	05145099	Bushing Retaining Flange
10	16	05144753	Stud, 7/8-9 x 6.50
11	2	05144555	HP Cylinder Liner
12	4	10074920	O-ring
13	2	05144480	End Flange
14	2	05034798	Retaining Ring
15	1	05144514	Hydraulic Cylinder
16	2	10074771	O-ring
17	2	05120092	Backup Ring
18	16	05119748	Cap Screw, Socket Head, 3/4-16 x 2-3/4
19	2	05130224	Switch, Proximity, 20-250 VAC/VDC
20	4	95119012	Cap Screw, Socket Head, 1/4-20 x 1.00
21	1	05146576	Piston Assembly, Hydraulic
22	12	10069904	Heavy Hex Nut, 7/8-9
23	2	05144522	Mounting Stem
25	8	05041058	Cap Screw, Socket head, 3/8-16 x 2-1/4
26	8	95688743	Washer, Lock, High Collar, 3/8
27	2	10118206	O-ring
28	2	49831258	Spacer, Proximity Switch
29	2	05146592	Gasket, Drip Pan, Upper
30	*	05146618	Special Tool, HP Seal Removal (Not Shown)
31	*	05066139	Special Tool, Wrench, HP Cylinder (Not Shown)
32	*	49830391	Special Tool, Plunger Removal

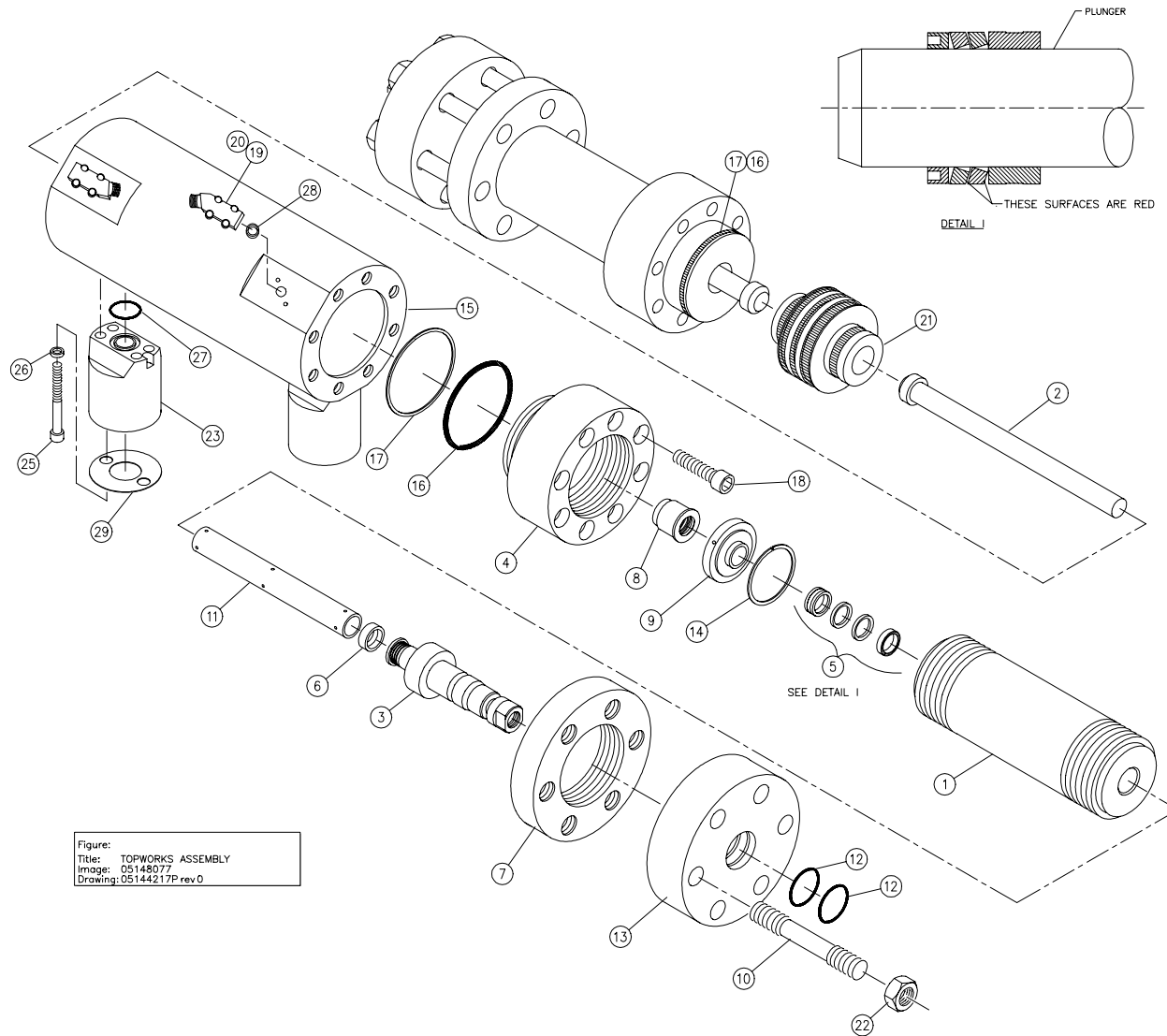


Figure:
Title: TOPWORKS ASSEMBLY
Image: 05148077
Drawing: 05144217P rev 0

Figure 12-3. SEALING HEAD ASSEMBLY 05119672

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05144472	Body, Sealing Head
2	1	05119680	Poppet, Valve
3	1	05116595	Gland, HP, Sealing Head
4	1	05116579	Seat, HP, Sealing Head
5	1	05116603	Poppet, Valve
6	1	05119839	Pin
7	1	05119698	Retainer
8	1	05147863	Spring, Compression

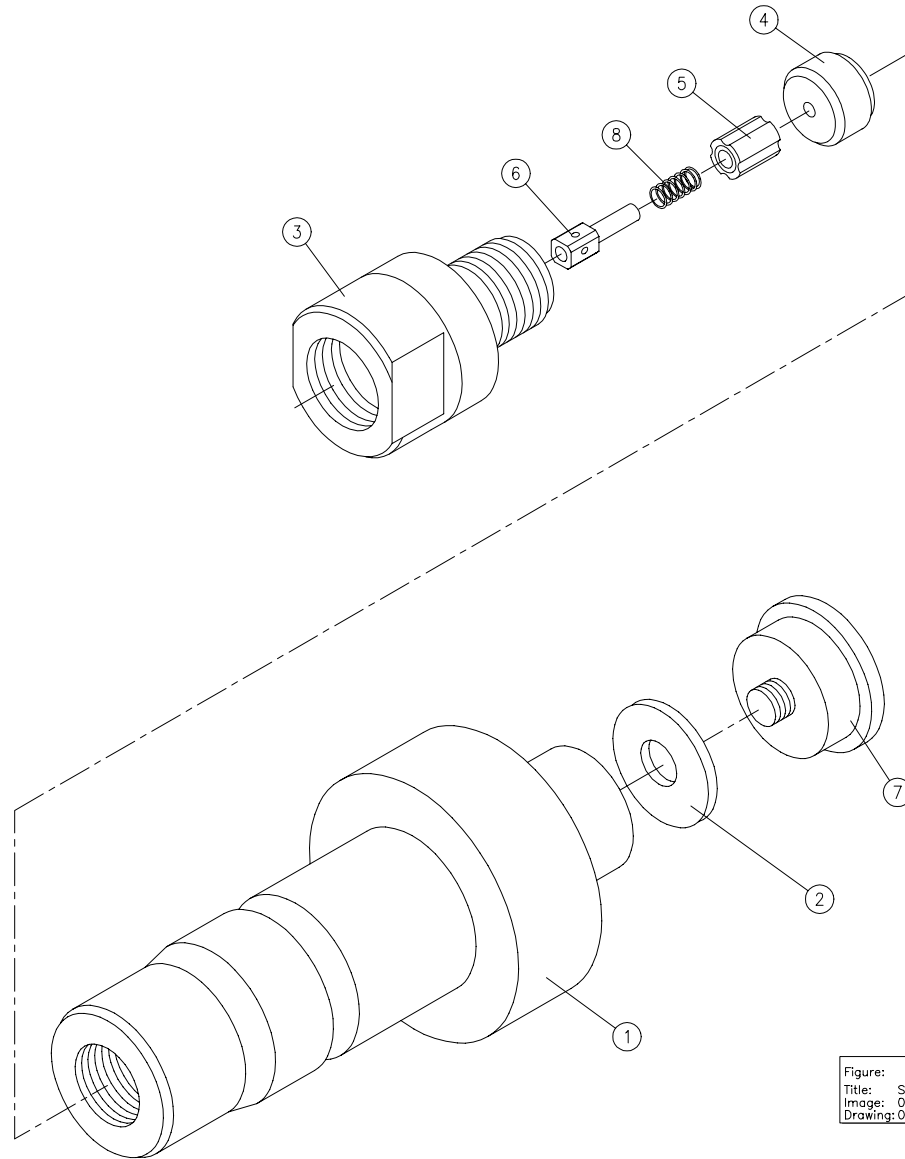


Figure:
Title: SEALING HEAD ASSEMBLY
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Drawing: 05149672P rev 0

Figure 12-4 HYDRAULIC PISTON ASSEMBLY 05146576

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05144589	Body, Hydraulic Piston
2	12	05074380	Pin, Clevis
3	2	05049887	Screw, Set, Socket, with Through Hole
4	2	10148757	Check Valve Cartridge, with O-ring
5	--	49877509	Adhesive, Thread Locker
6	2	05130216	Ring, Snap, Flat Wire
7	2	05146568	Ring, Backup
8	2	10074821	O-ring
9	1	05120118	Seal Assembly, Hydraulic Piston
10	2	05120100	Bearing, Hydraulic Piston

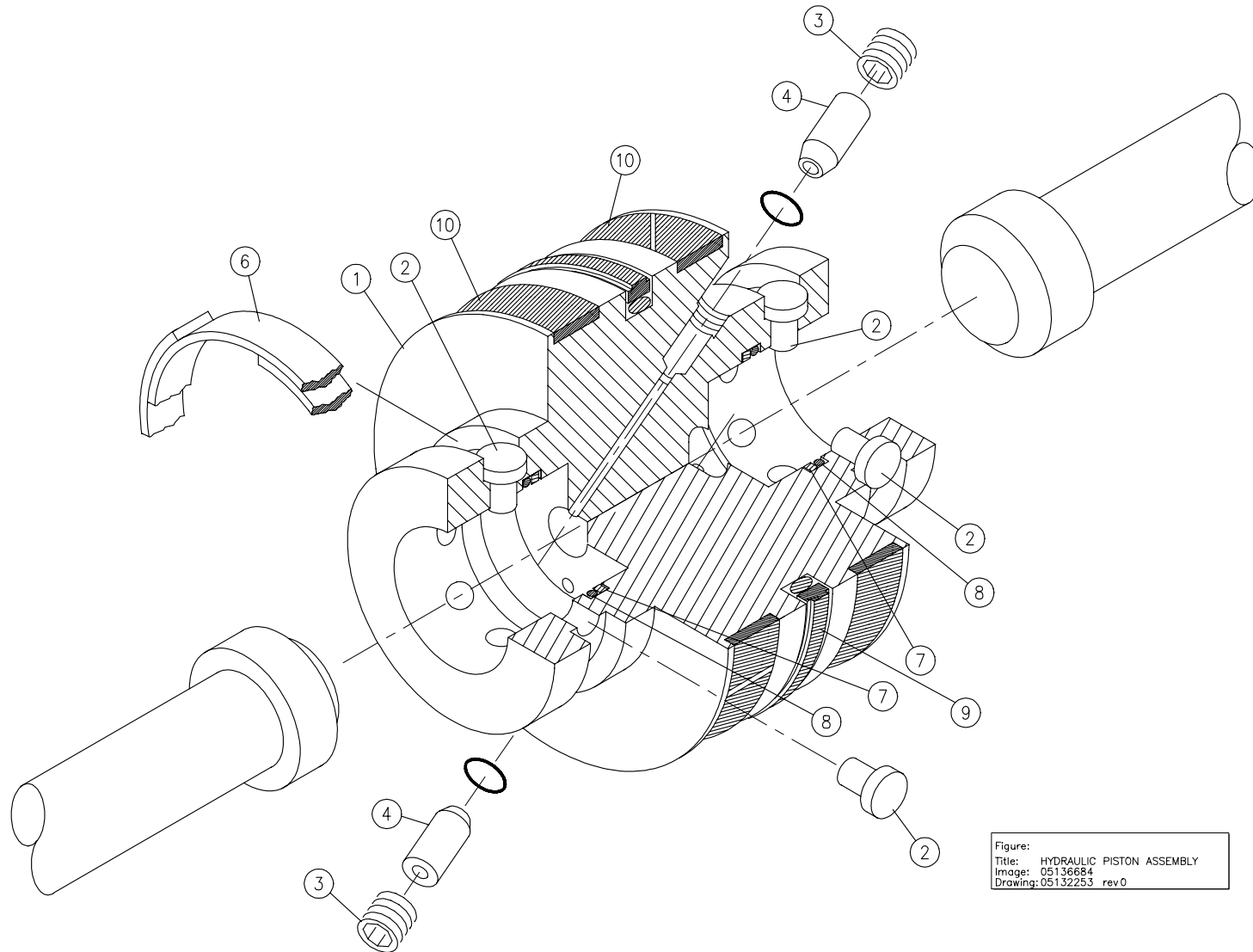


Figure 12-5 HYDRAULIC CARTRIDGE SEAL ASSEMBLY 05146584

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05144530	Seal Bushing
2	2	10142032	Packing Ring
3	1	10145431	O-ring
4	1	05116140	Back-up Ring
5	1	10168912	O-ring
6	1	05116124	O-ring
8	1	05116132	Seal, U-Cup
Ref 1	0	05009048	Tool, Seal Installation

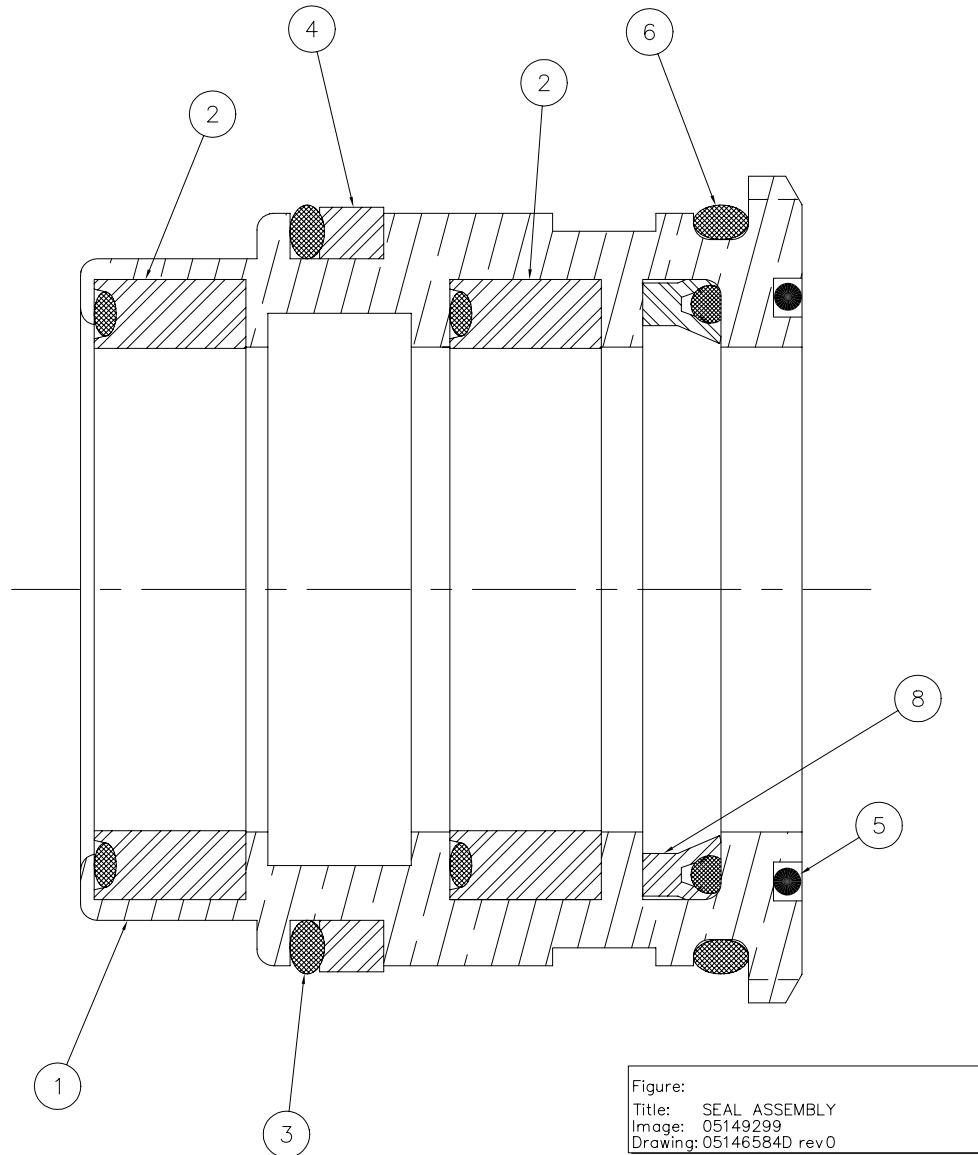


Figure 12-6. HYDRAULIC HOSE CONNECTIONS 05142351

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05106950	Hose Assembly
2	1	05106968	Hose Assembly
3	1	05106976	Hose Assembly
4	2	10194207	Hose Clamp
5	8.5"	10079754	Radiator Hose
6	1	49872245	Split Flange
7	1	05106984	Split Flange Elbow
8	1	05112750	Hose Assembly
9	1	05051214	Hose Assembly
10	2	80079544	JIC/O-ring 45 Degree Elbow, .75
11	2	80079536	Hose Assembly
12	1	05071121	Hose Assembly
16	1	05061163	Hose Assembly
17	1	05049713	Hose Assembly
Ref 1	-	05064407	Adapter-JIC/O-ring, Straight, 16-12
Ref 2	-	10091163	Adapter-JIC/O-ring, 90 Degree, 12-12
Ref 3	-	05085758	Adapter-JIC/O-ring, 90 Degree, 4-6
Ref 4	-	49876089	Adapter-JIC/O-ring, Straight, 4
Ref 5	-	10144749	Adapter-JIC/O-ring, 45 Degree, 4-4
Ref 6	-	10099760	Elbow-Tube/O-ring, 20
Ref 7	-	10142644	Adapter-JIC/O-ring, 90 Degree, 4-4

