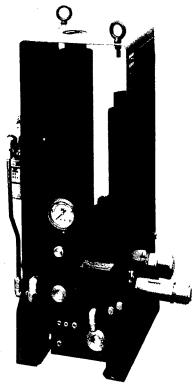
290.1X, 290.2X, 290.3X Hydraulic Service Manifold



012-807M



MTS SYSTEMS CORPORATION

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Section I Introduction

1.1 Functional Description

The MTS Series 290 Hydraulic Service Manifolds (HSM) are units designed to be inserted in the hydraulic lines between a hydraulic power supply (HPS) and servovalve(s).

The basic concept of the Series 290 HSM design is to provide line pressure regulation and auxiliary control functions in a small, easily implemented package. Size and weight have been kept to the minimum commensurate with operating safety. Additionally, provisions have been made to permit the addition of certain control functions for line isolation, pressure control and load abort as an option package. In Series 290.1X HSM units, the pilot pressure circuit is also an available option. Porting of the main pressure supply circuit and the return circuit has been increased to permit simultaneous hydraulic fluid supply to more than one servovalve without extensive plumbing.

Consideration has also been given to design requirements from a service aspect. Components are located to provide maximum ease of access within safety limits. Control devices have been kept as simple as possible while still providing optimal regulation. Depending on the specific model, the HSM incorporates the following functions:

- All models provide fluid filtration in addition to that furnished by the hydraulic power supply. A port is provided to permit drainage of the main filter and (if so equipped) the pressure control valve to reduce hydraulic fluid spills during service.
- All models provide accumulators in both the pressure and return lines, permitting energy storage and reduction of pressure fluctuations.
- All models are equipped with a push-to-read valve-isolated pressure gage which allows monitoring of output pressure. When the valve button is released, output pressure is removed from the gage, and the gage is ported to the drain line to reduce the possibility of gage damage from rapid pressure variations.
- All models have auxiliary pressure and return ports for operation of additional actuators and system hook-up versatility.

- Most models provide hydraulic control functions for pressure off, low pressure, and high pressure modes. These models have a fast pressure unloading feature which permits rapid removal of pressure from the servovalve in the event of an abnormal condition or emergency shutdown. An added accumulator provides slow turn-on/turn-off of pressure during normal operation. This allows smooth pressure transitions from off to low, low to high, and high to low modes. Units equipped for hydraulic control allow complete, independent control of individual channels or systems which are deriving hydraulic pressure from a common HPS.
- Most models have a separately filtered, accumulator equipped output for operation of the pilot stage in multistage servovalves.

The following list of major components is arranged in the order in which hydraulic fluid generally flows through the Series 290 HSM. The list includes all models and options. Refer to Table 1-1 for model variations. Figures 1-1, 1-2 and 1-3 illustrate the locations of these components for each model group.

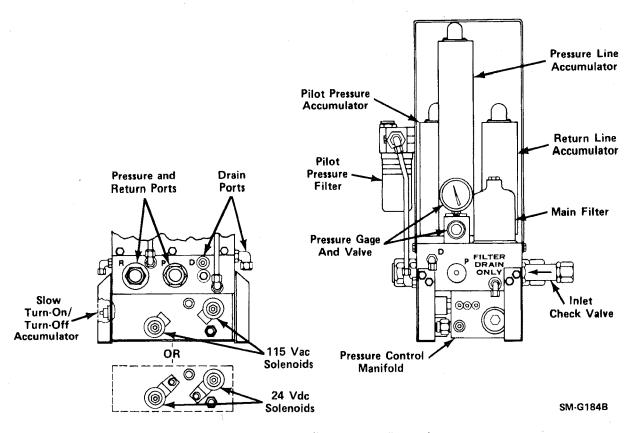


Figure 1-1. 290.1X Component Locations

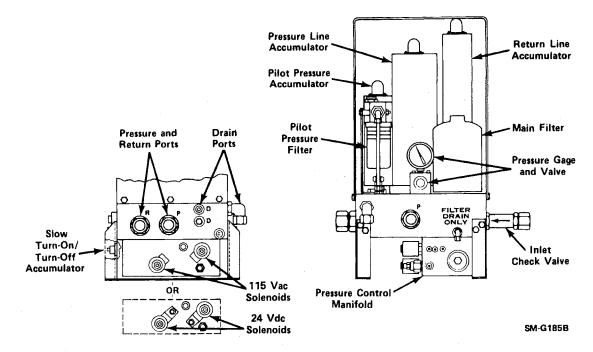


Figure 1-2. 290.2X Component Locations

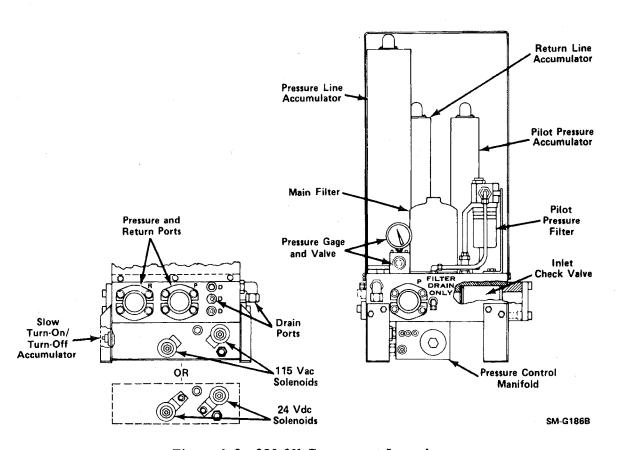


Figure 1-3. 290.3X Component Locations

- Inlet check valve: may be mounted internally or externally, depending on the HSM model. The valve prevents fluid from flowing backward through the main filter and causing reverse pressure damage.
- Main filter: provides 74 micron filtration of the fluid in addition to filtration provided by the HPS. This filter helps prevent large contaminants from reaching the servovalve(s) with minimal pressure drop across the filter.
- Pressure control manifold: contains a low pressure level control valve, low and high pressure solenoids, a main pressure control spool, and a slow turn-on/turn-off accumulator.
- Pressure accumulator: provides energy and volume storage and reduces pressure fluctuations in the pressure line.
- Pressure gage and valve: provides push-to-read indication of the outlet pressure. Releasing the isolation valve button causes the gage to be disconnected from the pressure line and connected to the drain line, protecting the gage from cyclic pressure fluctuations and high pressure spikes.
- Return line accumulator: reduces pressure fluctuations in the return line.
- Pilot pressure filter: provides 3 micron (absolute) filtration for fluid being applied to the pilot stage of multi-stage servovalve(s). The filter is equipped with a pop-up indicator which signals a dirty filter condition. Electrical switch activated indication is available as an option.
- Pilot pressure accumulator: provides energy and volume storage and assists in maintaining relatively constant hydraulic pressure at the servovalve pilot control sections.
- Pressure and return ports: each are dual ports for pressure and return line connection.
- Drain ports: are dual inlet ports for incoming drain lines. A larger outlet port is provided for connecting the HSM to the HPS.

Certain options may be available which include different filtration, reduced pilot pressure, electrical switch sensing of pilot pressure filter condition and different sized accumulators. Contact MTS Systems Corporation for additional information concerning available options.

1.2 Specifications

Figure 1-4 illustrates the flow versus pressure drop as measured from the main pressure inlet port to the main pressure outlet port. This graph assumes that filter elements are clean. The graph shows that a rapidly increasing pressure drop results as flow rates progressively exceed the recommended maximum rate.

Table 1-1 summarizes the standard Series 290 HSM units, functions, and differentiating specifications.

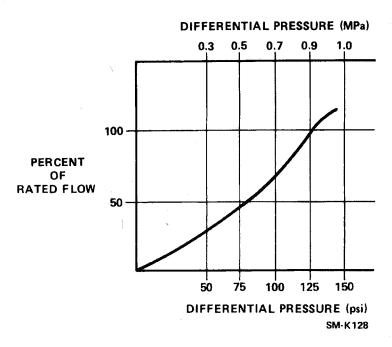


Figure 1-4. Flow Characteristics

Table 1-1. Model Specifications

	Ra	Rating			Acc	Accumulators	ırs	Port	Port Sizes	
Model¹	Gpm	e/min	Pilot Outlet	Pressure Control ²	Pressure	Return	Pilot	Pressure & Return (Input & Output)	Pilot	Drain
290.11B-01	90	190	No	No	l qt	1 pt	NA	JIC-16, -20	NA	JIC-6, -8
290.12B-01	50	190	Yes	No	1 qt	1 pt	1 pt	JIC-16, -20	JIC-6	JIC-6, -8
290.13C-01	50	190	oN .	115 Vac	l qt	1 pt	NA	JIC-16, -20	NA	JIC-6, -8
290.13D-01	90	190	No	24 Vdc	1 qt	1 pt	NA	JIC-16, -20	NA	JIC-6, -8
290.14C-01	20	190	Yes	115 Vac	1 qt	1 pt	1 pt	JIC-16, -20	JIC-6	JIC-6, -8
290.14D-01	50	190	Yes	24 Vdc	l qt	1 pt	1 pt	JIC-16, -20	JIC-6	JIC-6, -8
290.21B-01	100	380	Yes	No	ł gal.	1 qt	1 pt	JIC-20	JIC-6	JIC-6, -8
290.22C-01	100	380	Yes	115 Vac	½ gal.	1 qt	1 pt	JIC-20	JIC-6	JIC-6, -8
290.22D-01	100	380	Yes	24 Vdc	₹ gal.	l qt	1 pt	JIC-20	JIC-6	JIC-6, -8
290.31A-01	250	950	Yes	No	1 gal.	1 qt	1 pt	3SAE 2 in.	JIC-6	JIC-6, -8
290.32C-01	250	950	Yes	115 Vac	l gal.	1 qt	1 pt	³ SAE 2 in.	JIC-6	JIC-6, -8
290.32D-01	250	950	Yes	24 Vdc	l gal.	1 qt	1 pt	³ SAE 2 in.	JIC-6	JIC-6, -8
Maximum gross weights 290.1X - 138 lb (62 kg) 290.2X - 210 lb (95 kg)	gross w 138 lb (6. 210 lb (9.	Maximum gross weights by model series: 290.1X - 138 lb (62 kg) 290.2X - 210 lb (95 kg)	model se	ries:	2 Units Total 1.5A	with a l solenoid	pressure 1 valve 1 c or 0.3	Units with a pressure control manifold: Total solenoid valve power consumption (2 solenoids active): 1.5A @ 24 Vdc or 0.32A @ 115 Vac	; solenoid	s active):
- VC:067	1) gr 067	31 Kg)			³ 4 bol	4 bolt, 3000 psi (21 MPa)	si (21 M	(Pa)		

Specifications are subject to change without notice. Contact MTS for verification of specifications critical to your needs.

Section II Operation

Operation of the Series 290.XX HSM includes the control functions which can be selected (in some models) by remote units, and variation of the delivered pressure level when operating in low pressure mode. Additionally, all 290.XX units are equipped with a manually operated gage. The following subsections describe the control devices in detail.

2.1 Controls and Indicators

Figures 2-1, 2-2, and 2-3 illustrate the locations of the following control and indicator devices in the 290.1X, 290.2X, and 290.3X HSM assemblies respectively. The following descriptions discuss the detailed function of each control and indicator. Not all of these controls and indicators are available on all models.

- Pressure gage valve: used to port the pressure gage to the pressure output line. When the valve button is released, the valve disconnects the gage from the pressure output line and connects the gage to the drain line. This isolates the gage from the pressure output line, protecting it from cyclic pressure fluctuations during system operation.
- Pressure gage: permanently connected and available for monitoring the system hydraulic pressure. Operation of this gage is controlled by the pressure gage valve.
- Low-pressure solenoid valve: operated from the control panel or control unit. When energized alone, this valve permits low-pressure fluid to be developed by the main control valve and ported to the servovalve.
- High-pressure solenoid valve: operated from the control panel or control unit. When energized in conjunction with the low-pressure solenoid valve, this valve permits the main control valve to open completely and port high-pressure fluid to the servovalve.
- Main control valve: hydraulically operated by the control circuitry. When the low pressure solenoid valve is energized, low pressure in the control manifold internal control circuit is applied to a pilot port at one end of this valve. The valve modulates the fluid flow from the HPS such that reduced pressure is maintained. If the high pressure solenoid valve is then energized, full system pressure is applied to the control circuitry, opening the valve completely and allowing full flow at full system pressure.

- Low pressure adjustment: a variable orifice which regulates the output pressure of the HSM in the low pressure mode.
- Pilot filter ΔP indicator: a pop-up type indicator which is activated when the pilot filter becomes sufficiently dirty to cause a 35 psi (0.241 MPa) pressure drop across the filter. An approximate 50 psi (0.345 MPa) pressure drop across the filter causes the filter head to bypass the fluid past the filter.

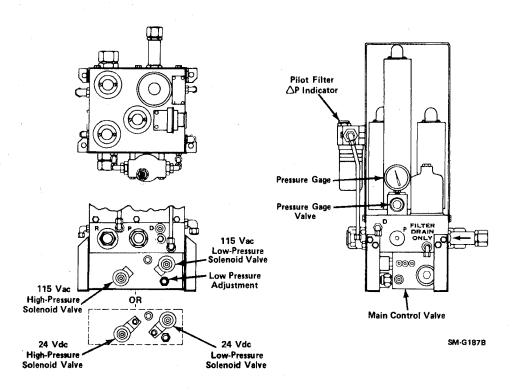


Figure 2-1. 290.1X Control and Indicator Locations

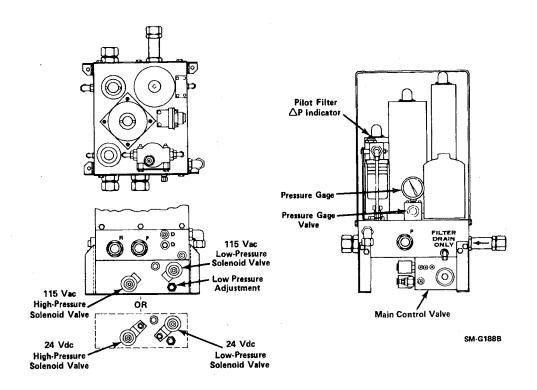


Figure 2-2. 290.2X Control and Indicator Locations

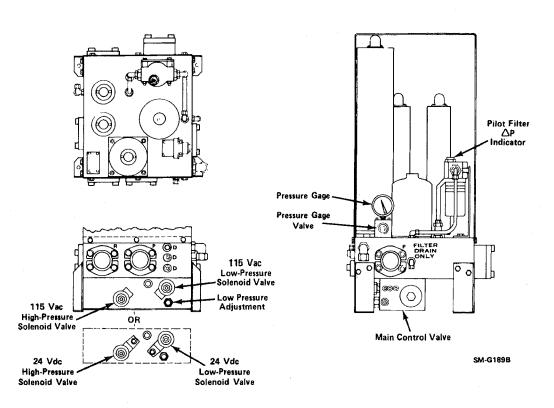


Figure 2-3. 290.3X Control and Indicator Locations

2.2 Basic Manifold Operation

HSM Models 290.11, 290.12, 290.21, and 290.31 operate as basic filtration, distribution and accumulator manifolds with no control functions. Once installed, these units function without operator adjustment and require only routine maintenance. Models 290.13, 290.14, 290.22, and 290.32 contain additional control valves and pressure regulation devices. These latter units provide control of fluid flow, pressure, and in the case of multiple HSM units connected to a common HPS, separate channel control.

The control valves are normally connected to an external control panel or control unit which provides switches, indicators, and interlocks. Low-pressure, high-pressure or pressure-off conditions can therefore be selected at the appropriate control device.

NOTE

On Series 290 HSMs which are equipped to provide pilot pressure, turning pressure on and off, or changing between low and high output pressure, does not affect the pilot pressure output. Pilot pressure is always present, as long as pressure is available from the HPS.

2.3 Hydraulic Control Valve and Setting Low Pressure

The pressure delivered in high-pressure mode is determined by the HPS output pressure. Refer to the operation section of the appropriate HPS manual for instructions on setting this level. In low-pressure mode, the pressure delivered is determined by the setting of the low pressure adjustment noted in Figures 2-1, 2-2, and 2-3. This setting can be changed by the following procedure. Equipment required includes a 9/16-inch open end wrench and a 3/16-inch hex key.

- 1. Turn on the system electrical power. Adjust the system controller to provide a zero dc error. Activate the HPS in high-pressure mode.
- Activate the HSM in low pressure mode. Push the HSM pressure gage valve button to check the present low pressure setting.
- 3. While holding the setting of the low pressure adjust with the 3/16-inch hex key. Turn the locking nut a half turn counterclockwise.
- 4. Press the pressure gage valve button. Using the hex key, set the pressure to the desired level, as registered on the gage. Clockwise rotation increases pressure.