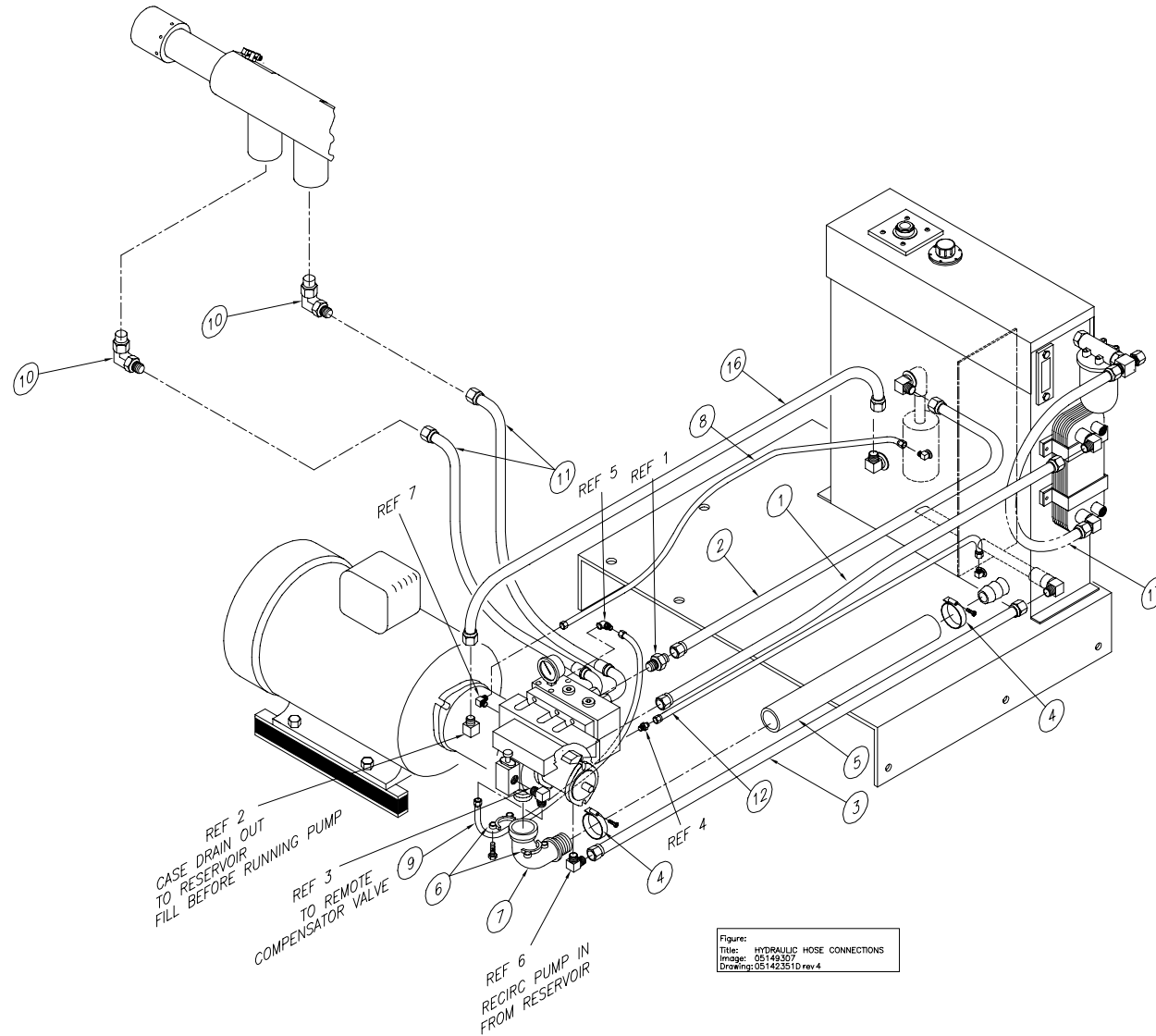


Figure 12-7. HIGH PRESSURE PIPING 05142427

ITEM No	QTY	PART No.	DESCRIPTION
1	1	05144407	Intensifier Assembly, SL-IV
2	2	05040696	Accumulator, HP, .96 liter (56 cu. in.), 4,200 bar, TUV
3	4	05090717	Nut, Retaining, HP Accumulator
4	4	05144837	Spacer, Bracket, HP Accumulator
5	6	10079465	Tee, HP, .56, 60ksi, stainless
6	2	10078772	Plug-HP,.56
7	3	05112057	Tube, .56-in. HP x 4.97
8	7	10078525	Elbow, HP, .56, 60ksi, stainless
9	1	10069524	Tube, .56-in. HP x 8.00
10	5	10069326	Tube, .56-in. HP x 4.00
11	1	05145271	Tube, .56-in. HP x 56.06
12	1	05145297	Tube, .56-in. HP x 4.18
13	1	49899065	Tube, .56-in. HP x 15.09 Lg
14	1	05105473	Tube, .56-in. HP x 10.13 Lg
15	1	05109939	Tube, .56-in. HP x 10.69 Lg
16	1	10079457	Adapter-HP, Male/Female, 9-6
17	1	10094704	Tube, .38-in. HP x 3.00 Lg
18	1	10184760	Pneumatic Valve Assembly
19	2	10078608	Gland, .56-in. HP Tube, 60 ksi, Stainless
20	1	10079580	Adapter-HP, Male/Female, 9-4
21	1	10079715	Collar, .38-in. HP Tube, 60 ksi, Stainless
22	1	10078913	Gland, .38-in. HP Tube, 60 ksi, Stainless
23	1	10077030	Elbow-Poly, 90 Degree, Male, .25 x .13
24	1	05112552	Tube, .25-in. HP x 34.00 Lg
25	1	10079705	Bulkhead Coupling, .56
26	4	95413696	Washer, Lock, 1/2-ID
27	4	95383790	Cap Screw, Socket Head, 1/2 - 13 x 1-in., Stainless
28	180"	05086905	Conduit, Extra Flexible, .63-in. ID, Galvanized
29	1	05131347	Ferrule, .50 Hose

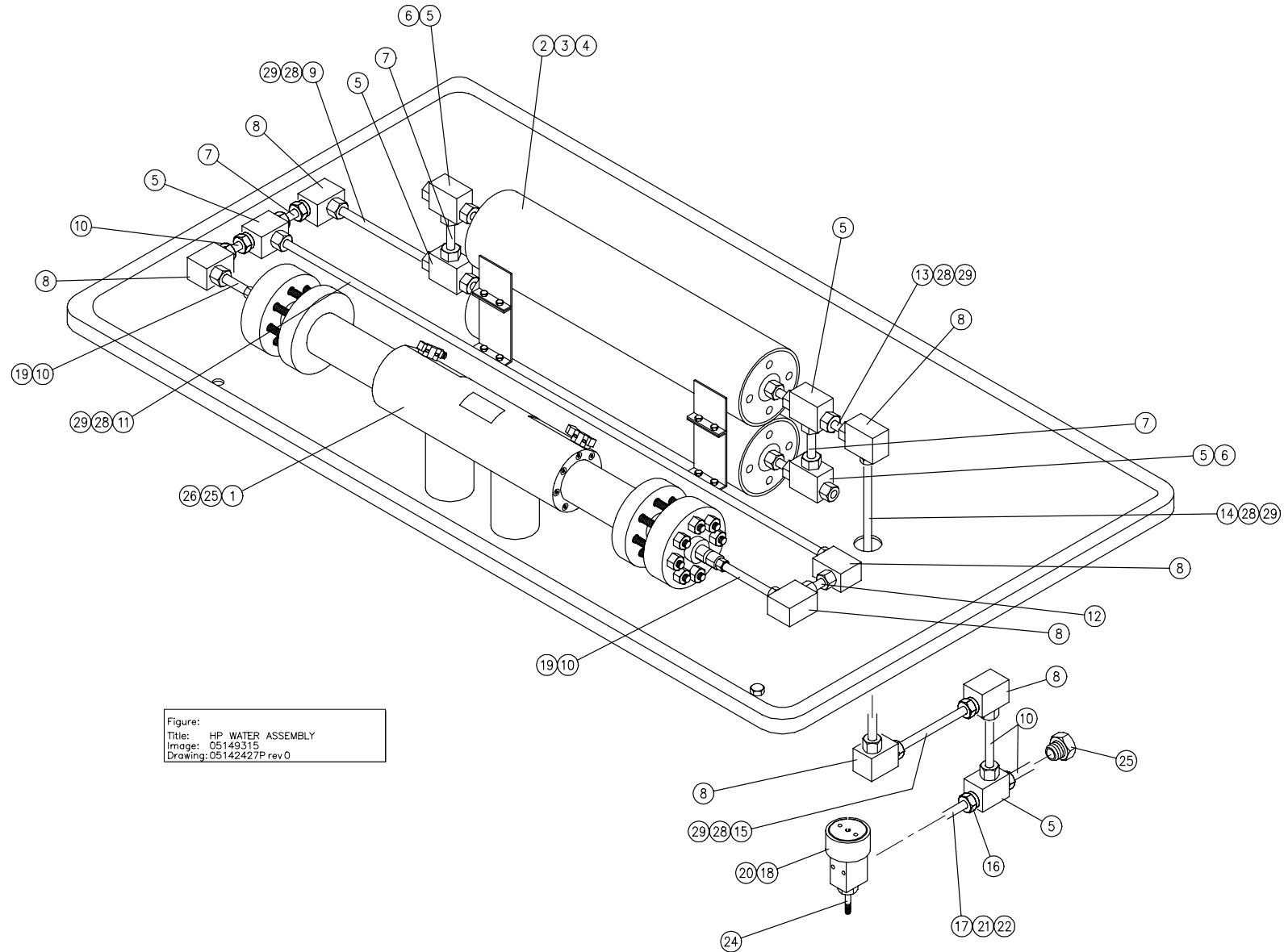


Figure:
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Figure 12-8 HYDRAULIC MANIFOLD ASSEMBLY 49835796

ITEM No.	QTY.	PART No.	DESCRIPTION
1	1	05103197	Manifold Block
2	1	10187417	O-ring, -128
3	4	05071055	Plug, -12 SAE O-ring, Hex Socket, Steel
4	1	05103189	Valve, Check, Hyd, Cartridge
5	1	10187060	Valve, Relief, Hyd, 25 – 800 psi Range, Adjustable
6	1	10187052	Valve, Relief, Hyd, 100 – 3,000 psi Range, Knob-Adjustable
7	1	05071717	Valve, Relief, Hyd, 234 bar (3,400 psi), Non-adjustable, TUV
8	2	05055017	Plug, -2 SAE O-ring, Hex Socket, Steel
9	1	49835754	Gage, Pressure, Hyd, 0 – 5,000 psig
10	1	10185585	Valve, Solenoid, Hyd, 24 – VDC, Normally – Closed, 2-Way/2-Position
11	3	05064407	Adapter, Straight, -16 JIC x -12 O-ring
12	1	10144749	Adapter, 45 Degree, -4 JIC x -4 O-ring
13	1	49876089	Adapter, Straight, -4 JIC x -4 O-ring
14	1	10142644	Adapter, 90 Degree, -4 JIC x -4 O-ring
15	1	49889769	O-ring Plug
Ref	--	10189595	Kit, O-ring, 4-way Valve (6 each O-ring)

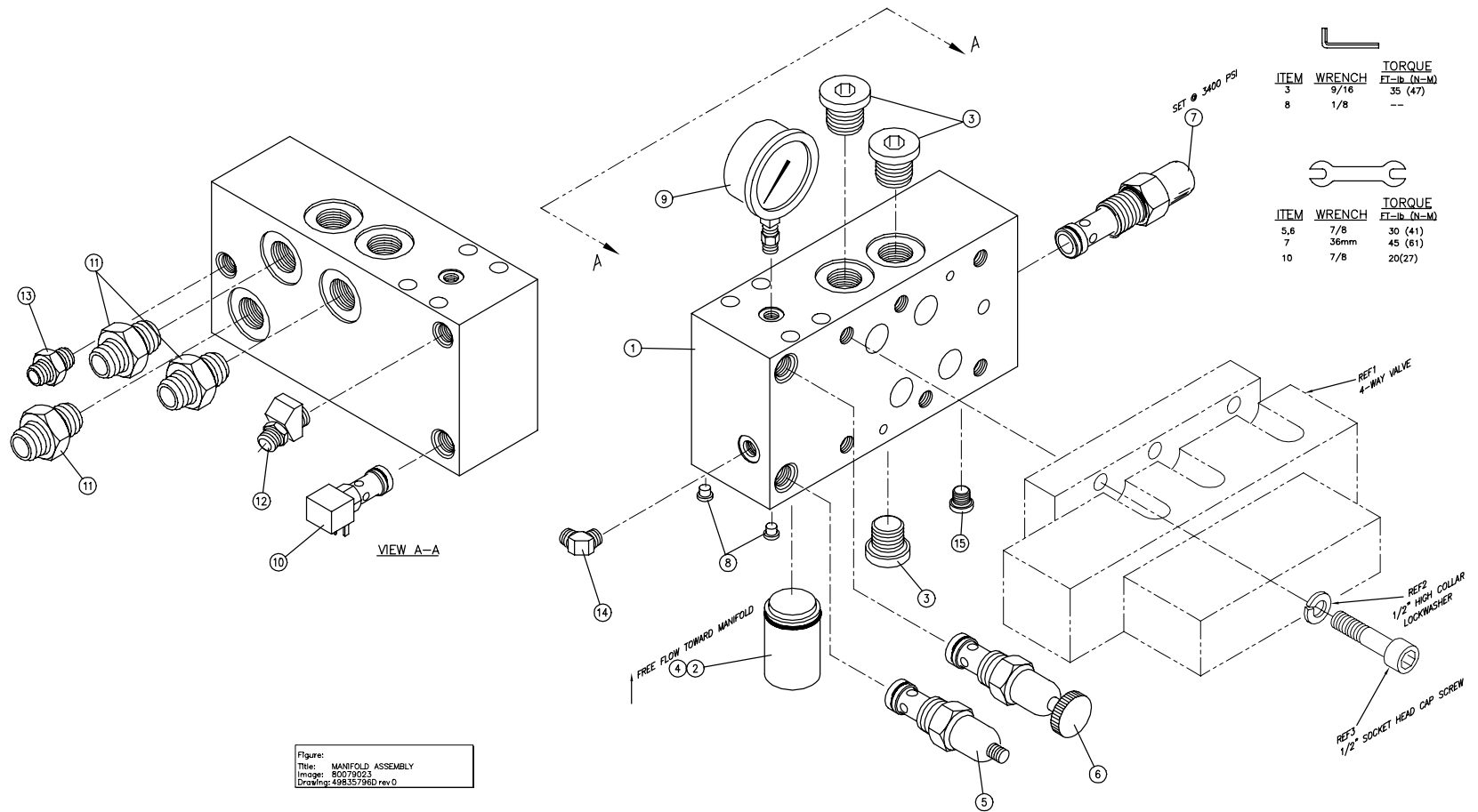


Figure 12-9. BULKHEAD PIPING ASSEMBLY 05142344

ITEM No	QTY	PART No.	DESCRIPTION
1	2	49887011	Adapter-Pipe/JIC, 90 Deg, 8-8
2	1	10091866	Water Modulating Valve
3	1	05060207	Nipple, 1/2 - NPT x 5-in
5	1	05024815	Solenoid Valve, 24-VDC , .50
6	4	49886922	Adapter, Bulkhead, 8-24, SST
7	-	10127348	Push-On Hose, .50
8	1	49888035	Solenoid Valve, .13, 24-VDC
9	4	10070092	Jam Nut, 1-14
10	1	10073823	Tee, Street, .50 Brass
11	2	05111364	Tee, JIC, .50 SS
12	1	49838378	Filter Assembly, LP
13	1	49834328	Adapter, .25 OD Tube x 1/2-NPT
14	3	10173805	Hose Barb,.50
15	2	10079713	Hose Barb,.50
16	1	10077055	Adapter, Bulkhead, 4-15,
18	1	49895303	Adapter-Pipe/JIC, 8
19	16	10069714	Washer, .38
21	1	95157418	Adapter-Pipe/JIC, 8-8
			22 1 49834302 Female Union, .50 Sch 40
			23 1 10078335 Reducing Nipple, .25 x .125
			24 2 95680922 Adapter-Pipe/JIC, 90Deg 8 - 8
			25 3 10189025 Adapter-Hose/JIC, -8 x -8
			26 16 95416319 Screw-Hex Head, 3/8-16 x 1
			27 16 95750394 Lock Washer, .38
			29 1 10078095 Coupling-Poly, Male,.25x.125
			30 36" 10079903 Tube, Polyethylene, .25-in.
			31 1 49834310 Nipple, Close, 1/2-NPT, Bra
			32 6 05113964 Grommet-1.75
			33 1 10084523 Nipple, 1/2-in. NPT x4-in.,
			34 2 05139506 Pressure Gage
			35 72" 10084226 Push On Hose, .25
			37 2 49830722 Hydraulic Hose, .25
			38 4 95146429 Adapter-Pipe/Hose Barb, -4
			39 3 10069763 Hex Nut, #8
			40 3 95716890 Washer, .50
			41 3 95716882 Screw, Hex Hd, 1/2-13 x 1-1/4
			42 1 49831480 Grommet
			42 6 49838790 Grommet