- 5. Tighten the locking nut a half turn clockwise, holding the setting of the low pressure adjustment with the hex key. Check the pressure at the gage. If necessary, repeat steps 3 through 5 to improve the accuracy of the setting.
- Turn off the system.

2.3.1 Slow Turn-On/Turn-Off

The structure of the control manifold in the HSM is such that, when the system is turned on and low pressure is selected, low pressure is applied to the servovalve in a controlled manner rather than as a sudden step. When the operator selects a shift to high pressure, the control manifold accomplishes this change as a smooth transition, rather than as a step function. Pressure reductions are also accomplished as smooth transitions. Figure 2-4 illustrates the resulting pressure transitions.

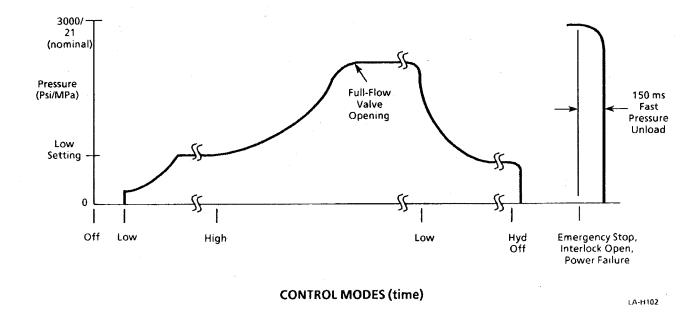


Figure 2-4. Pressure Transition Curves

2.3.2 Fast Pressure Unloading

As shown in Figure 2-4, the fast pressure unloading feature in the HSM control manifold permits high pressure to be decreased rapidly. This is accomplished by de-energizing both the on-off and high-low solenoid valves simultaneously, which turns off the input fluid flow and ports the output pressure line to the return line. Control of fast pressure unloading is usually assigned to the emergency stop circuits or similar control devices.

2.4 Pilot Function

Most Series 290 HSMs are equipped with a hydraulic circuit which will provide separately filtered fluid at HPS pressure to operate the pilot stage of multi-stage servovalves. This portion of the HSM operates automatically and requires only routine maintenance. See Section III of this manual for detailed service requirements and procedures.

NOTE

On Series 290 HSMs which are equipped to provide pilot pressure, turning pressure on and off, or changing between low and high output pressure, does not affect the pilot pressure output. Pilot pressure is always present, as long as pressure is available from the HPS.

2.5 Operation from a Control Panel or Control Unit

Those models of the Series 290 HSM which contain a control manifold are typically operated remotely from the system hydraulic pressure control switches. The manifold design requires the HSM to be switched to low pressure from the off condition. Thus, the sequence to obtain a high pressure HSM output is from off to low to high. Pressure is then reduced by returning to low pressure mode. Smooth pressure transitions between one mode and another are provided automatically by the HSM. Pushing the Emergency Stop or Hydraulics Off pressure control switches causes the HSM to turn off input hydraulic pressure and connect the pressure output to the return line. Using the Emergency Stop switch usually also causes the HPS to shut down.

Section III Service

The Series 290 HSMs require limited maintenance. Items requiring periodic service include the main filter, the pilot filter (in models equipped to provide pilot pressure), and the accumulators. Additionally, a solenoid valve may occasionally require replacement.

3.1 Hydromechanical System Precautions

This product contains certain devices which either require special handling, present possible hazards to the user, or can be damaged or cause damage to other system components if improperly used. The next two subsections discuss basic areas where caution must be observed, the proper methods to be employed in these areas, and the possible consequences of ignoring the cautions. Procedures in this manual contain additional specific warnings and cautions where appropriate.

3.1.1 General Hydromechanical Precautions

Hydraulic systems contain equipment which can be hazardous to personnel and damaging to equipment if improperly used or handled, due to the capacity for rapid and forceful movement. Therefore, the user should be thoroughly familiar with the following warning.

/ WARNING /

Depending on system configuration and current usage, performance of calibration, maintenance, or repair procedures with the hydraulic system operating can result in damage to equipment or injury to personnel due to unexpected actuator movement. Turn on the hydraulic system only when, and to the extent, instructed. Use the following guidelines any time hydraulic systems are active.

• Turn off the hydraulic system whenever direct contact with the actuator is required. Reactivate the hydraulic system only when all personnel are clear of contact with the actuator.

- Unless specifically instructed otherwise, remove from the test area all devices which can be damaged by full force, rate, distance, or rotational movement of the actuator to either extreme.
- Hydraulic system fluids can be irritating to skin, will irritate eyes, and are poisonous if taken internally.
- Hydraulic systems operate at high pressures (typically in excess of 100 psi). Spray from a leak can cause cutting or piercing (hypodermic) injuries. Test newly connected equipment only when personnel are cleared away from the area. Test first at low pressure, if available.
- Use only specified parts for replacement. Ordinary low-pressure pipe and fittings (such as brass, copper, or cast iron fittings or tubing found in hardware stores) are not suitable for typical hydraulic or pneumatic pressures and may rupture explosively when pressurized. Plumbing fittings, tubing, and hoses used in this system must be rated for the anticipated operating pressures.

If part suitability is in question, contact the local MTS service representative or the Service Division, MTS Systems Corporation.

 Do not permit untrained personnel to access, work on, or operate the system.

3.1.2 Accumulator Servicing Precautions

Personnel performing maintenance or repair procedures which involve working with accumulators should be thoroughly familiar with the following warning.

<u>M</u>WARNING

Damage to equipment or injury to personnel can result from charging accumulators with gases other than pure ("commercial" grade), ("dry") nitrogen gas. Observe the following guidelines when working with accumulators.

 Completely discharge both gas and fluid pressure from an accumulator before removing any parts except the gas valve protective cap(s). Charged accumulators and their parts can become lethal projectiles if disassembled while under pressure.

- Exercise caution during recharging, since a nitrogen supply bottle may be charged to pressures greater than 3000 psi (21 MPa). The accumulators supplied by MTS Systems are rated for 3000 psi (21 MPa) working pressure, and must not be charged above this level. Gages, fittings, transfer hoses, or other system components can also be damaged by extreme pressure. Use of a suitable regulator and gage set is required (although not supplied by MTS Systems Corporation) and is assumed in procedures in this manual.
- Use only dry nitrogen in procedures requiring charging of accumulators.
- The maximum pressure accumulator precharge ratio for operating this product is six system pressure units to one unit of precharge pressure (6:1) to reduce the possibility of accumulator damage. This ratio can be diminished (approaching 1:1) but not expanded.
- Transfer of gases from high- to lower-pressure containers causes refrigeration which can be sufficient to freeze skin.
 Wearing of heavy gloves and safety glasses is recommended when working with pressurized gases.
- Open the regulator output valve only enough to permit a low velocity and volume of gas flow. Rapid flow rates, with a pressure differential of more than 300 psi (2 MPa) across an input check valve, can cause damage to the valve seals.
- Venting of pressurized gas can generate sounds which can cause damage to, or loss of, hearing. Use proper precautions (ear plugs or other hearing protection devices) when venting or transferring gases.
- Use pressurized gases only in well-ventilated areas. The possibility of suffocation exists when these gases leak or are vented in confined areas.
- Piston type accumulators gradually collect hydraulic fluid in the gas chamber, even though the piston seals are intact and functioning properly. If checking an accumulator's precharge shows a consistent trend of pressure being higher than expected, if precharging requires smaller volumes of gas than expected to obtain a desired pressure level, or if fluid is expelled from a gas valve during gas venting, the accumulator must be removed and the fluid dumped out of the gas side (refer to Subsection 3.3, Accumulator Maintenance).

3.2 Filter Maintenance

Each HSM contains a main pressure filter which should be periodically removed and cleaned, or replaced if damaged. Models 290.12, 290.14, 290.21, 290.22, 290.31 and 290.32 also are equipped with a pilot pressure supply circuit which contains a filter. This pilot pressure filter should be replaced periodically or whenever the indicator signals that the filter is dirty. Information concerning the cleaning of the main filter can be found in Subsection 3.2.1. The procedure for changing the pilot filter is documented in Subsection 3.2.2.

3.2.1 Main Filter Maintenance

The main filter on the Series 290 HSM is a metal screen, meshtype filter which should be removed and cleaned or replaced at six month intervals. Equipment required includes 9/16-, 5/8- and 11/16- inch open-end wrenches, a 1/2-gallon (2-liter) drain pan or can, an ultrasonic cleaner, cleaning and rinsing fluids, and a 12-inch adjustable open-end wrench.

1. Turn off the system electrical power and allow the system hydraulic pressure, as registered on the HPS output pressure gage, to drop to zero.



Hydraulic power supply and system pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when removing hydraulic components and opening pressure seals. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

- 2. If necessary, on Series 290.1X HSM units equipped for pilot pressure, use a 7/16-inch open-end wrench to remove the two nuts, spacers, and bolts which secure the pilot pressure filter to the HSM cover. For all HSM units, use the 9/16-inch open-end wrench to remove the six hex bolts which secure the HSM cover. Remove the cover.
- 3. With the 5/8-inch open-end wrench, remove the vent plug from the main filter bowl (refer to Figure 3-1).

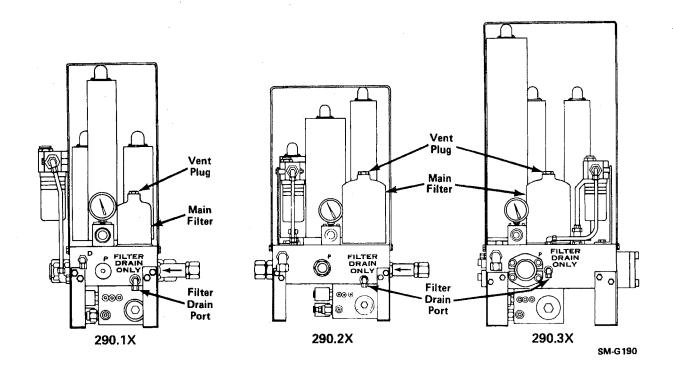


Figure 3-1. Drain Port and Vent Plug Locations

- 4. Place the drain pan under the drain port and remove the tube cap from the filter drain port fitting using the 11/16-inch open-end wrench. Allow the fluid from the filter to drain for about five minutes.
- 5. Use the adjustable open-end wrench to unscrew the filter bowl and remove it. Carefully remove all contaminated fluid from around the base of the filter element. Check the inside of the filter bowl for signs of visible contamination. Small, easily visible particles adhering to the inside of the filter bowl can indicate failure of other system components. In this case, check the system thoroughly for signs of wear or loss of seal integrity. Refer to the appropriate product manual(s) for the seal or part replacement procedure(s). If the source of the particles cannot be determined, contact the Service Division, MTS Systems Corporation, for further information. In the case where the filter bowl appears to be clear of visible particles, wipe it out with a lint-free cloth.

CAUTION

Removing the filter element in the next step without removing all contaminated fluid from around the base of the element can result in improper, erratic system operation due to contamination of the system servovalve.

6. Remove the filter element. Inspect the element for physical damage. If it is damaged, replace it and continue at step 15.

NOTE

Ultrasonic cleaning is one of the better methods for obtaining filter cleanliness. The cleaner and rinsing solutions may be obtained from MTS Systems Corporation as part numbers 111617-01 and 111617-02, respectively. If an ultrasonic unit is not available, these solutions can be used with a plastic bristle brush for manual cleaning. After use, wash the hands thoroughly and discard the brush.

- 7. Fill the ultrasonic unit tank with approximately 5 in. (130 mm) of water. Turn the unit on for a ten-minute warm-up.
- 8. Obtain a plastic container with sufficient volume to entirely submerge the element and small enough to stand in the ultrasonic unit. Fill it with cleaner.
- 9. Remove any rubber components, such as the ring seal, from the element. Place the element in the container and agitate it by hand for two minutes. Remove it and apply pressurized air to remove large particles.
- 10. Stand the container in the ultrasonic unit tank and submerge the element in the container for at least five minutes. In extreme cases, allow additional time.
- 11. Remove the element from the container. Apply compressed air to the element to remove fluid and dirt.
- 12. Empty the container. Rinse and refill it with cleaner fluid.
- 13. Repeat steps 10 and 11. Inspect the element. If contamination is still present, repeat steps 10, 11 and 12 until it is clean, or discard the element and replace it. If replaced, continue at step 15.
- 14. Empty the container. Rinse and fill it with rinsing solution. Repeat steps 10 and 11.

- 15. Replace the filter seal ring. Install the element on the manifold. Ensure that the filter bowl seal is seated in its channel. Screw the filter bowl into place until it is seated. Tighten it to 30 lb-ft (40.7 N-m).
- 16. Remove and empty the drain pan. Replace the tube cap on the drain port fitting. Replace the vent plug. Tighten it to 35 lb-ft (47.5 N-m).
- 17. Turn on the system electrical power. Activate the HPS in LOW pressure mode. Switch the HPS to HIGH pressure mode. Check the filter bowl, vent plug, and drain port for leaks. Remove hydraulic pressure and tighten components as necessary. Repeat the high pressure checks until leakage is stopped.
- 18. If removed, replace the HSM over. Tighten the mounting bolts. For 290.1X HSM units equipped with pilot pressure, reattach the pilot pressure filter to the HSM cover. Refer to the HPS product manual for instructions on checking and replenishing the hydraulic fluid.

3.2.2 Pilot Filter Maintenance

The pilot filter on the Series 290 HSM is a disposable, noncleanable paper cartridge type filter. The element should be replaced when indicated by the pop-up indicator. Equipment required includes a 9/16-inch open-end wrench.

1. Turn off the system electrical power. Allow system pressure as registered on the HPS output pressure gage to drop to zero.

NOTE

Step 2 can be omitted for 290.1X HSM models, since the filter is located outside the cover.

- If necessary, using the 9/16-inch open-end wrench, remove the six hex bolts which secure the HSM cover. Remove the cover.
- 3. Locate the pilot filter. Figure 3-2 illustrates the location of this filter on the various models.

<u>M</u>WARNING <u>M</u>

Hydraulic power supply and system pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when removing hydraulic components and opening pressure seals. Turning off hydraulic pressure at the HSM does not turn off pilot pressure. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

4. Remove the pilot filter element bowl by manually turning it clockwise as viewed from the element head end and as indicated in Figure 3-2. Dispose of any fluid in the filter bowl in a suitable container. Pull the filter element off the filter head. Wipe the filter base dry with a clean, lint-free cloth and visually check the main seal and back- up ring for damage. If necessary, replace them with new seals from the pilot filter service kit. Dispose of the old filter element.

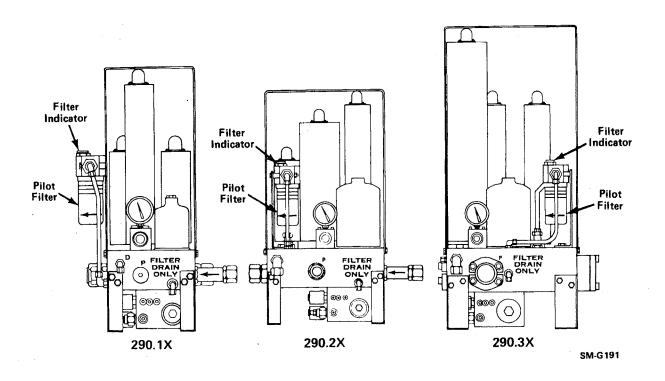


Figure 3-2. Pilot Filter and Indicator Locations

Check the inside of the filter bowl for signs of visible contamination. Small, easily visible particles adhering to the inside of the filter bowl can indicate failure of other system components. In this case, check the system thoroughly for signs of wear or loss of seal integrity. Refer to the appropriate product manual(s) for the seal or part replacement procedure(s). If the source of the particles can not be determined, contact the Service Division, MTS Systems Corporation, for further information. In the case where the filter bowl appears to be clear of visible particles, wipe it out with a lint-free cloth.

CAUTION

Attempts to clean and re-use the old element may cause damage to the element, loss of filtration, and corresponding damage to, or improper function of, the equipment. The pilot filter element is constructed of paper and is not cleanable.

5. With a small amount of clean hydraulic fluid, lubricate the main seal and back-up ring, and the internal seal of a new pilot pressure filter. Slide the new filter element onto the filter head center post and re-install the filter bowl. Tighten the bowl by turning it counterclockwise until it is hand tight.

NOTE

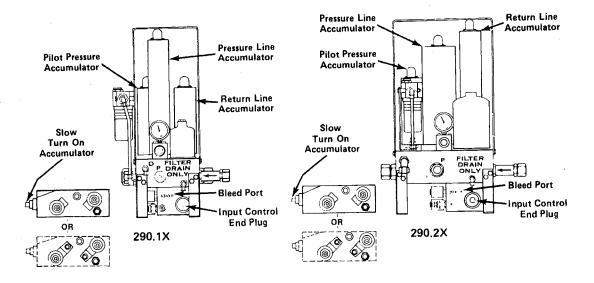
The seals in this filter seat when the unit is pressurized. If the seals leak, further tightening will not improve the seal. In this event, replace the leaking seals with new ones from the pilot filter seal kit.