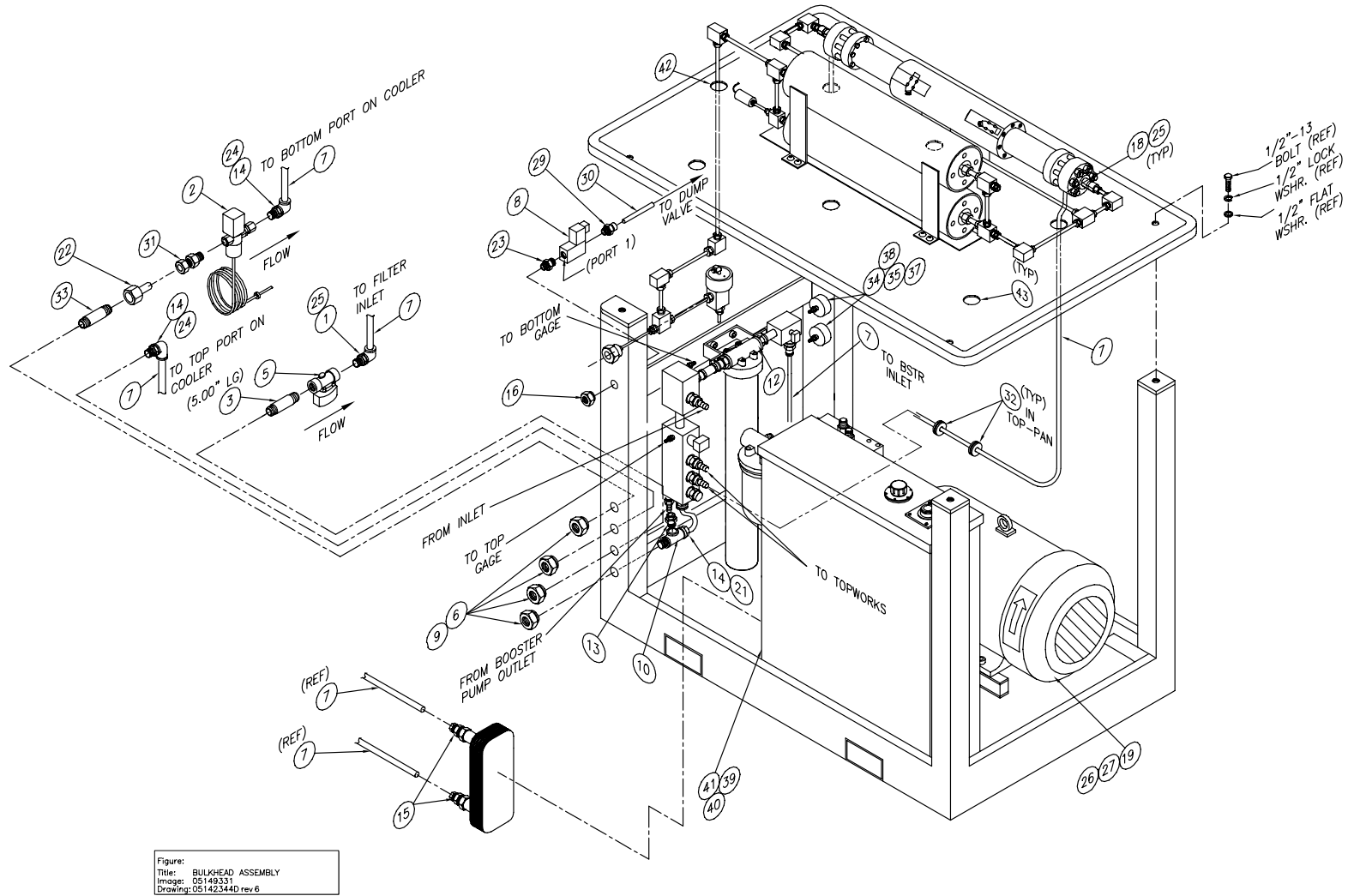


Figure 12-10. PNEUMATIC VALVE 10184760

ITEM No	QTY	PART No.	DESCRIPTION
1	1	10189181	Body
2	1	10178697	Valve Seat
5	1	BV701184	Gland, .38 HP Tube, Anti-Vibration
6	1	BV901184	Stem, Valve, 0.080-in Diameter
7	1	10188233	Back-up Ring
8	1	10178978	Seal Assembly, HP Valve, .25 Bore
12	-	10087385	Grease
14	1	10189553	Cylinder Assembly

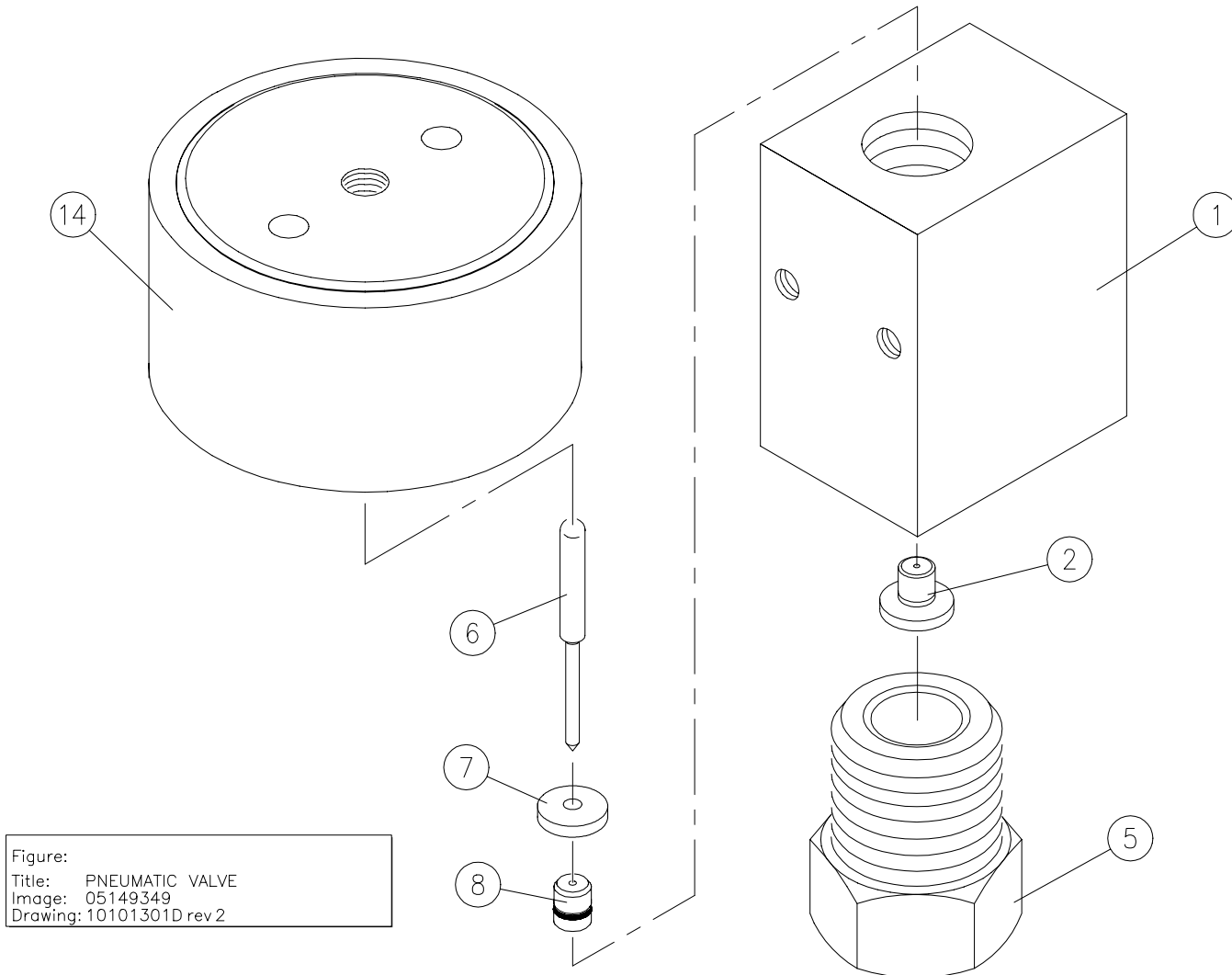


Figure:
Title: PNEUMATIC VALVE
Image: 05149349
Drawing: 10101301D rev 2

Figure 12-11 LOW PRESSURE WATER FILTER ASSEMBLY 49838378

ITEM No.	QTY.	PART No.	DESCRIPTION
1	1	49833924	Low Pressure Manifold
2	1	49833957	Low Pressure Manifold
3	1	49833742	Low Pressure Manifold
4	2	49838386	Nipple, 3/4 NPT x 4-in., Stainless
5	4	49833882	Adapter-O-ring/Hose, Straight, 8-8
6	1	05140751	Pressure Switch
7	1	05142062	Pressure Switch
8	1	49868813	Temperature Sensor
9	1	05070982	Valve, Relief, 50 – 150 psi, ½ NPT
10	1	05135645	Adapter-Pipe/Hose Barb, -8 NPT x -8 Hose
11	1	05135652	Check Valve
12	2	49830714	Adapter-Pipe/Hose Barb, 90 Degree, -4
13	1	05038690	Body, Filter, Water, ¾ - NPT
14	1	49834716	Element, Filter, LP Water, Polypropylene, 10 Micron
15	4	95391322	Washer, Flat, .25
16	4	95838314	Washer, Lock, .25
17	2	10083384	U-Bolt, ¼ - 20, Stainless
18	1	05135660	Elbow, JIC/O-ring, 90 Degree, -8 x 2
19	1	10189025	Adapter-Hose/JIC, .50 x .50

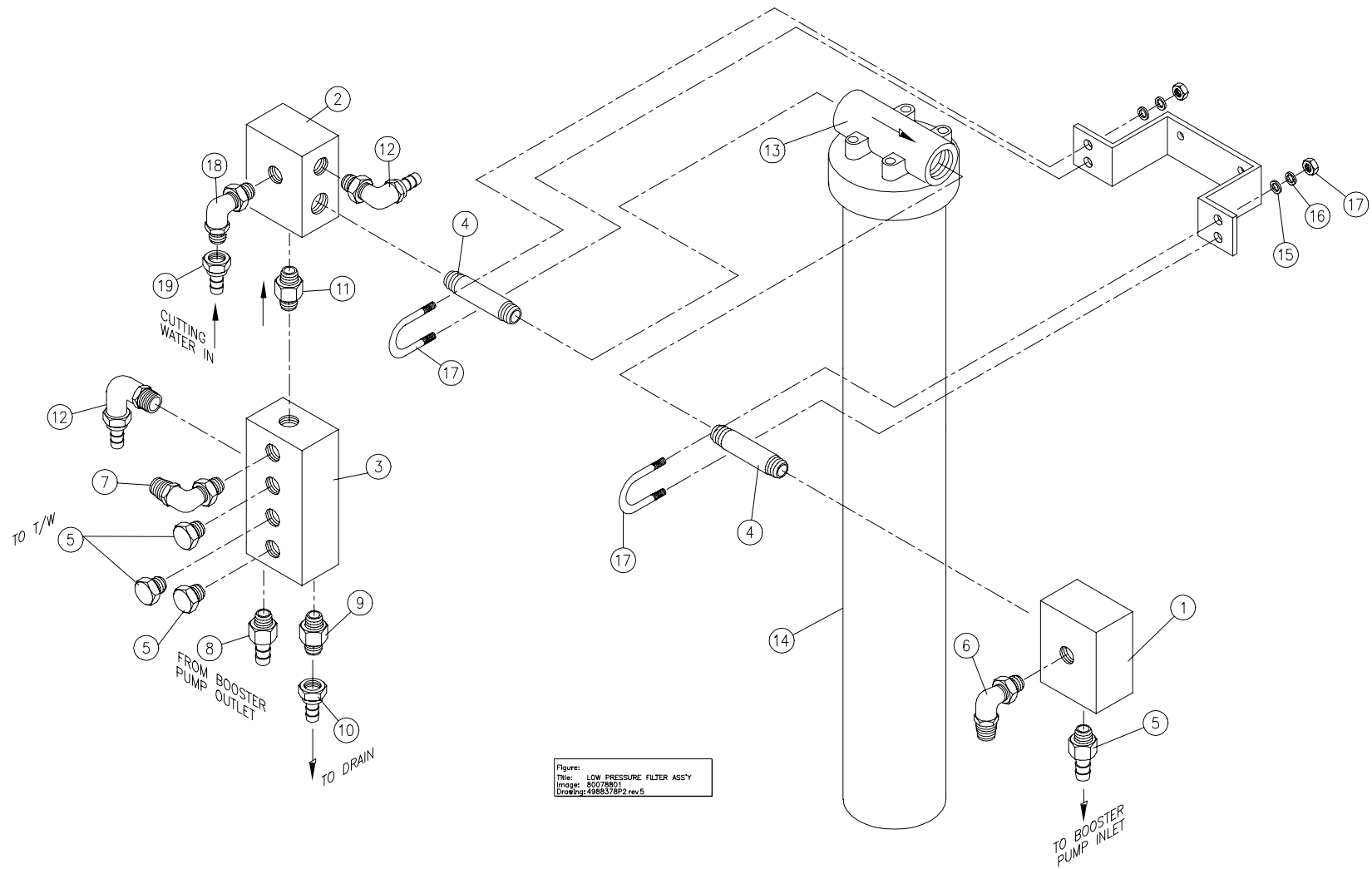


Figure 12-12 HYDRAULIC POWER PACKAGE, 49835846

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	49835812	Motor/Pump Assembly
2	1	05103411	Water Pump Adapter
3	3	95572897	Hex Head Screw, 1/4-20 x 5/8
4	3	95838314	Lock Washer, .25
5	1	49836778	Vane Water Pump
6	1	05069885	Temperature Switch Adapter
7	1	05103429	Spline Shaft
12	1	05103395	Shaft Coupling
13	6	95688750	Lock Washer, .50
14	2	95750394	Lock Washer, .38
15	2	05041033	Socket Head Screw, 3/8-16 x 1-1/4
16	1	10091510	Arrow Decal
18	1	05112107	Directional Control Valve
19	6	95055026	Socket Head Screw, 1/2-13 x 1-3/4

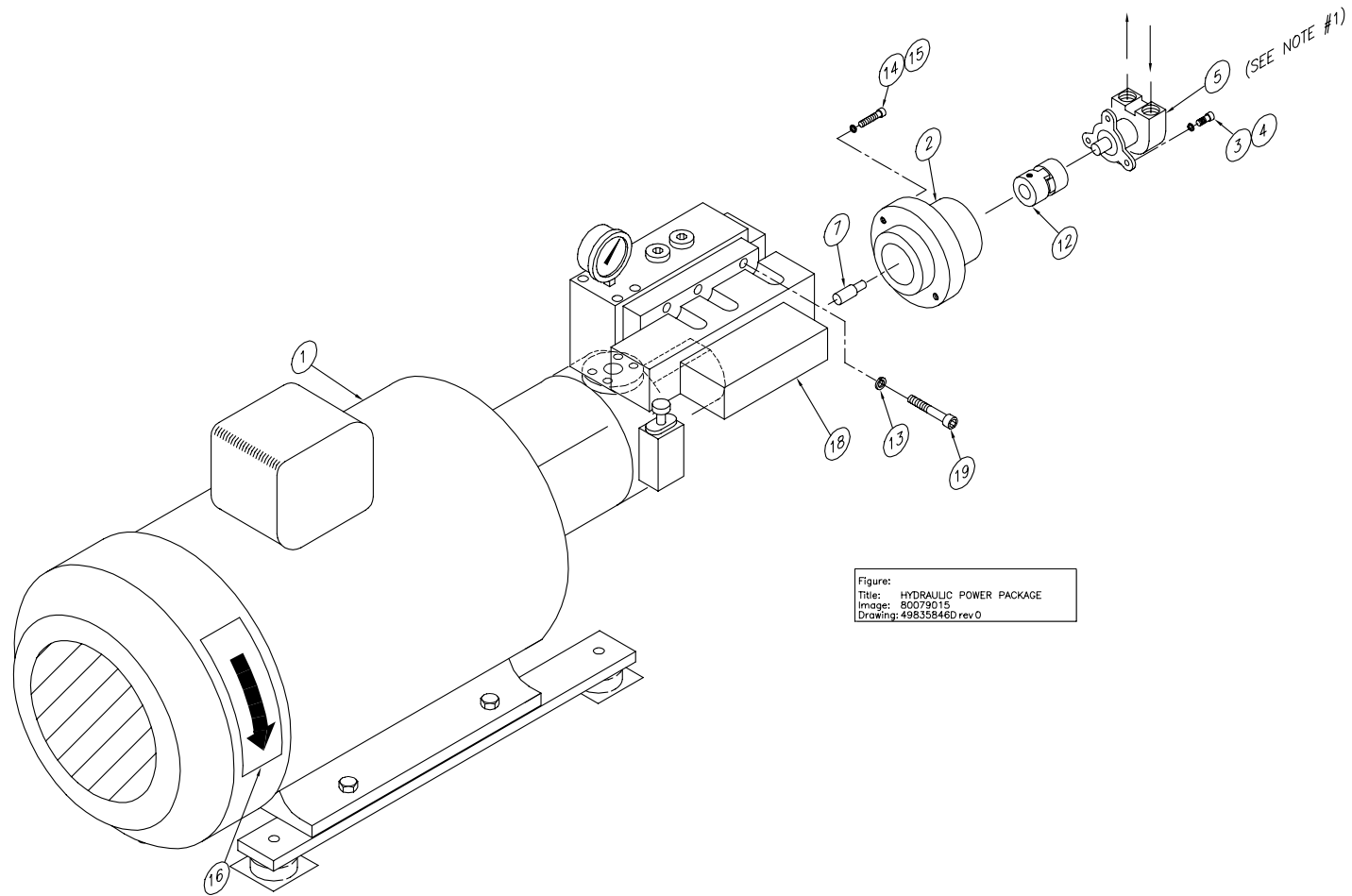


Figure:
Title: HYDRAULIC POWER PACKAGE
Image: 80079015
Drawing: 49835846D rev 0

NOTES:

- 1. SET ITEM #5 (BOOST PUMP) @ 120-125 PSI.