- 6. Reset the pilot filter indicator by pressing it down.
- 7. Turn on the system electrical power. Activate the HPS in HIGH pressure mode. Activate the HSM in HIGH pressure mode (if control is available). Remove any specimen from the test area and operate the actuator for at least five minutes using a square wave drive signal at a frequency above 10 Hz to bleed air from the pilot circuit(s). Turn off the system electrical power.
- 8. If removed, replace the HSM cover, except on 290.1X units where it was not removed. Tighten the mounting bolts.

3.3 Accumulator Maintenance

Series 290 HSM units are equipped with piston type accumulators. Refer to Figure 3-3. The main pressure, return, and pilot pressure accumulators are similar in design and may require maintenance in the following areas:

- Seal Replacement: To replace seals in accumulators manufactured by MTS Systems Corporation, refer to the Model 111 Accumulator product manual. For accumulators not manufactured by MTS Systems Corporation, reference the accumulator label for the seal kit part number. If the seal kit part number is not on the label, note the manufacturer and the accumulator part number and contact MTS Systems Corporation for assistance.
- Checking Precharge and Precharging: The procedure for checking the precharge and precharging accumulators manufactured by MTS Systems Corporation can be found in the Model 111 Accumulator product manual. For accumulators not manufactured by MTS, refer to the vendor literature or MTS part number 408266-01 (Procedure For Checking Piston and Bladder Type Accumulator Precharge and Precharging).
- Purging Fluid from Gas Chamber: The procedure for purging fluid from accumulators manufactured by MTS Systems Corporation can be found in the Model 111 Accumulator product manual. For accumulators not manufactured by MTS Systems Corporation, refer to the vendor literature for the accumulator.



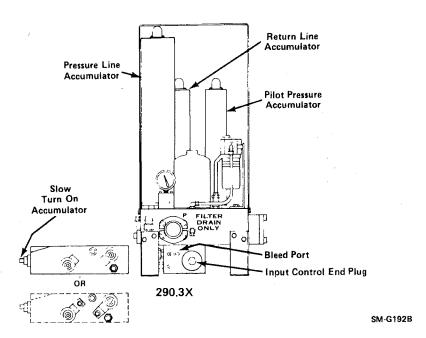


Figure 3-3. Accumulator Locations

To gain access to the accumulators, remove the six hex bolts which secure the HSM cover.

The slow turn-on/turn-off accumulator is designed differently than the other accumulators and requires separate maintenance procedures. Service instructions for the slow turn-on/turn-off accumulator are found in Subsection 3.3.1 of this manual.

3.3.1 Slow Turn-On Accumulator Maintenance

The following steps describe the procedure for disassembly, seal replacement and reassembly of the slow turn-on accumulator located in the control manifold assembly. Equipment required includes a seal kit, an adjustable open-end wrench, an open-end wrench set, a hex key set, and a charging kit.

- 1. Turn off the system electrical power. Allow the system hydraulic pressure, as registered on the HPS output pressure gage, to drop to zero.
- 2. Locate the slow turn-on accumulator. Figure 3-3 shows the location of this accumulator on the various 290.XX models. Accumulator structure is illustrated in Figure 3-4.

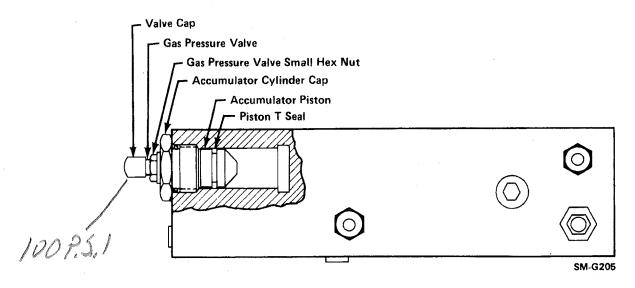


Figure 3-4. Slow Turn-on Accumulator Structure

<u>Marning</u> <u>Marning</u>

System pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when opening connections in the hydraulic assembly. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.2.

3. Remove the cap from the gas pressure valve on the accumulator. Using a 5/8-inch open-end wrench, rotate the small hex nut on the gas pressure valve 1/2 turn counterclockwise to release the gas precharge.

⚠WARNING ⚠

Gas pressure must be reduced to zero to minimize the possibility of damage to equipment or injury to personnel when disassembling the accumulator. If it is suspected that gas pressure has not been reduced to zero, contact the Service Division, MTS Systems Corporation.

- 4. Using the adjustable open-end wrench, remove the 1 7/8-inch accumulator cylinder cap from the control manifold. Using a 5/32-inch hex key remove the bleed port cap (refer to Figure 3-3).
- 5. Thread the 2-inch screw from the accumulator seal kit into the hole in the accumulator piston. Use the screw as a pull rod to extract the piston from the control manifold.
- 6. Replace the piston T seal and the bleed port cap seal.
- 7. Install the piston in the manifold block, ensuring that the seal is not pinched as it passes the accumulator cylinder chamber. Push the piston all the way into the cylinder. Remove the screw. Install and tighten the bleed port cap.
- 8. Remount the accumulator cylinder cap.
- 9. Precharge the accumulator. Nominal slow turn-on accumulator precharge pressure is 100 psi (0.69 MPa). Use the same precharging procedure as for MTS Model 111 Accumulators. Refer to Subsection 3.3, Accumulator Maintenance.
- 10. Turn on the system electrical power. Activate the HPS in HIGH pressure mode. Activate the HSM in HIGH pressure mode. Remove any specimen from the test area. Switch between HIGH and LOW pressure modes at least ten times, allowing one minute after each change. Then operate the actuator for at least five minutes using a square wave drive signal at a frequency greater than 10 Hz to bleed air from the accumulator and control circuits. Turn off the system electrical power.

3.4 Solenoid Valve Replacement

This procedure describes the process for removing and replacing a control manifold cartridge valve and/or the corresponding drive solenoid. Equipment required includes an adjustable open-end wrench, and a replacement solenoid and/or cartridge valve. Refer to Figure 3-5 during the following procedure.

- 1. Turn off the system electrical power. Allow the system hydraulic pressure as registered on the HPS output pressure gage to drop to zero.
- 2. Disconnect the control cable from the appropriate solenoid. Note the orientation of the coil and connector to the control manifold.
- 3. Remove the solenoid coil assembly by removing the retaining nut using the adjustable open-end wrench and pulling the coil assembly off the cartridge valve stem. On 24 Vdc Solenoids remove the Din to Amp connector. If only the coil assembly is to be replaced, skip to step 6.

<u>∕</u>! WARNING <u>∕</u>!

System pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when opening connections in the hydraulic assembly. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

4. Remove the cartridge valve by unscrewing it from the control manifold using the adjustable open-end wrench.

NOTE

MTS Systems Corporation recommends that cartridge valves be replaced if the valve core becomes dirty or the seals wear out.

5. Coat a new cartridge valve with clean hydraulic fluid. Insert the cartridge valve into the control manifold, ensuring that the seals slip past the chamber and are not pinched or deformed, and tighten it.

- 6. Slip the (new) coil assembly onto the valve stem. Seat it with the connector oriented as noted in step 2. Install and tighten the retaining nut sufficiently to prevent the coil assembly from being rotated by hand. On 24 Vdc solenoids install the Din to Amp connector on the solenoid coil.
- 7. Reconnect the control cable. If only the coil assembly has been exchanged, the unit is now ready for use. If the cartridge valve was replaced proceed to to step 8.
- 8. Turn on the system electrical power. Activate the HPS in HIGH pressure mode. Select LOW pressure mode at the HSM controls. Toggle the HSM between LOW and HIGH pressure modes at least ten times, allowing one minute to elapse after each selection. This purges most of the air from the control manifold.
- 9. Turn off the system electrical power.

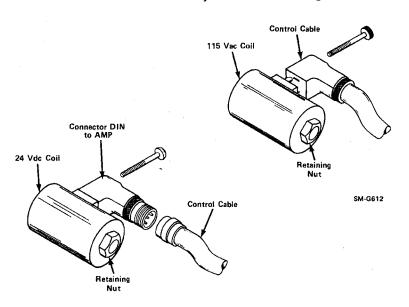


Figure 3-5. Solenoid Valve Replacement

3.5 Main Control Valve Maintenance

This subsection contains instructions for replacing the seals in the main control valve. Equipment required includes 5/8- and 3/4-inch hex keys for the 290.1X or 290.2X or 3/4- and 1- inch hex keys for the 290.3X, and a seal kit.

1. Turn off the system electrical power. Allow the system hydraulic pressure as registered on the HPS output pressure gage to drop to zero.

<u>M</u>WARNING <u>M</u>

System pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when opening connections in the hydraulic assembly. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

- 2. Using the 5/8-inch hex key for the 290.1X or 290.2X or the 3/4-inch hex key for the 290.3X, remove the output control end plug from the control manifold (see Figures 3-3 and 3-6).
- 3. Remove the input control end plug from the control manifold using the 3/4-inch hex key for the 290.1X or 290.2X or the 1-inch hex key for the 290.3X. Remove the spring washer and retainer ring.
- 4. Remove the coil spring from the output control end of the cylinder.

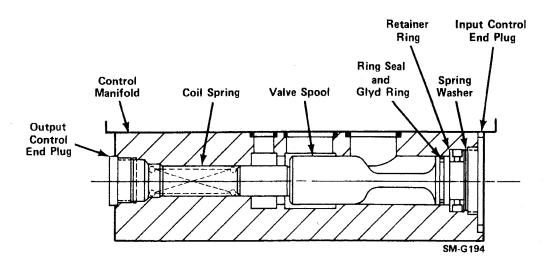


Figure 3-6. Main Control Valve Part Locations

CAUTION

In steps 5 through 7, failure to prevent scratching of the valve spool surfaces or manifold bore can cause leakage and improper valve operation.

- Thread the hex cap screw from the seal kit into the input control end of the valve spool. Using the screw as a pull rod, remove the valve spool from the control manifold. If the valve spool will not move, the push rod from the seal kit may be used to apply force to the output control end of the valve spool. When this is not sufficient force to move the valve spool, a plastic or rubber mallet may be used with the push rod to start the valve spool moving. Note the orientation of the valve spool to the control manifold.
- 6. Replace the ring seal and glyd ring on the valve spool. Install new ring seals on both cylinder plugs if necessary.

CAUTION

In the following step, failure to ensure that the glyd ring is not damaged can cause leakage and improper valve operation. Use silicone grease to lubricate the glyd ring.

- 7. Install the valve spool in the control manifold with the same orientation as noted in step 5. Remove the hex cap screw. Return the retainer ring and spring washer to their locations. Thread in the input control end plug and tighten it.
- 8. Insert the coil spring into the output control end of the control manifold. Install and tighten the output control end plug.
- 9. Turn on the system electrical power. Activate the HPS in HIGH pressure mode. Select LOW pressure mode at the HSM controls. Check the HSM fittings for leaks. Tighten the fittings as necessary with pressure turned off. Toggle the HSM between LOW and HIGH pressure modes at least twenty times, allowing at least one minute to elapse after each selection. This purges air from the control manifold.
- 10. Turn off the system electrical power.

Section IV Installation

The data in this section applies to new installations and HSM units which have been removed from a system for reconfiguration or repair. The following subsections are arranged in sequence for installation of a new HSM. Some procedures may not apply to specific models.

4.1 Site Preparation

Site selection for a HSM location requires consideration of the following items:

- The HSM must be installed in an area where it is protected from extremes of temperature and humidity. Limit specifications are 40° to 125°F (4° to 51°C) and 20 to 80% humidity. A normal shop or laboratory environment with a non-corrosive atmosphere is recommended.
- A minimum floor space of 4 ft by 4 ft (1.2m by 1.2m) is required for each HSM. This will provide space for hydraulic connections and service access. Additionally, a minimum 6 ft (1.8m) vertical clearance is required to permit removal of the HSM cover for service.
- The HSM should be located as close as possible to the servovalve(s) it supplies. A precise definition of the maximum distance allowable must take the specific system dynamic flow transient requirements and turn-on/turn-off transient requirements into account. For assistance in calculation of these factors, contact the Service Division, MTS Systems Corporation.
- Provisions should be made to mount the HSM to prevent movement due to hydraulic line transients. Recommended mounting methods include anchor bolts set in concrete, or bolting to a steel framework. It may be desirable to mount the HSM to an elevated framework which will allow a catch pan to be placed under the unit during service.

Once a site which meets the above criteria has been selected and prepared, mount the HSM in its proper location, and secure it in place. Then perform the applicable procedures from the following subsections.

4.2 Conversions for 115 or 24 Volt Operation

Certain 290.XX HSM models are equipped with a control manifold. The functions of this manifold are controlled by two solenoid activated cartridge valves. In some systems, these solenoids are driven by 115 Vac. Other system configurations utilize a 24 Vdc drive. Field exchange of a solenoid can be done by performing steps 1, 2, 3, and 6 of the procedure described in Subsection 3.4. Then connect the appropriate control cable. Connectors on cables and solenoids for 24 Vdc operation are different from those intended for 115 Vac use. Therefore, changing the solenoids also requires use of different cables and changes to the control unit or control panel. Figure 4-1 illustrates the respective connector configurations.

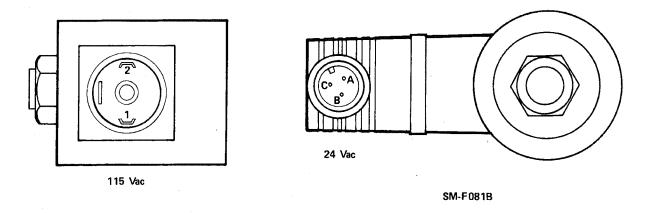


Figure 4-1. Control Solenoid Connectors

After making a change in control voltage, note the changes on the system level documentation. Also tag the HSM unit to notify service personnel that the part number on the unit no longer represents the correct operating voltage.

4.3 Electrical Cable Connections

Most 290.XX HSM units are equipped with a control manifold which permits selection of various hydraulic pressures. Control cable connections must be made between the HSM and the control unit or control panel. Certain units use 115 Vac for driving the HSM control functions. Others use 24 Vdc. Table 1-1 describes which models use which voltage. Figure 4-2 illustrates the connections which must be made.

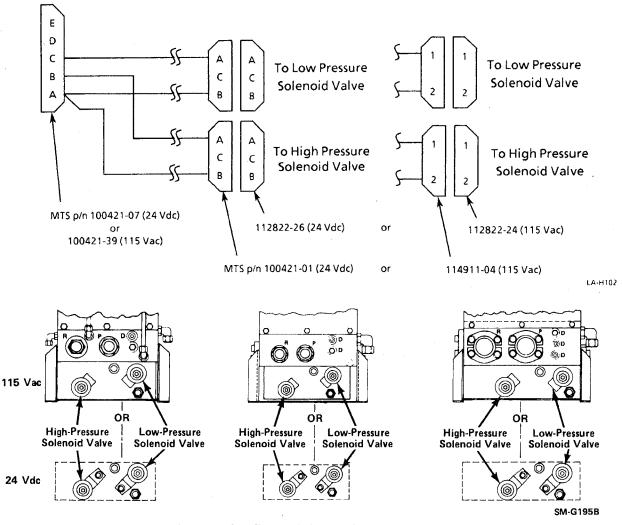


Figure 4-2. Control Cable Connections

4.4 Hydraulic Hose Connections

HSM units may be used in a wide variety of system configurations. Figures 4-3 through 4-5 illustrate some of the more common basic configurations. These may be augmented to meet specific system requirements. For proper operation of the pressure gage, these HSM units require a drain line connection to the HPS.

Remove each fluid port cap plug only when a hose is ready for immediate connection. Retain the removed caps and plugs for use during service.