Figure 12-13 MOTOR / PUMP ASSEMBLY-49835812

ITEM No	QTY	PART NO.	DESCRIPTION
1	4	95296281	Screw, Hex Head, 3/4-10 x 2.00
2	8	95688735	Washer, Lock, 3/4
3	2	05103205	Mount, Motor
4	1	05103221	Electric Motor, 100hp
5	4	10066256	Screw, Hex Head, 3/4-10 x 2-1/2
6	-	10184802	Grease, Anti-Seize, Optimol
7	1	05103239	Pump, Hyd, Variable-Displacement, Axial-Piston
8	2	10192961	Screw, Socket Head, M12x1.75 x 30mm
9	2	10069763	Washer, Flat, 1/2
10	1	49835796	Manifold Assembly
11	1	10151470	Adapter, 90-deg, -12 JIC x -16 SAE O-ring
12	1	05091301	Pump, Gear, Hyd
13	4	95013785	Screw, Socket Head, 5/8-11 x 1-1/2
14	4	05103254	Vibration Isolator Pad
15	4	05103247	Capscrew, Soc Head, 1/2-13 x 6.00
16	4	95688750	Washer, Lock, High Collar, 1/2
17	1	49882087	O-ring
18	1	05112727	O-ring
19	1	05085758	Adapter-JIC/O-ring, 90 degree, 4-6
20	1	10091163	Adapter, 90-deg, 12-12 JIC/O-ring
21	1	10118057	Plug-O-ring Boss
22	1	10099760	Elbow-Tube/O-ring, 20
23	1	05139639	Adapter, M14 x 4,M/F SAE O-ring

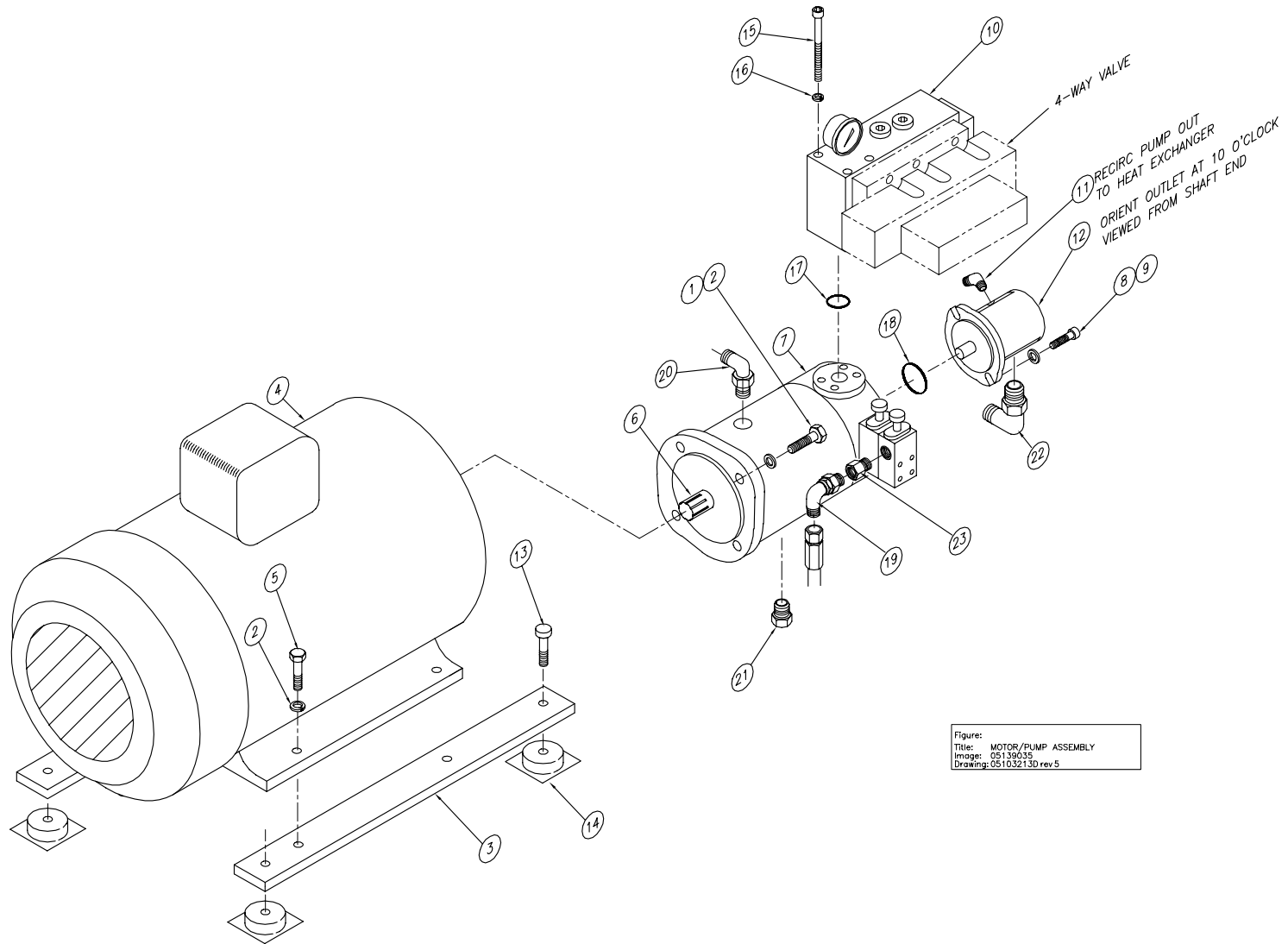


Figure:
Title: MOTOR/PUMP ASSEMBLY
Image: 05139035
Drawing: 05103213D rev 5

Figure 12-14 RESERVOIR ASSEMBLY 05104153

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05104161	Weldment, Reservoir
2	1	05104179	Gasket, Cover, Reservoir
3	1	05050026	Switch, Temperature / Level, Hyd, Cartridge- Type, 149 deg F
4	1	05092739	Breather, Air
5	1	10168862	Gage, Dual Scale, Level/Temperature, Oil
6	1	05103809	Housing, Filter, Hyd Oil, w/Gage
7	1	05104187	Element, Filter, Hyd Oil, Spin-on
8	1	05049655	Adapter, 90-Deg, 1" NPTx-12 JIC,
9	1	05069976	Cap, 3/4 NPT Hex, Steel
10	1	05071063	Tee, Male Branch, O-ring/JIC,-12,
11	1	05049713	Hose Assy, Hyd
12	1	05145941	Heat Exchanger
13	1	05060777	Adapter-JIC, 45 Degrees, M/F 12-12
14	4	95830766	Lock Washer, .31
15	1	10091858	Bulb Well, .75
16	4	95829248	Screw, Hex Head, 5/16-18 x 1.00
17	1	05104195	Bushing-Straight Thread, 1.0 SAE M x .75 SAE F O-Ring Boss
18	2	05104203	Elbow-90 Deg, 1.25 Male NPT x 1.25 Male JIC
19	1	05079967	Gasket, Sensor, Hyd Oil, 0.06"
20	1	10170645	Adapter, Pipe/O-ring, Straight, 12-16
21	1	05079371	Adapter, Straight Swivel, -12 JIC x -12 BSPP
22	1	05006291	Diffuser, Return Line, Hyd Oil
23	2	10099901	Elbow, 90-Deg, 1/4 NPT x -4 JIC,
24	1	10080901	Valve, Shutoff, Manual, 1/2 NPT,
25	2	10091163	Adapter-JIC/O-ring, 90 Degree, 12-12
26	1	95033619	Square Head Plug, .50
27	1	05145966	Heat Exchanger Bracket

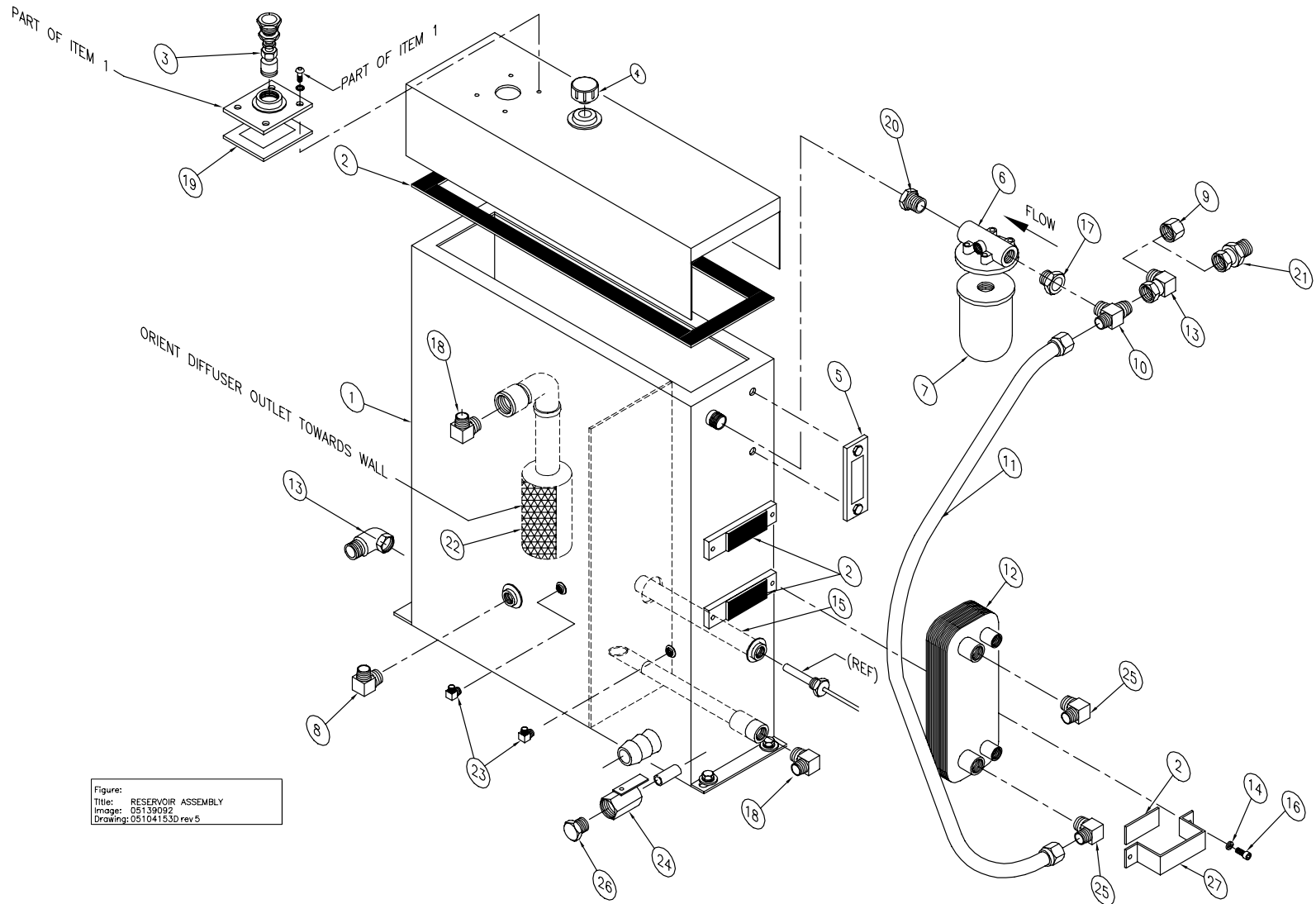


Figure:
Title: RESERVOIR ASSEMBLY
Image: 05139092
Drawing: 05104153D rev 5

Figure 12-15. TOP COVER ASSEMBLY 80074768

ITEM No.	QTY.	PART No.	DESCRIPTION
1	1	80074750	Support Assembly
2	1	80074735	Hinge
3	2	80074727	Cover, Top
4	2	49834708	Cover, End
5	2	49834690	Cover, End
7	4	49837511	Mounting Bracket
8	4	49837529	Mounting Bracket
9	4	49837503	Gas Spring
10	32	49837743	Screw-Button Head, 3/8-16 x 1.25
11	32	05091988	Nut, Flanged, 3/8 - 16
12	24	95897948	Screw-Button Head, #10-24
13	24	49832181	Nut, Flanged, #10-24
14	1	80074719	Gasket, Cover
15	6	95670972	Lock Washer, .38
16	6	05091954	Screw-Button Head, 3/8-16 x 1.00
17	4	80076748	Cable

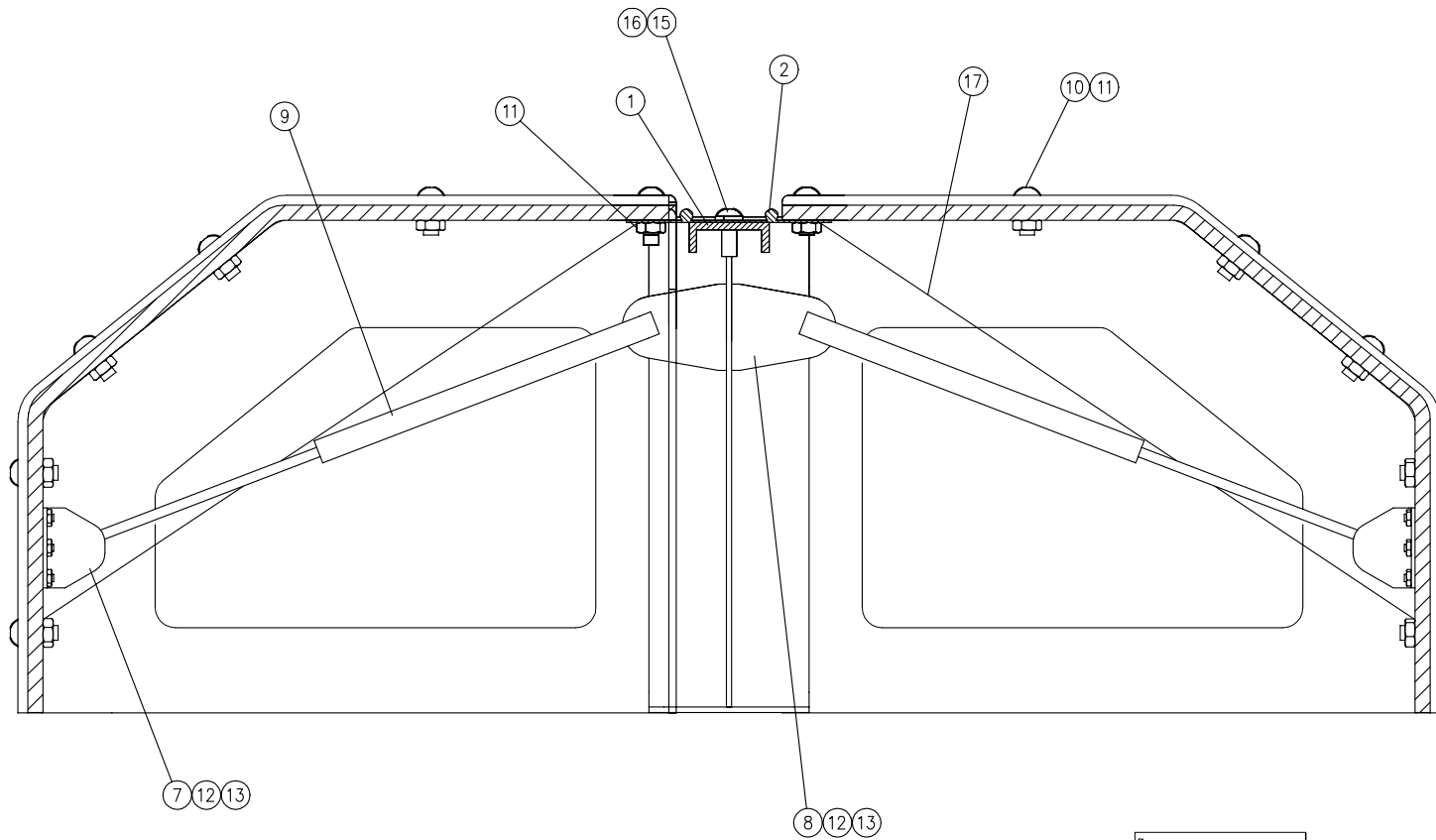


Figure:
Title: COVER ASSEMBLY
Image: 80079031
Drawn: 80074788 rev.1

Figure 12-16. ELECTRICAL ASSEMBLY 80077910 – 400V, 49838600 – 480V

ITEM No.	QTY	PART No.	DESCRIPTION
1	1	05148531	Harness, Cable, Sensor/Solenoid
2	1	10085520	Flexible Conduit Connector
3	6	05097464	Terminal Ring, #4
4	42"	10086700	Flexible Conduit
5	1	10115830	Flexible Conduit
6	1	05081377	Conduit Bushing
7	6	05113923	#6 Terminal Ring
8	4	10069763	Washer
9	588"	10105674	#4 Wire, Black (480V)
	504	10121648	#3 Wire, Black (400V)
10	24"	05075692	Vinyl Tape, Green (480V)
	84"	05139498	Wire #3, Green (400V)
11	1	05107354	Adapter Block
12	3	49887102	Hex Head Screw, 3/8-16 x 2-3/4
13	1	05107321	Terminal Block
14	2	95686721	Socket Head Screw, 1/4-20 x 1-3/4
15	4	95423695	Hex Nut, 1/2-13
16	1	05097464	#4 Terminal Ring
17	2	05062344	Lock Nut, 1/4-20
18	4	95716890	Lock Washer, 1/2
19	5	10125912	Cable Tie
20	1	49838618	Electrical Panel Configuration (480V)
		80077928	Electrical Panel Configuration (400V)
21	1	05107339	Conduit Bushing
22	1	05107347	Conduit Lock Nut
23	1	05112545	Rigid Conduit Lock Nut
24	2	10085405	Gasket Assembly