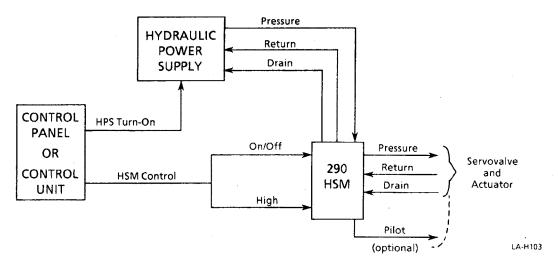


Figure 4-3. Basic HSM Installation (Pilot Circuit Optional)

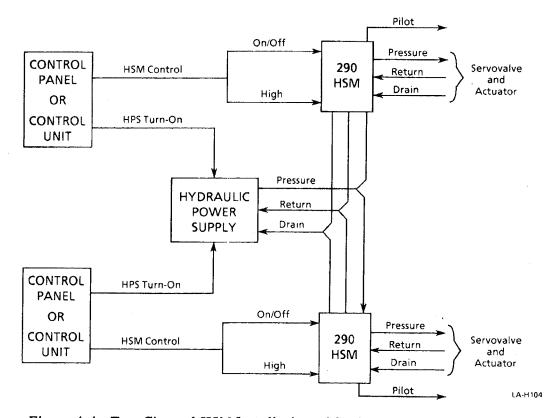


Figure 4-4. Two Channel HSM Installation with Pilot Circuits

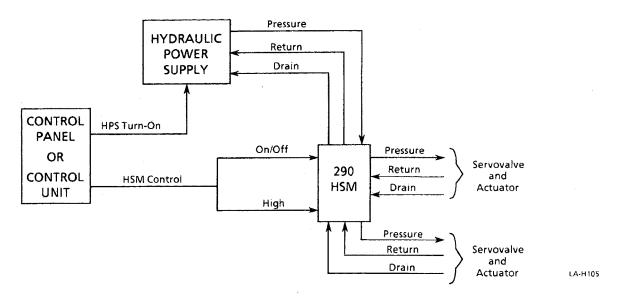


Figure 4-5. Single HSM Driving Two Actuators (No Pilot Circuits)

4.5 Pressure Control Manifold Installation

Certain models of the Series 290 HSM are not equipped for pressure control. These units can be retrofitted to incorporate control functions with the following procedure. Equipment required for this procedure includes the correct control manifold and cables, a 3/4-inch open-end wrench, a 3/8-inch hex key, a torque wrench and a 3/8-inch hex-tipped socket.

NOTE

Operation of the control manifold requires additions to existing system electrical cabling. Refer to Subsection 4.3 for electrical connection information.

1. Turn off the system electrical power. Allow system pressure, as registered on the HPS output pressure gage, to drop to zero.

<u>MARNING</u> <u>MARNING</u>

Hydraulic power supply and system pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when removing hydraulic components and opening pressure seals. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

2. Using the 3/8-inch hex key, remove the four bolts holding the bypass manifold onto the main service manifold assembly (see Figure 4-6). If necessary, remove the nuts from the HSM mounts and tip or elevate the HSM sufficiently to obtain access. Remove the bypass manifold and its seals.

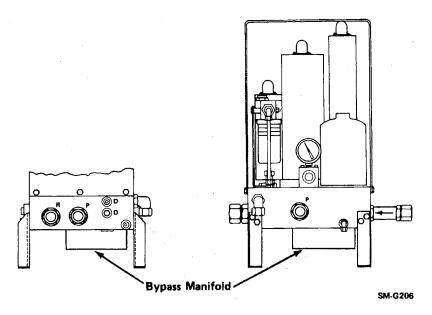


Figure 4-6. Typical Bypass Manifold Location

- 3. With the hex key and the 3/4-inch open-end wrench, remove the four mounting bolts and nuts from the new control manifold. Remove the port cover plate, ensuring that the port seals remain in place on the manifold. Install the port cover plate on the bypass manifold, using the old mounting bolts, and the nuts just removed.
- 4. Mount the control manifold. Lubricate the four mounting bolts and torque them to 80 ft-lb (108 N-m) using the torque wrench and the 3/8-inch hex-tipped socket.
- 5. Connect the electrical cables as illustrated in Figure 4-2.
- 6. Check the precharge level of the slow turn-on/turn-off accumulator. Refer to Subsection 3.3, Accumulator Maintenance.
- 7. Note changes to the system in the system level documentation. Tag the HSM unit to inform service personnel that the part number on the unit no longer represents the unit structure.

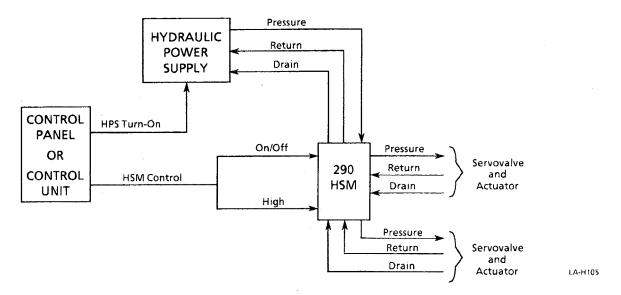


Figure 4-5. Single HSM Driving Two Actuators (No Pilot Circuits)

4.5 Pressure Control Manifold Installation

Certain models of the Series 290 HSM are not equipped for pressure control. These units can be retrofitted to incorporate control functions with the following procedure. Equipment required for this procedure includes the correct control manifold and cables, a 3/4-inch open-end wrench, a 3/8-inch hex key, a torque wrench and a 3/8-inch hex-tipped socket.

NOTE

Operation of the control manifold requires additions to existing system electrical cabling. Refer to Subsection 4.3 for electrical connection information.

1. Turn off the system electrical power. Allow system pressure, as registered on the HPS output pressure gage, to drop to zero.

<u>M</u>WARNING M

Hydraulic power supply and system pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when removing hydraulic components and opening pressure seals. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

2. Using the 3/8-inch hex key, remove the four bolts holding the bypass manifold onto the main service manifold assembly (see Figure 4-6). If necessary, remove the nuts from the HSM mounts and tip or elevate the HSM sufficiently to obtain access. Remove the bypass manifold and its seals.

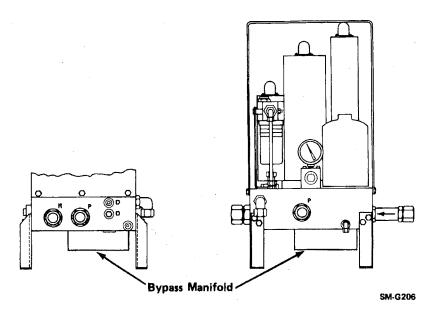


Figure 4-6. Typical Bypass Manifold Location

- 3. With the hex key and the 3/4-inch open-end wrench, remove the four mounting bolts and nuts from the new control manifold. Remove the port cover plate, ensuring that the port seals remain in place on the manifold. Install the port cover plate on the bypass manifold, using the old mounting bolts, and the nuts just removed.
- 4. Mount the control manifold. Lubricate the four mounting bolts and torque them to 80 ft-lb (108 N-m) using the torque wrench and the 3/8-inch hex-tipped socket.
- 5. Connect the electrical cables as illustrated in Figure 4-2.
- 6. Check the precharge level of the slow turn-on/turn-off accumulator. Refer to Subsection 3.3, Accumulator Maintenance.
- 7. Note changes to the system in the system level documentation. Tag the HSM unit to inform service personnel that the part number on the unit no longer represents the unit structure.

4.6 Pilot Pressure Kit Installation

HSM models 290.11 and 290.13 are not equipped with a pilot pressure circuit. This subsection discusses the procedure for adding the pilot pressure kit to these HSM units. Equipment required includes a pilot pressure parts kit, flaring and bending tools for 3/8-inch tubing, a hex key set, an open-end wrench set, an adjustable open-end wrench, and a tubing cutter.

1. Turn off the system electrical power. Allow the system pressure, as registered on the HPS output pressure gage, to drop to zero.

/ WARNING /

System pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when opening connections in the hydraulic assembly. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

2. Using a 1/4-inch hex key, remove the two pilot pressure filter port plugs illustrated in Figure 4-7.

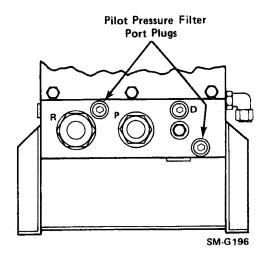


Figure 4-7. Pilot Pressure Filter Port Locations

- 3. Install the check valve in the left port. The arrow stamped on the check valve should point into the manifold. Thread a small elbow into each port, orienting the open ends as shown in Figure 4-8. Tighten the seal nuts using an 11/16-inch open-end wrench.
- 4. Remove the port plugs from the filter assembly. Install the reducing fittings in the filter, tightening them with the adjustable open-end wrench.
- 5. Install the large elbows in the reducing fittings. Do not tighten the seal nuts at this time.
- 6. Orient the filter assembly to the position shown in Figure 4-9. Push the two mounting bolts through the holes in the filter base. Slip the two small tubing nuts onto the threaded ends of the bolts as mounting spacers.