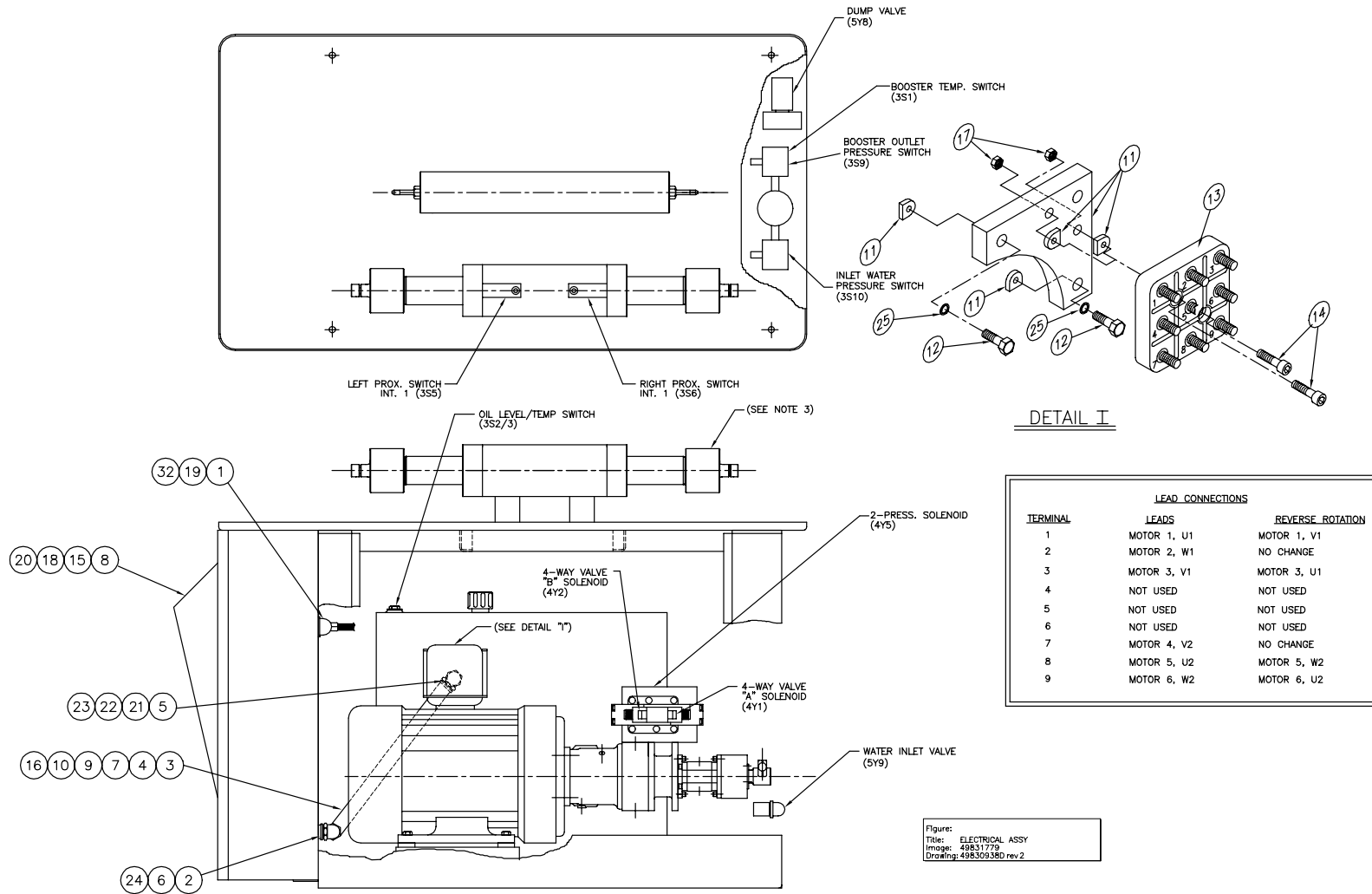


Figure 12-17 CONTROL PANEL CONFIGURATION, 49838618 – 480V, 80077928 – 400V

ITEM No.	QTY	PART No	DESCRIPTION				
1	1	05106372	Circuit Breaker, 175A	20	42"	10170157	#10 Wire, Green/Yellow
2	4	05031620	Socket Hd Screw, 10-32 x 1 3/4	21	90"	05019898	#14 Wire, Black
4	1	05075650	Shaft Extension	22	12	05019617	Crimp Connector
5	1	05075643	Door Interlock Handle			05049325	Circuit Breaker, 600v (480V)
6	1	05106406	Terminal Cover	23	1	05140686	Circuit Breaker, 600v (400V)
7	144"	10105674	#4 Wire, Black	24	7	05032362	End Anchor
8	20	05149778	Crimp Connector			05140223	Power Supply (480V)
		05111463	Non-reversing Contactor (480V)	25	1	05140876	Power Supply (400V)
9	2	49839814	Non-reversing Contactor (400V)			49834658	Control Sub-assembly (480v)
10	8	10157667	Hex Head Screw, #10-32 x 3/4	26	1	80077845	Control Sub-assembly (400v)
11	24"	10103034	DIN Rail			05091699	Timing Relay (480V)
12	1	05111448	Relay Overload	27	1	49833429	Timing Relay (400V)
14	1	05111471	Interlock Contactor	28	8	10185395	Crimp Connector
15	1	05117635	Non-reversing Contactor (480V)	29	48"	10146410	#16 Wire, Blue
		49836950	Non-reversing Contactor (400V)	30	48"	10170165	#16 Wire, Green/Yellow
16	1	49830607	Y-Delta Wiring Kit 72A (480V)	32	1	49836562	Control Transformer (400v)
		49830367	Y-Delta Wiring Kit 85A (400V)	33	1	80074131	Circuit Breaker (400v)
17	2	05095609	Ground Lug	34	1	10098226	Tube Base Relay (400v)
18	2	95423620	Hex Head Screw, 5/16-18 x 3/4	35	1	10098242	Screw Terminal Socket (400v)
19	24"	05106398	#3 Wire, Green/Yellow	36	100"	10181550	#16 Wire, Red

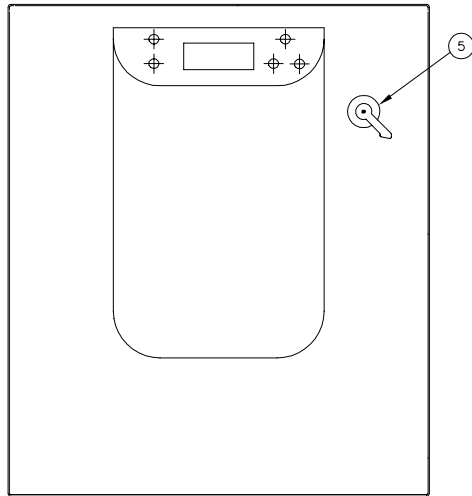


Figure:
Title: ELECTRICAL CONFIGURATION
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Drawing: 05148564 rev.1

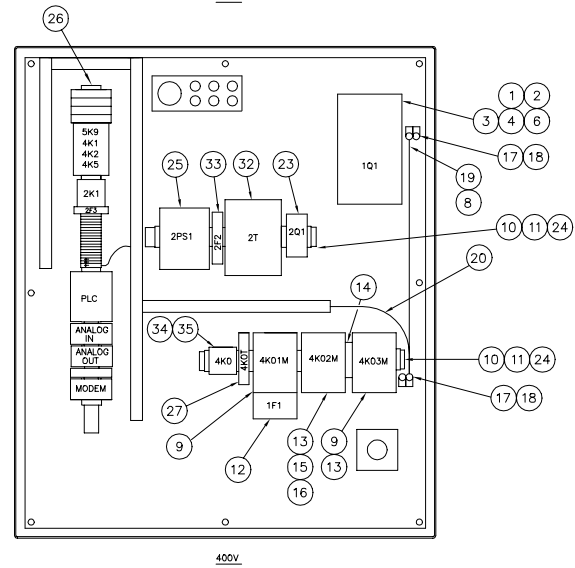
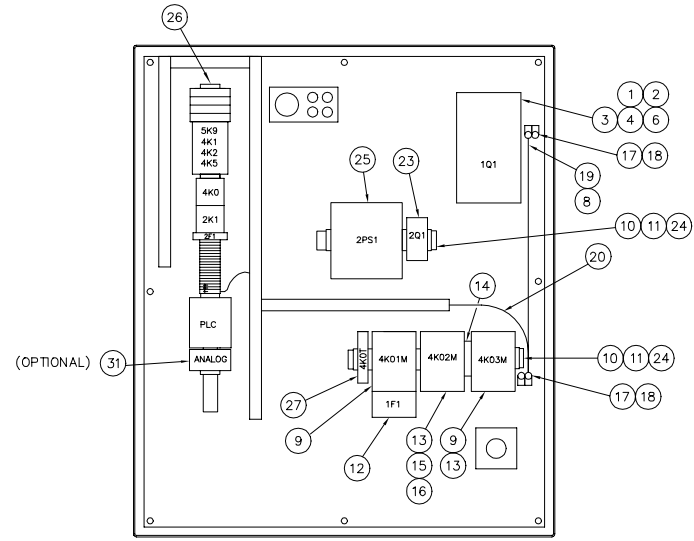
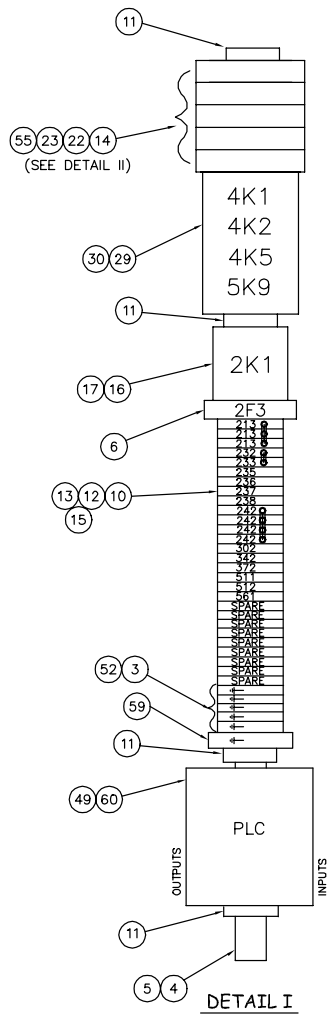


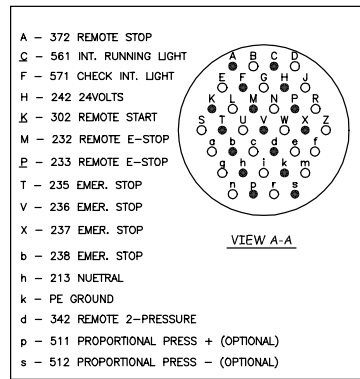
Figure 12-18. CONTROLS SUBASSEMBLY 49834658-480v, 80077845-400v

ITEM No.	QTY	PART No	DESCRIPTION
1	--	10176410	#16 Wire, Blue
2	--	10170165	#16 Wire, Green/Yellow
3	3	05032420	Terminal Block
4	36"	10103034	Din Rail
5	12	10157667	Screw, #10-32 x 3/4
6	1	05045994	Circuit Breaker
7	1	49833403	Push/Pull Switch, ES
8	2	05140652	Contact Block
9	1	05049473	Legend Plate
10	20	05032438	Terminal Block
11	4	05032362	End Anchor
12	1	05032370	End Barrier
13	1	05032388	Jumper
14	1	05112818	Marker
15	1	05032412	Marker
16	1	10186104	Tube Base Relay
17	1	10196012	Relay Base
18	1	49833395	Push Button Switch
19	1	49833486	Lamp Socket Block
21	1	49833379	Pilot Light-Green
22	14	05113634	Terminal Block
23	1	05112826	Terminal Block
24	1	49830268	Cable
26	1	05049432	Legend Plate Holder
28	1	05140504	Sub-Plate
29	1	10156859	I/O Rack
30	4	10146363	Single Point Module
31	2	10157659	Lock Washer, .25
32	1	05021944	Wiring Duct
			33 28 10170132 Rivet
			34 6 49874191 Hole Seal
			35 - 05140926 #16 Wire, Orange
			36 - 10185395 Crimp Connector
			37 4 10069888 Lock Washer, #6
			38 1 49834641 Enclosure
			39 1 05140082 Gasket Connector
			40 36" 10170157 #10 Wire, Green/Yellow
			41 3 10094712 Ring Terminal
			42 4 95416335 Hex Nut, 1/4-20
			43 1 49833387 Pilot Light
			44 1 05140975 Cap Connector
			45 12" 10102242 Spiral Wrap
			46 1 10098226 Tube Base Relay
			47 1 10098242 Socket
			48 4 10069797 Flat Washer, #6
			49 1 05144316 Base Control
			50 4 10070951 Pan Head Screw, #6-32 x 3/4
			51 1 05140157 Panel View Display
			52 1 05115134 End Barrier
			53 1 49833411 Selector Switch
			54 1 05114889 Legend Plate
			55 1 05117601 End Barrier
			56 1 10174431 Receptacle
			57 37 10174712 Socket Contact
			58 4 10069946 Hex Nut, #6
			59 1 05115704 Terminal Block
			60 1 05144308 Controller Program (PLC)
			61 2 49874233 Hole Seal
			62 1 05061312 Hole Seal



213	521	PROP PRESSURE SOLENOID (OPTIONAL)
213	521	PROP PRESSURE SOLENOID (OPTIONAL)
501	501	PRESSURE TRANSDUCER (OPTIONAL)
3132	3132	RIGHT PROX - INT2 (OPTIONAL)
3122	3122	LEFT PROX - INT2 (OPTIONAL)
3102	3102	INLET WATER PRESSURE
352	352	BOOSTER OUTLET PRESSURE
352	352	RIGHT PROX
352	352	LEFT PROX
332	332	HIGH OIL TEMP
242	242	OIL LEVEL SWITCH
312	312	BOOSTER PUMP TEMP
312	312	WATER SUPPLY VALVE
321	321	SAFETY DUMP
452	452	2-P SOLENOID
422	422	4-WAY B
422	422	4-WAY A

DETAIL II



OPTIONAL

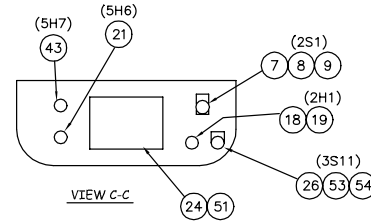
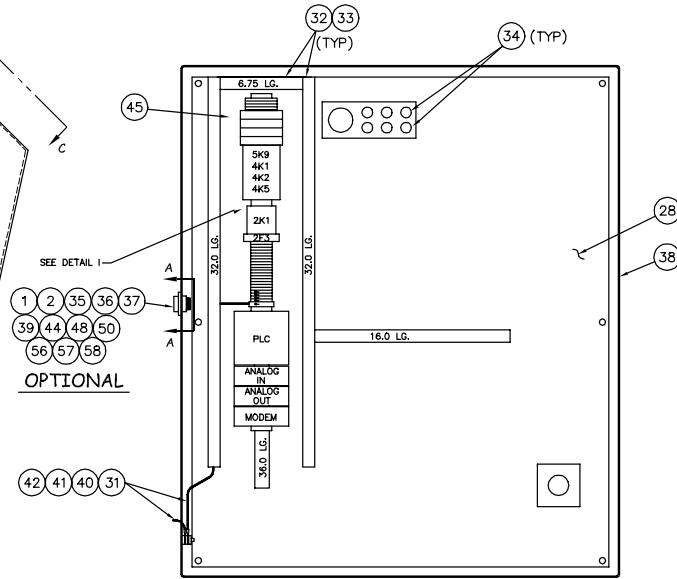


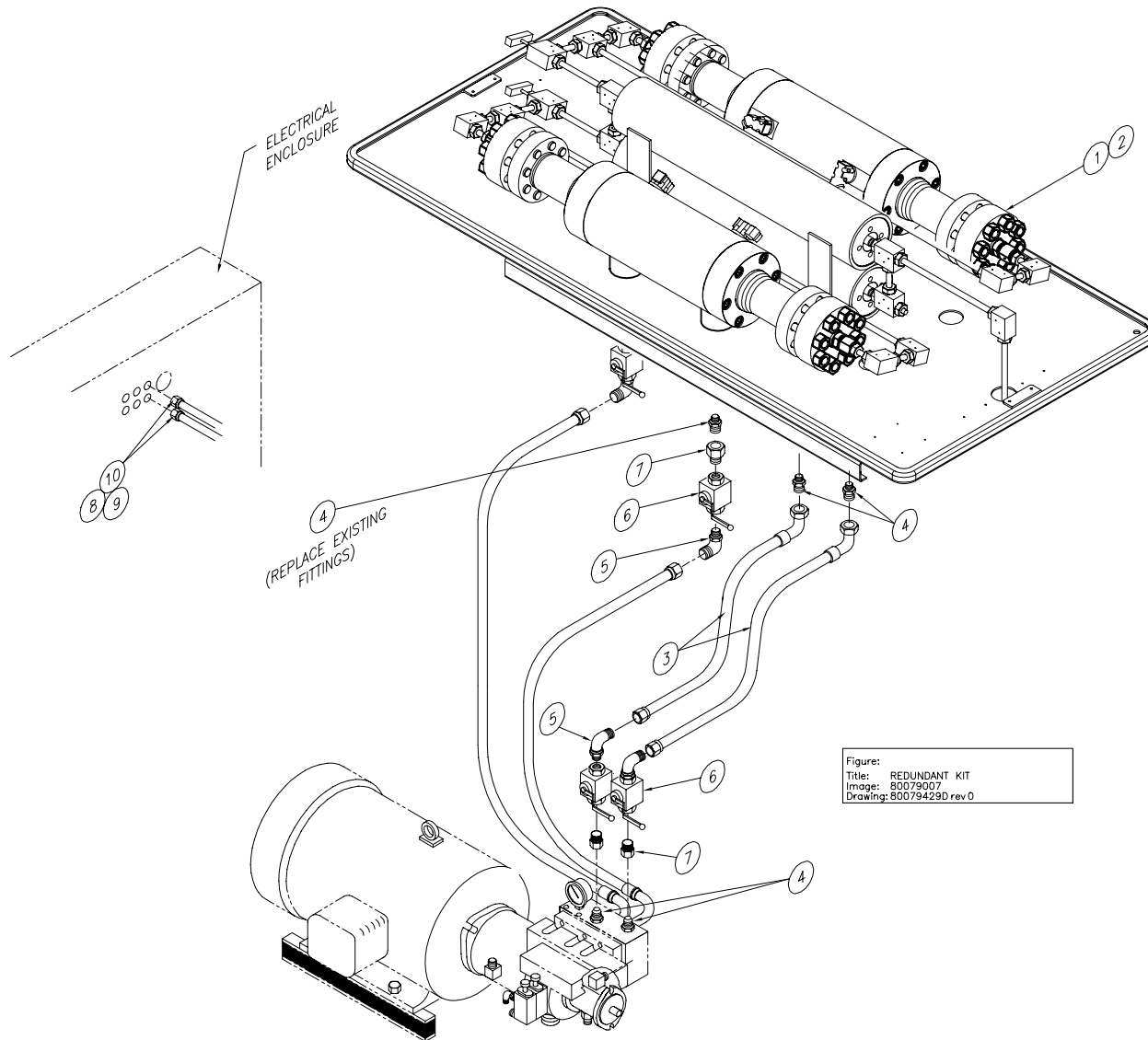
Figure:
Title: CONTROLS SUB-ASSEMBLY
Image: 80079056
Drawing: 49836620D rev 3



ENCLOSURE SHOWN IN THIS VIEW WITHOUT DOOR.

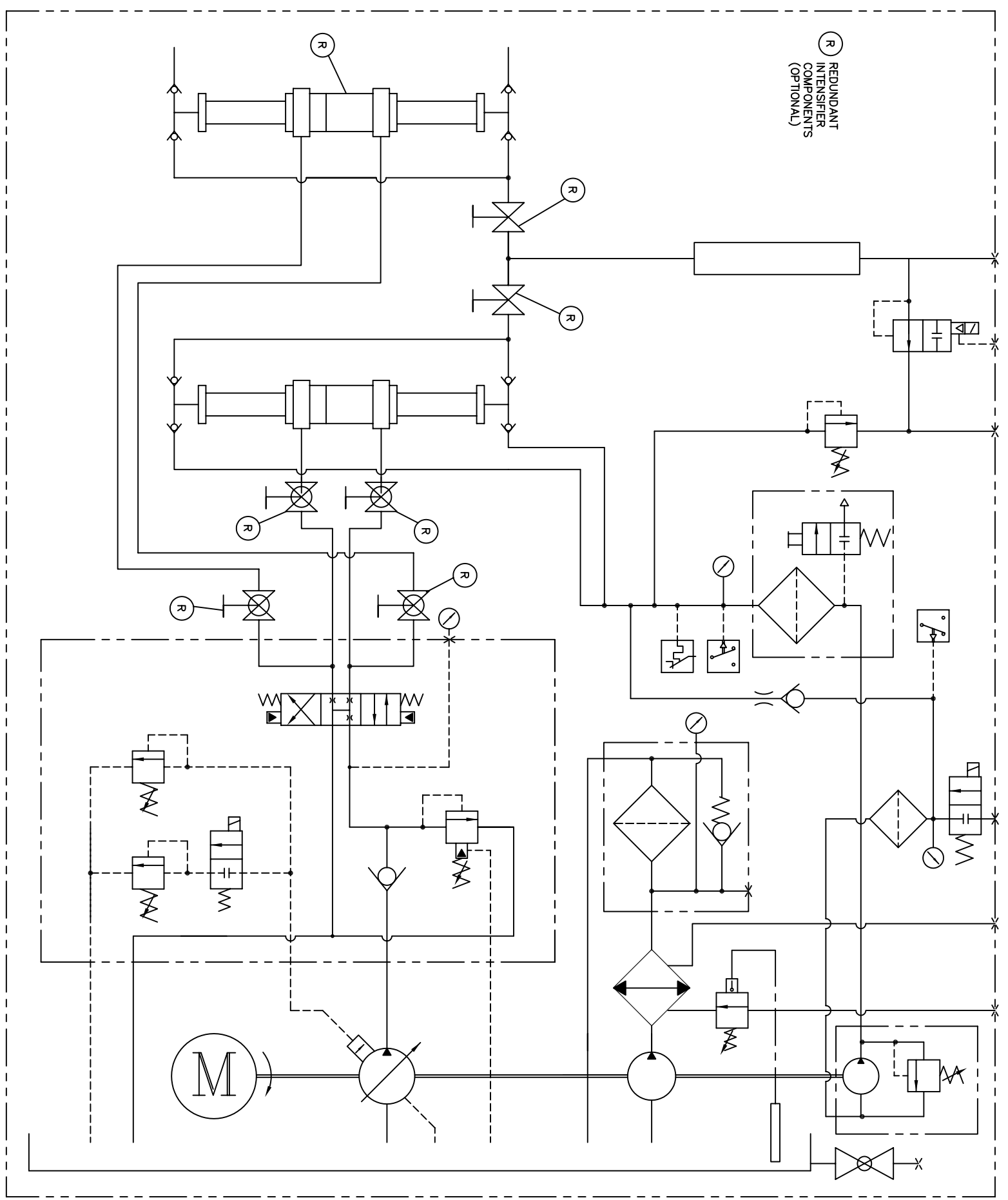
Figure 12-19. REDUNDANT KIT 80079429

ITEM No.	QTY.	PART No.	DESCRIPTION
1	1	49831175	Redundant Kit-HP Water
2	2	49895303	Adapter-Pipe/JIC, 8
3	2	80079536	Hose Assembly
4	6	05064407	Adapter-JIC/O-ring, 16-12
5	4	05025184	Adapter-JIC/O-ring, 90, 16-16
6	4	80079551	Ball Valve
7	4	10153831	Adapter-JIC/O-ring, 16-16
8	2	10084184	Plug Connector
9	2	10067205	Cable Connector
10	2	10083014	Lock Nut, .50





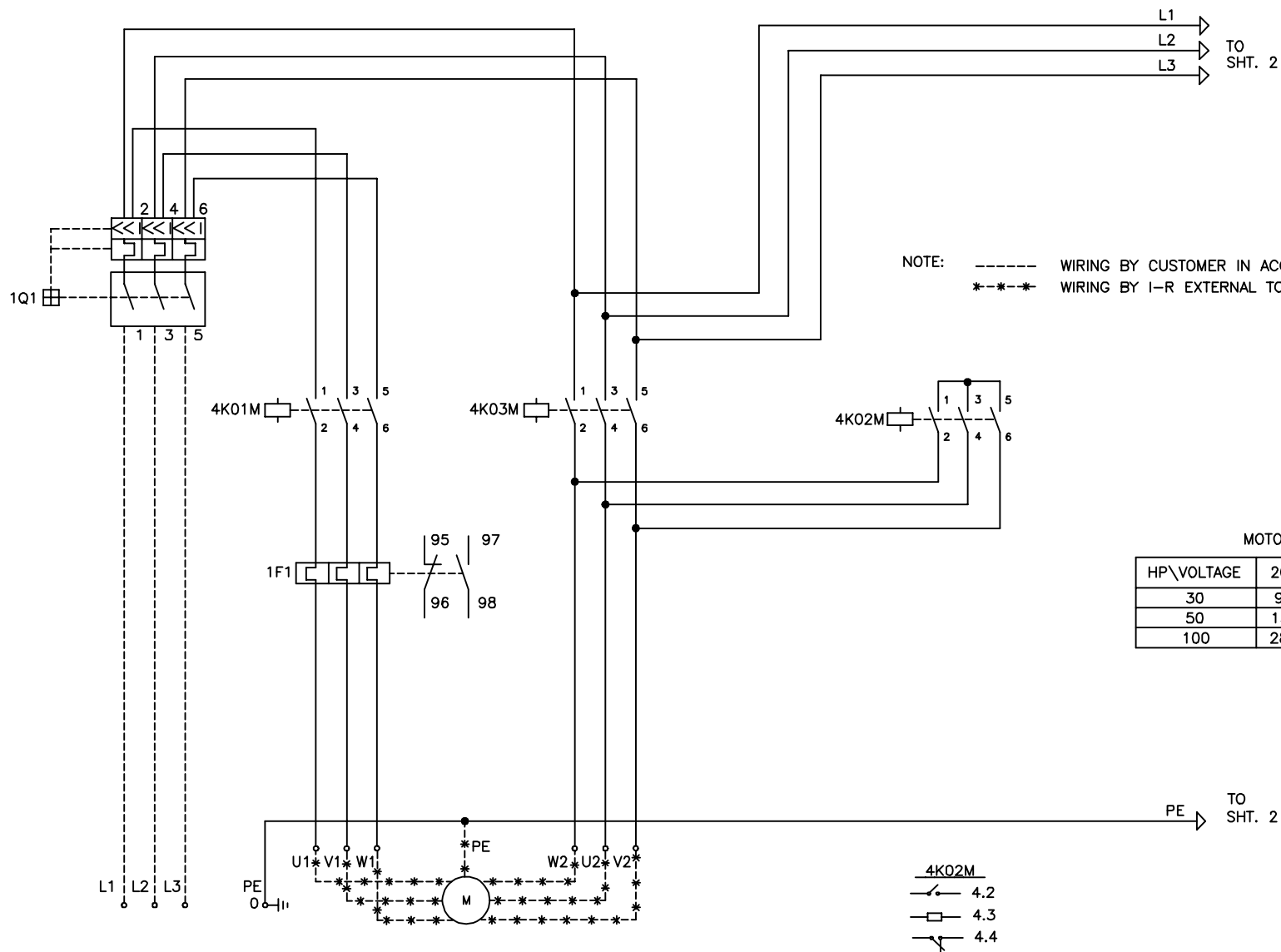
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2	REVISED LP WATER CIRCUIT REF FOR REV02572	7/27/04	JDS
		7/27/04	JDS



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NEXT ASSEMBLY				HARDNESS				SHEET 1 OF 1		REV. 2	

1 2 3 4 5 6 7 8 9

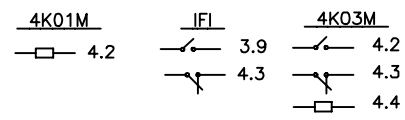
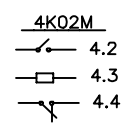
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NO	DESCRIPTION	DATE	APPROVED		



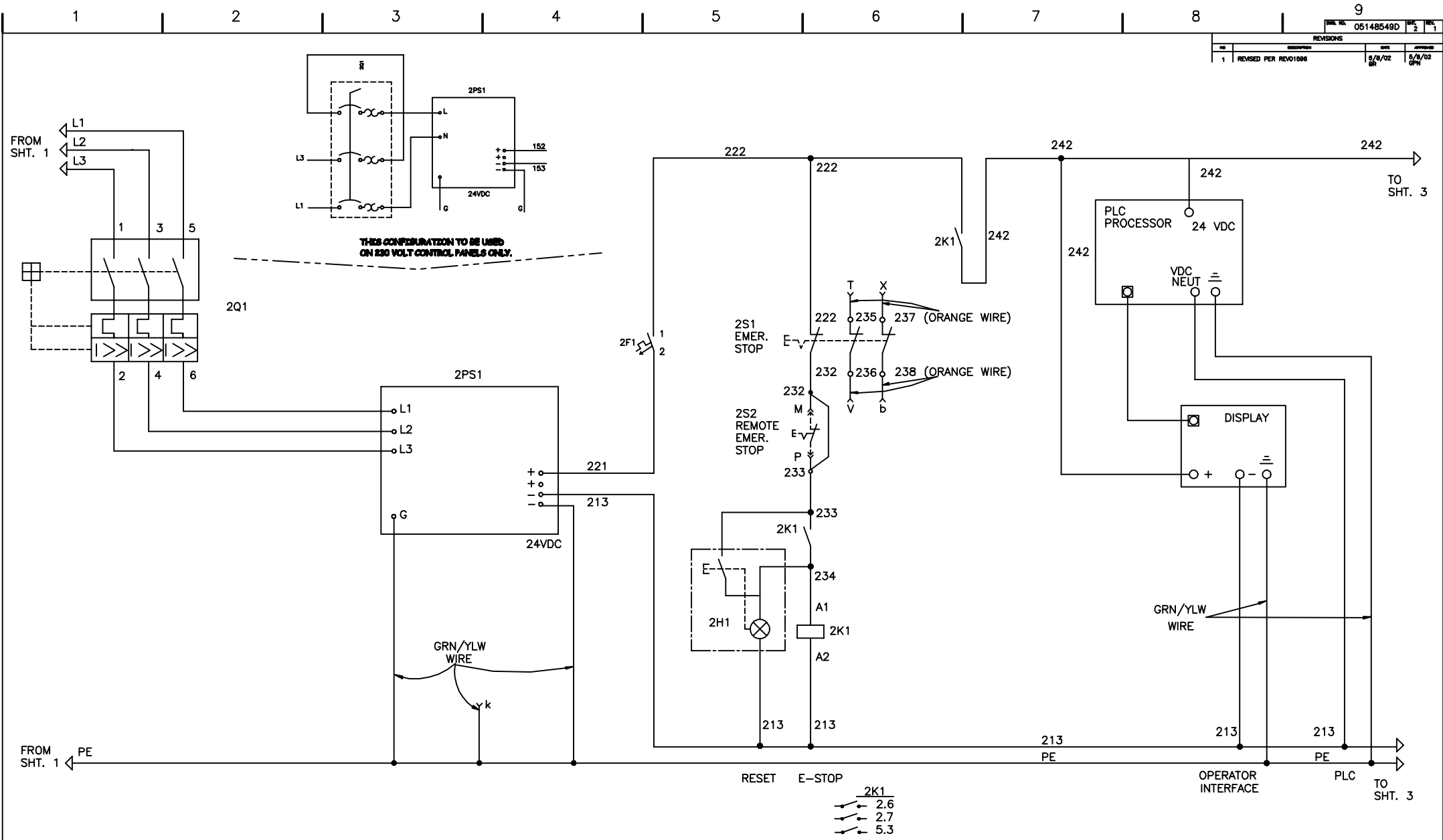
NOTE: ----- WIRING BY CUSTOMER IN ACCORDANCE WITH LOCAL REGULATIONS.
 --*-* WIRING BY I-R EXTERNAL TO PANEL

MOTOR FLA

HP \ VOLTAGE	200	208	230	400	415	460
30	92	88	80	46	44	40
50	150	143	130	75	72	65
100	285	273	248	143	138	124



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		<p>ALL DIMENSIONS IN INCHES (mm)</p> <p>W.TORAL -</p> <p>HEAT TREAT -</p> <p>HARDNESS -</p>	<p>TITLE ELECT SCHEM SL4K, Y-DELTA</p> <p>DRW. NO. 05148549D</p> <p>SCALE -</p>	<p>REV. 1</p> <p>SHEET 1 OF 5</p>	



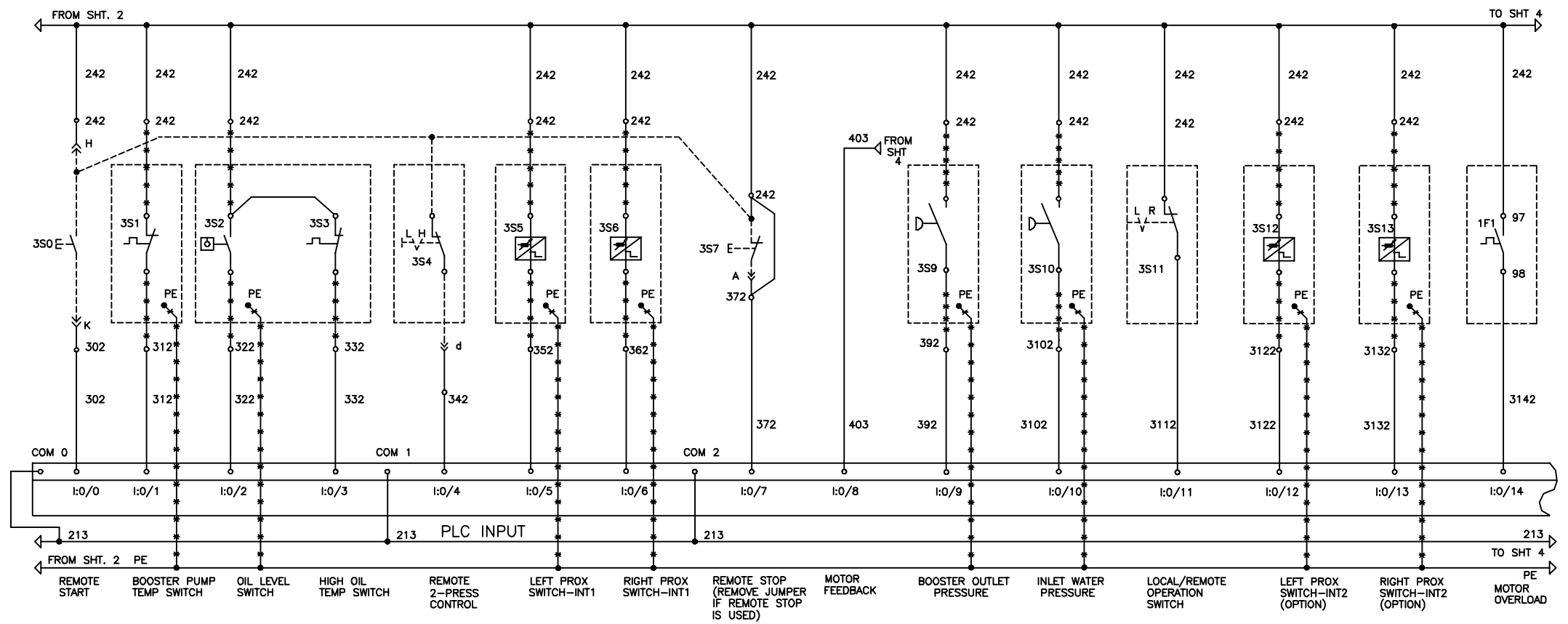
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1	REVISED PER REV010906	8/6/02	BR

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WARNING 1 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 of regulations.			TITLE ELECT SCHEM SLI4K, Y-DELTA	
			DWG. NO. 05148549D	REV. 1

1 2 3 4 5 6 7 8 9

REVISONS		
NO	DESCRIPTION	DATE
3		
1		

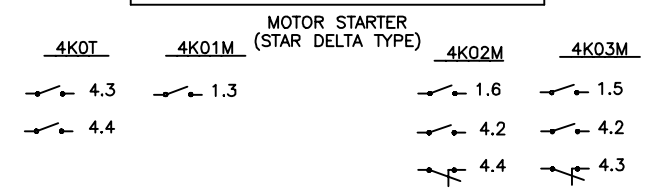
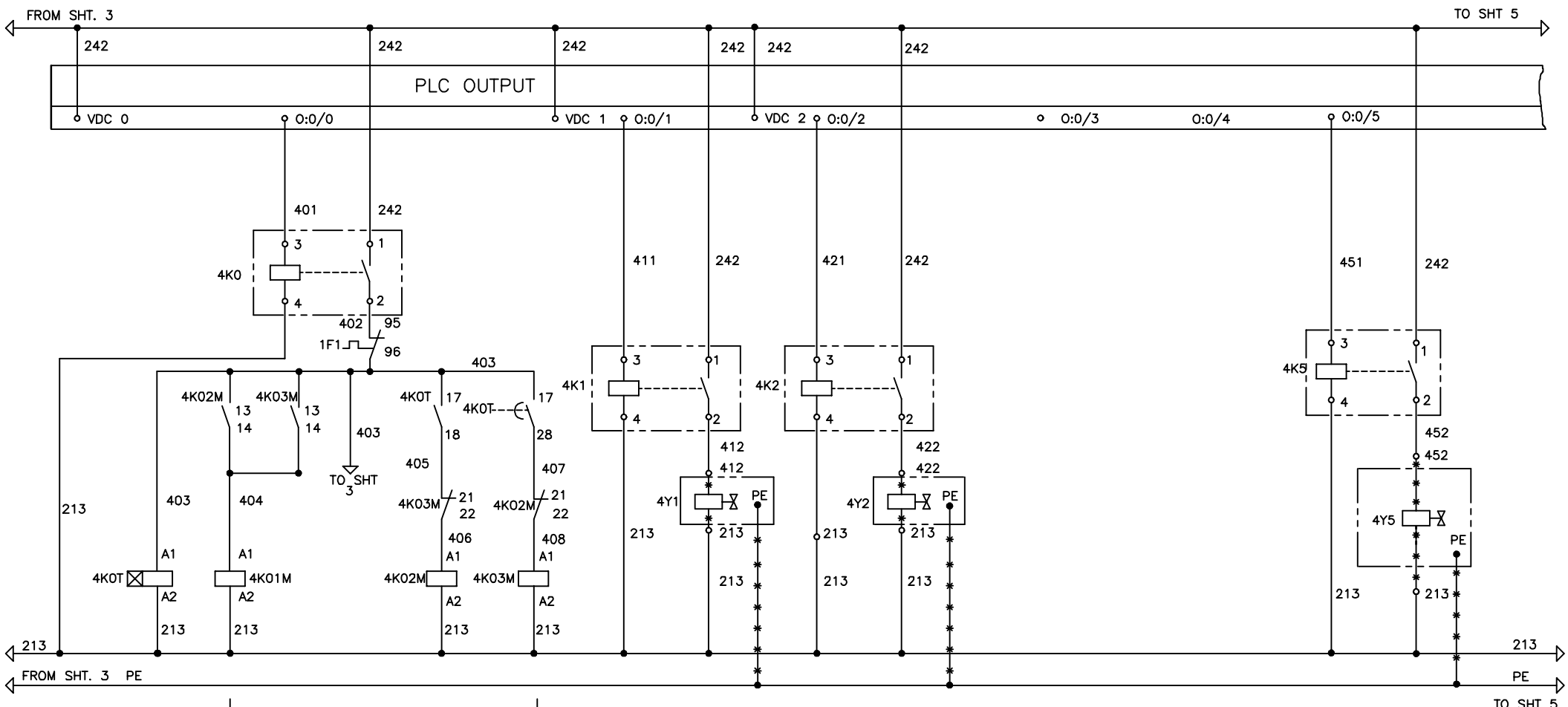


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	TITLE ELECT SCHEM SL4K, Y-DELTA	Dwg. No. 05148549D	SHEET 3 OF 5	

1 2 3 4 5 6 7 8 9

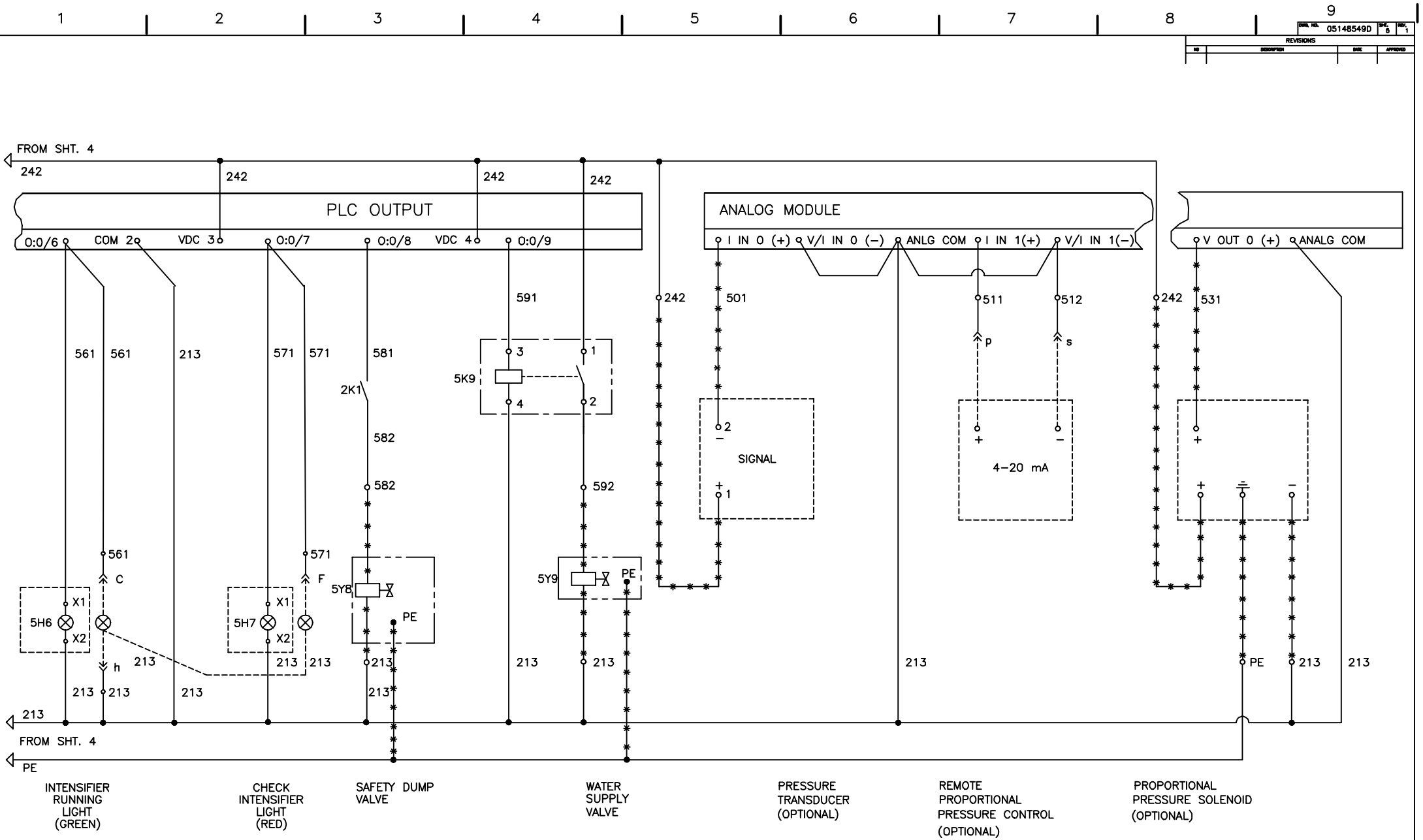
REV. NO.	05148549D	REV. 1
REVISIONS		
NO.	DESCRIPTION	DATE



4-WAY VALVE SOLENOID "A" 4-WAY VALVE SOLENOID "B" SPARE SPARE 2-PRESS SOLENOID

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WARNING I 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.	ELECT SCHEM SL4K, Y-DELTA DWG. NO. 05148549D SCALE: - TITLE BLOCK REVISION: 1 SHEET 4 OF 5			

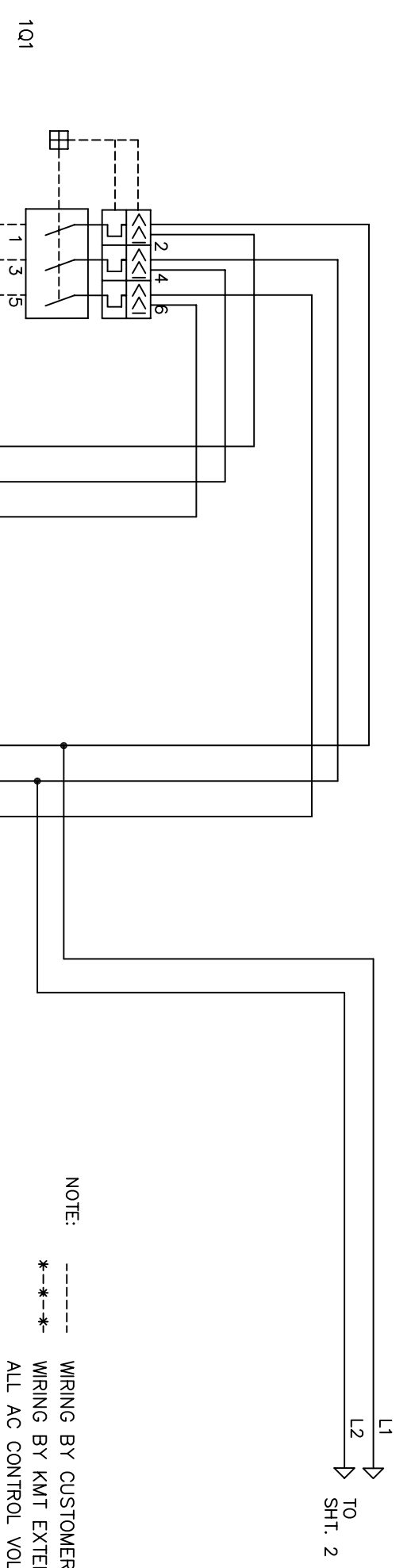


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NO.	DESCRIPTION	DATE	APPROVED

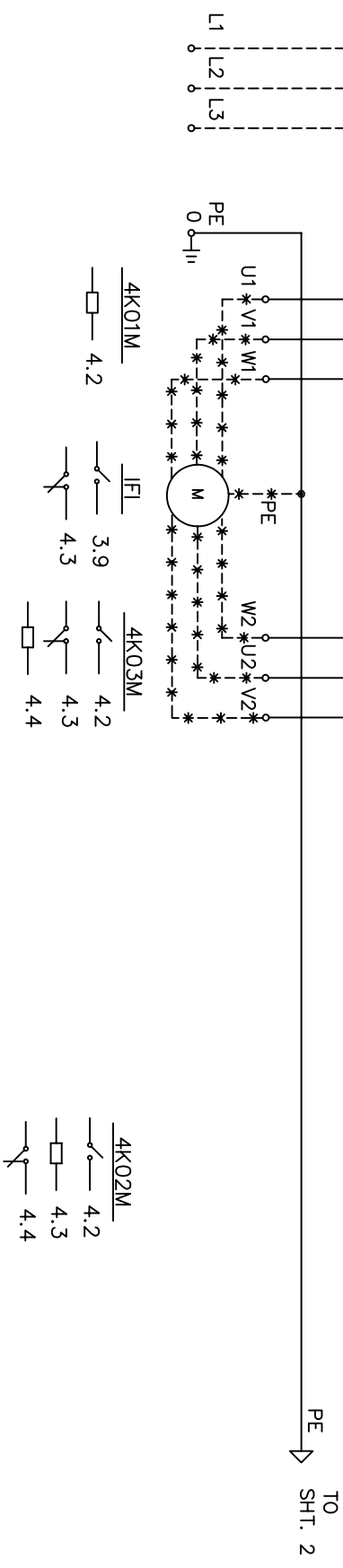
PKT. NO. 49836604D SH. 1 OF 5



NOTE: ----- WIRING BY CUSTOMER IN ACCORDANCE WITH LOCAL REGULATIONS.
 --* WIRING BY KMT EXTERNAL TO PANEL
 ALL AC CONTROL VOLTAGE WIRES MUST BE RED IN COLOR

MOTOR FLA

HP \ VOLTAGE	200	230	400	415	460
30	92	88	80	46	44
50	150	143	130	75	72
100	285	273	248	143	138



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PROPRIETARY NOTICE

STANDARD TOLERANCES

GD&T TO ASME Y14.5M 1994

KMT Waterjet Systems

WARNING !

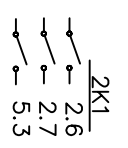
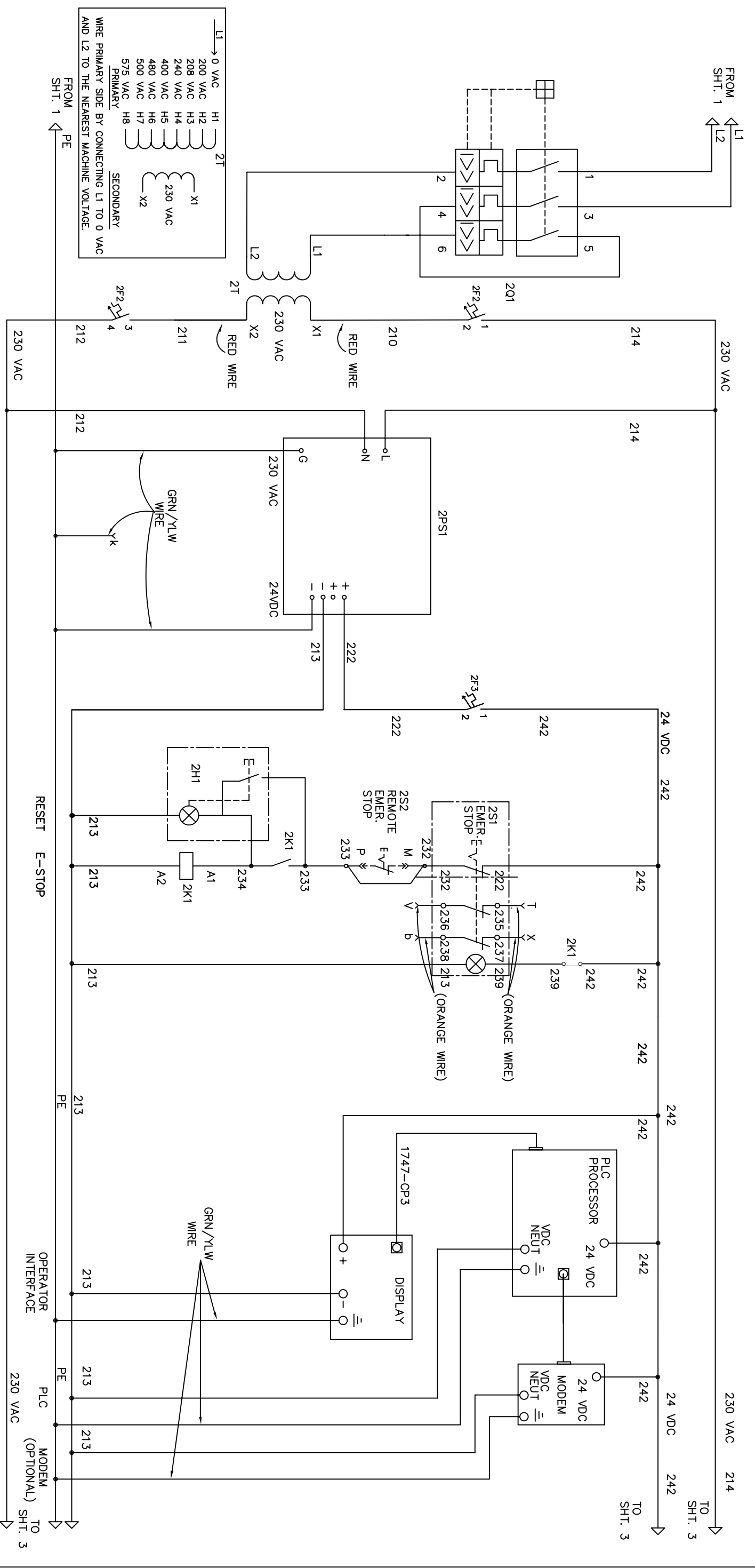
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 COMMON CENTRAL LINE
 BREAK SHARP EDGES
 AND CORNERS 015
 SURFACE FINISH -
 STANDARD TOLERANCES:
 XX = ±.003
 XXX = ±.015
 XXXX = ±.030
 ANGLE = ±2°

DRAWN BY: B RUMBEL
 DATE: 7/02
 CHECKED BY: JPN
 DATE: 7/02
 INCHES

TITLE: ELEC SCHEM
 SLIV PLUS, Y-DELTA
 PKT. NO. 49836604D
 SCALE: 1" = 1" (HARD ANGLE PROJECTION)
 SHEET 1 OF 5

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
7	ADDED 210 AND 211 NUMBERS	01/12/04	01/12/04
7	CHANGED E-STOP PER FOR REV02797.	10/12/04	10/12/04
8			



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NEXT ASSEMBLY		TITLE		SCALE		SHEET		OF		8		8		8		8	

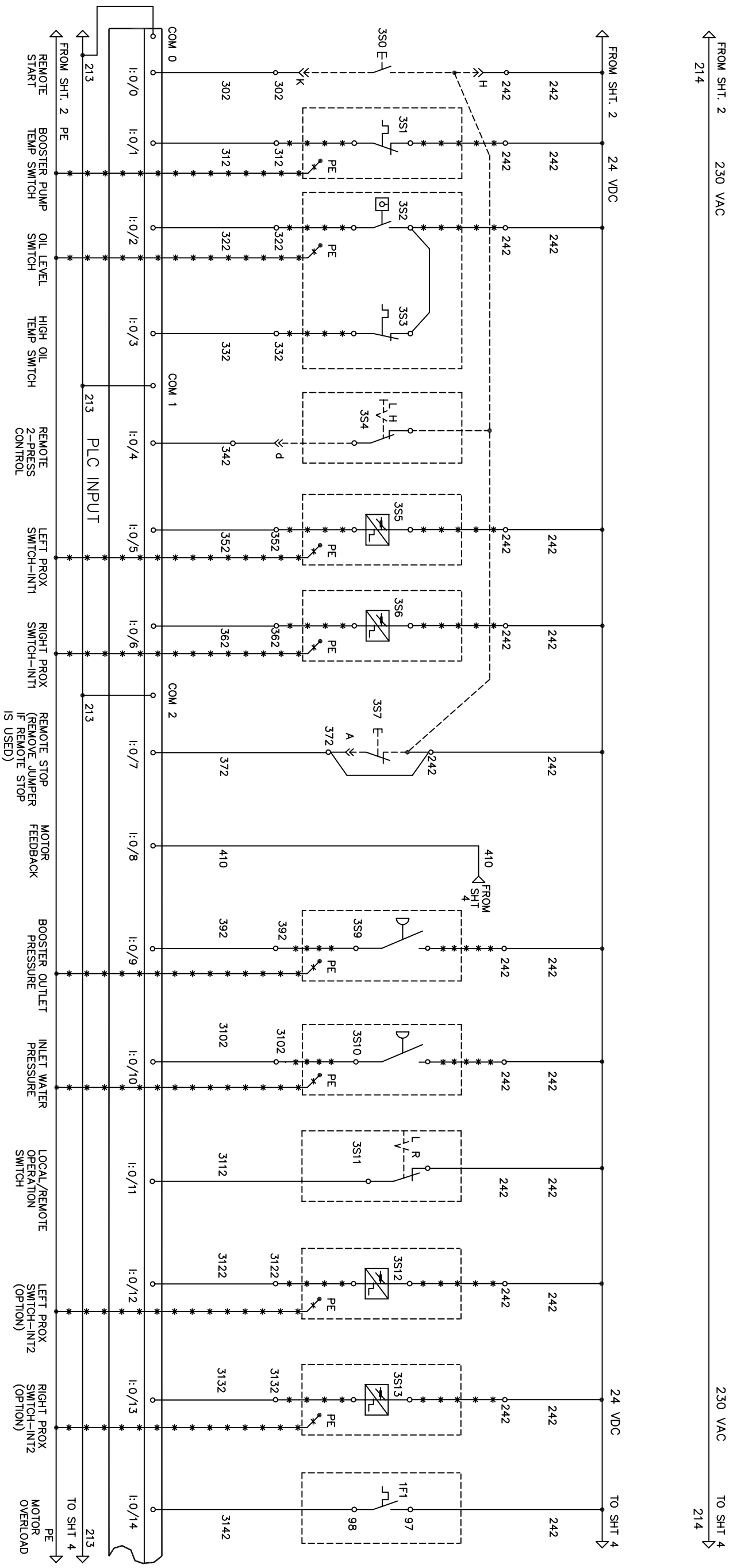


ELEC SCHEM
SLIV PLUS, Y-DELTA

49836604D

REVISIONS		DATE	APPROVED
NO.	DESCRIPTION	DATE	APPROVED
1	REVISED PER REV01787	10/21/02 BR	10/21/02 GPN

PKG. NO. 49836604D
SHEET 3 OF 5



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 WIRING BY KMT EXTERNAL TO PANEL
 ALL AC CONTROL VOLTAGE WIRES MUST BE RED IN COLOR

TO SHT. 3
 FROM SHT. 2 230 VAC 212

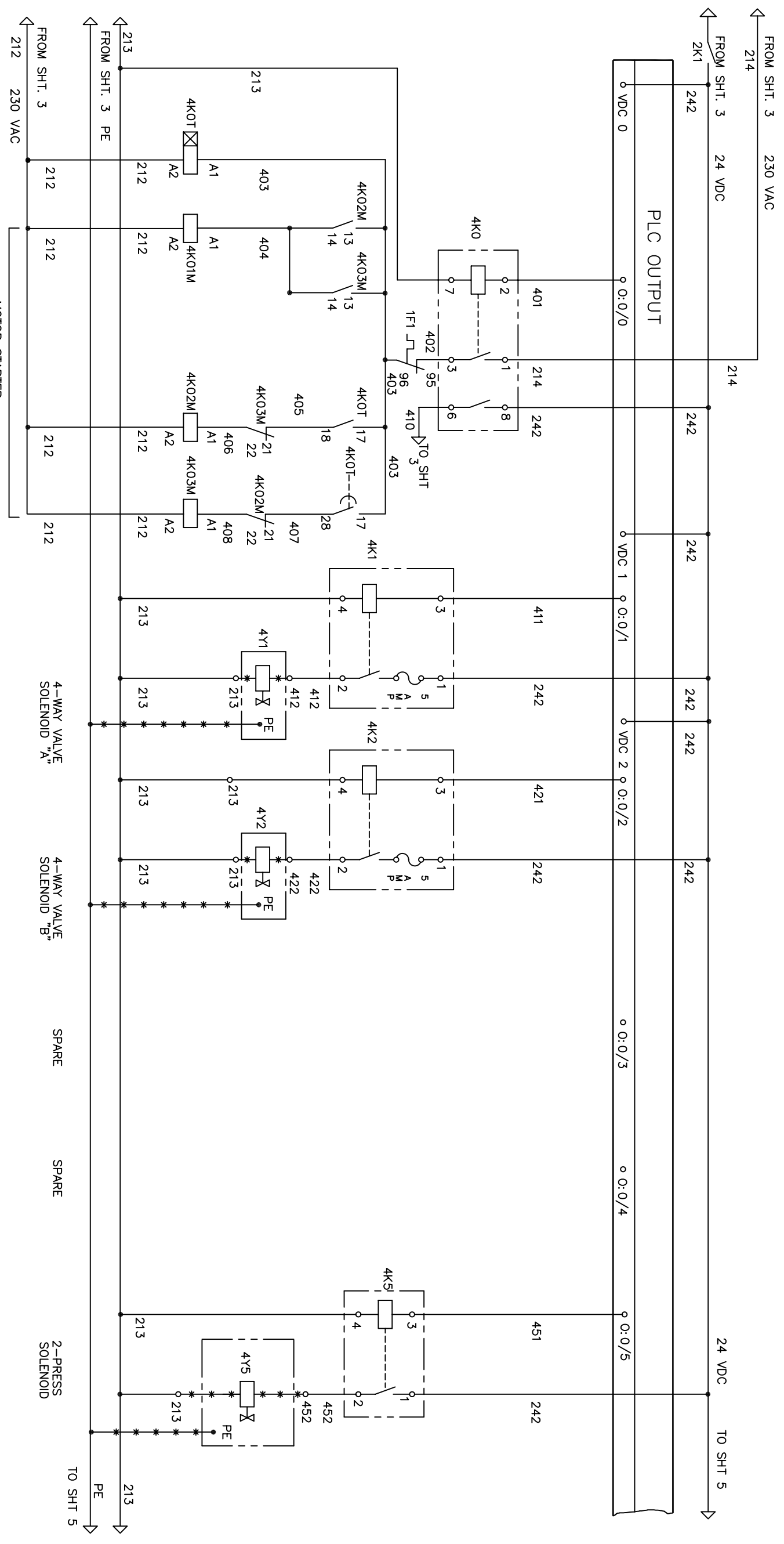
TO SHT. 4
 FROM SHT. 2 24 VDC 214

TO SHT. 4
 FROM SHT. 2 230 VAC 212

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NEXT ASSEMBLY		SCALE: 1" = 1"		TITLE BLOCK REVISION: 1		SHEET: 3		OF: 5		REV: 8	

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
2	REVISED PER REV01825	11/7/02	BRN
6	ADDED 5 AMP FUSE TO SOLENOID PER REV02308	12/01/03	K.A.L.

PKG. NO. 49836604D SHEET 4 OF 5



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WIRING BY KMT EXTERNAL TO PANEL

ALL AC CONTROL VOLTAGE WIRES MUST BE RED IN COLOR

KMT Waterjet Systems

ELEC SCHEM
SLIV PLUS, Y-DELTA

PKG. NO. 49836604D

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SURFACE FINISH - STANDARD TOLERANCES:
X.X = ±.005
X.XX = ±.015
X.XXX = ±.020
ANGLE = ±2°

GD&T TO ASME Y14.5M 1994
REF. DIM 05148549D

DATE: 7/02
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CHECKED BY: [blank]
DATE: 7/02

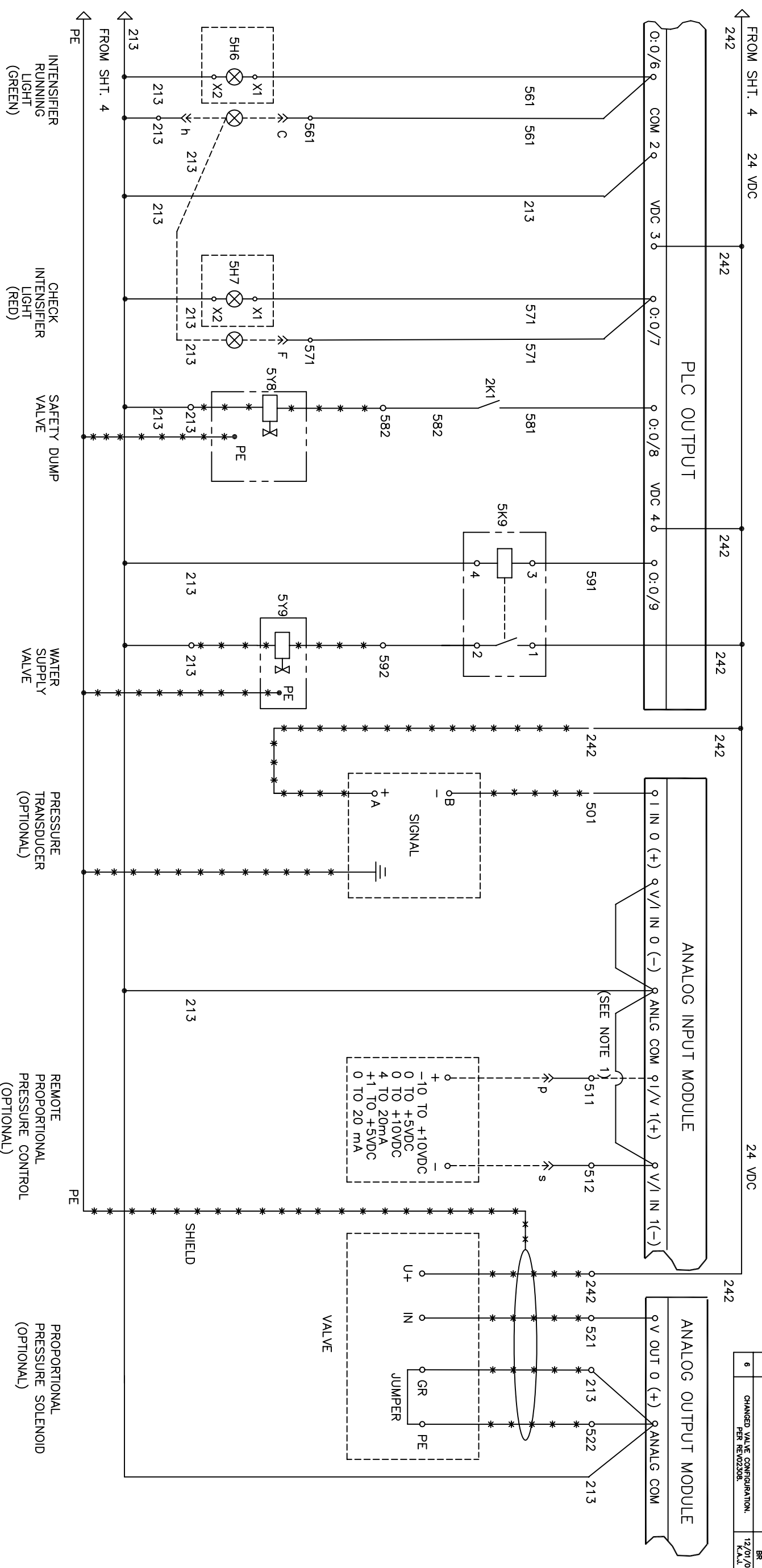
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DATE: 7/02

REVISIONS			
NO.	DESCRIPTION	DATE	APPROVED
2	REVISED PER REV01826	11/7/02	BRN
3	A & B WERE 1 & 2, REV01931.	1/21/03	BRN
4	ON VLV. 4 WAS 3 & 5 WAS 4. PER REV02116.	05/29/03	K.A.L.
5	REVISED PER REV02169	7/11/03	BRN
6	CHANGED VALVE CONFIGURATION. PER REV02308.	12/01/03	K.A.L.



NOTE: VOLTAGE OR CURRENT CONTROL SPECIFIED BY CUSTOMER.
 USE I IN 1(+) FOR CURRENT OR V IN 1(+) FOR
 VOLTAGE CONTROL ON ANALOG MODULE.

 WIRING BY CUSTOMER IN ACCORDANCE WITH LOCAL REGULATIONS
 --*-*
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