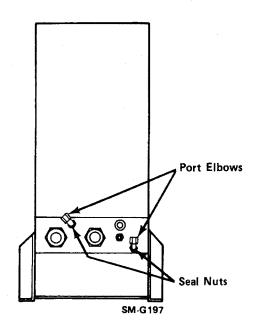


Figure 4-8. Port Elbow Orientation

4.6 Pilot Pressure Kit Installation

HSM models 290.11 and 290.13 are not equipped with a pilot pressure circuit. This subsection discusses the procedure for adding the pilot pressure kit to these HSM units. Equipment required includes a pilot pressure parts kit, flaring and bending tools for 3/8-inch tubing, a hex key set, an open-end wrench set, an adjustable open-end wrench, and a tubing cutter.

1. Turn off the system electrical power. Allow the system pressure, as registered on the HPS output pressure gage, to drop to zero.

<u>M</u>WARNING <u>M</u>

System pressure must be at zero to minimize the possibility of damage to equipment or injury to personnel when opening connections in the hydraulic assembly. If system pressure cannot be reduced to zero, contact the Service Division, MTS Systems Corporation, before performing the following steps. Read and observe the WARNING in Subsection 3.1.1.

2. Using a 1/4-inch hex key, remove the two pilot pressure filter port plugs illustrated in Figure 4-7.

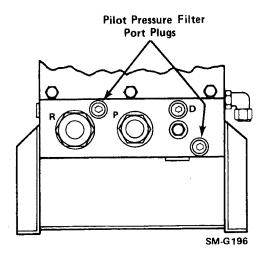


Figure 4-7. Pilot Pressure Filter Port Locations

- 3. Install the check valve in the left port. The arrow stamped on the check valve should point into the manifold. Thread a small elbow into each port, orienting the open ends as shown in Figure 4-8. Tighten the seal nuts using an 11/16-inch open-end wrench.
- 4. Remove the port plugs from the filter assembly. Install the reducing fittings in the filter, tightening them with the adjustable open-end wrench.
- 5. Install the large elbows in the reducing fittings. Do not tighten the seal nuts at this time.
- 6. Orient the filter assembly to the position shown in Figure 4-9. Push the two mounting bolts through the holes in the filter base. Slip the two small tubing nuts onto the threaded ends of the bolts as mounting spacers.

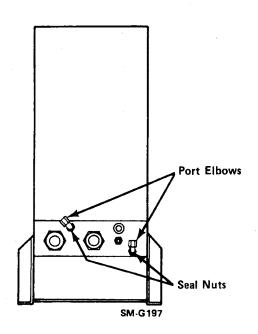


Figure 4-8. Port Elbow Orientation

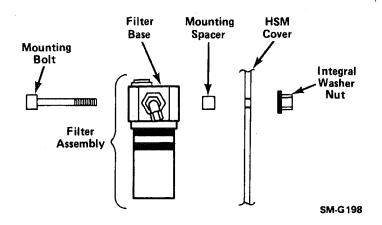


Figure 4-9. Filter Mounting Parts Assembly

- 7. Insert the threaded end of the mounting bolts into the two holes in the HSM cover. Thread the two integral washer nuts onto the bolt ends inside the cover, tightening them with a 7/16-inch open-end wrench.
- 8. As illustrated in Figure 4-10, measure the distance "D" between the tips of the right side fittings. Calculate the cut length for tubing to connect these fittings according to the following formula:

L = D + D(0.0235) + 0.25

where L = the cut length

D = the measured distance.

Measure and cut a piece of tubing from the parts kit to the calculated length L.

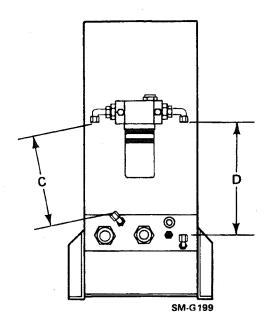


Figure 4-10. Tube Measurement

9. With the flaring tool, form a flare flange on one end of the tube. Slide two flare sleeves and tube nuts onto the other end of the tubing with these parts oriented as shown in Figure 4-11. Form a flare flange on the other end of the tube.

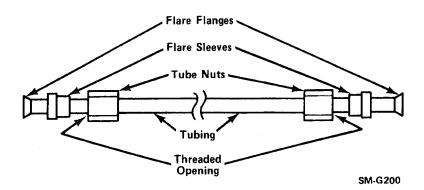


Figure 4-11. Tubing Parts Orientation

10. Install the tube between the right side fittings, bending as needed. Figure 4-12A and B shows the approximate bend location and tube routing. Tighten the tube nuts with an 11/16-inch open-end wrench. Then tighten the right side filter elbow seal nut with a 7/8-inch open-end wrench.

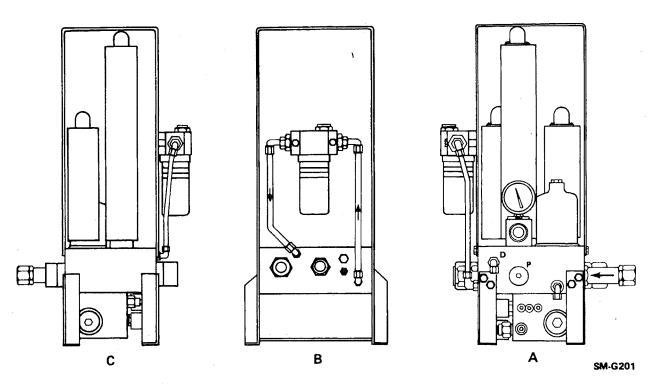


Figure 4-12. Tubing Installation

11. As illustrated in Figure 4-10, measure the distance "C" between the tips of the left side fittings. Calculate the cut length for tubing to connect these fittings according to the following formula:

L = C + C(0.0955) + 0.25

where L = the cut length

C = the measured distance.

Measure and cut a piece of tubing from the parts kit to the calculated length L.

- 12. Perform step 9 for the left side tube.
- 13. Install the tube between the left side fittings, bending as needed. Figure 4-12B and C shows the approximate bend location and tube routing. Tighten the tube nuts with an 11/16-inch open-end wrench. Then tighten the left side filter elbow seal nut with a 7/8-inch open-end wrench.

14. Remove the pilot pressure supply and return port plugs illustrated in Figure 4-13 using a 1/4-inch hex key. Install the remaining two small elbows in the supply and return ports. Orient the open ends of the elbows downward. Tighten the seal nuts using an 11/16-inch open-end wrench.

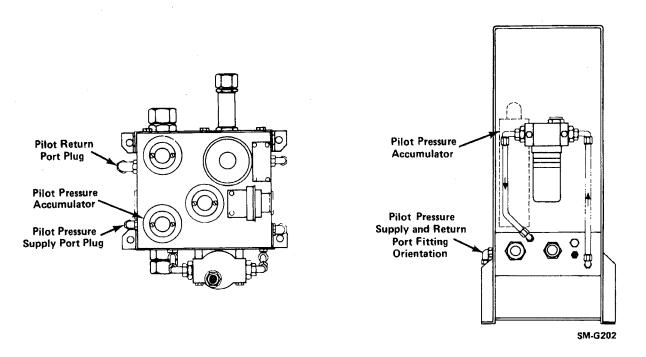


Figure 4-13. Pilot Pressure Supply and Return Port Locations

- 15. Connect the pilot supply and return port elbows to the appropriate servovalve pilot ports with hoses.
- 16. Use a 7/16 inch open end wrench to remove the two nuts, spacers, and bolts which secure the pilot pressure filter to the HSM cover. Remove the six bolts which secure the HSM cover using a 9/16 inch open end wrench. Remove the cover.
- 17. Locate the pilot pressure accumulator port (refer to Figure 4-13). Using a 5/8 inch hex key, remove the port plug. Install the hex nipple in the port using an adjustable open end wrench. Thread the accumulator port onto the hex nipple and tighten it using a strap wrench.
- 18. Replace the HSM cover. Replace the six cover bolts. Replace the two bolts, spacers, and nuts which secure the pilot pressure filter to the HSM.
- 19. Check the pilot pressure accumulator precharge. Refer to Subsection 3.3, Accumulator Maintenance.

4.7 System Checks

This subsection contains a procedure for checking the installation of the HSM. The procedure assumes that the unit has been installed on a site which meets the criteria specified in Subsection 4.1, and that applicable conversions, connections and functional additions have been accomplished as specified in Subsections 4.2 through 4.6.

- 1. Check the HSM for secure mounting. Ensure that the cover is in place and tightly bolted.
- 2. Check all hydraulic connections against the system diagrams. Ensure that the connections are tight.
- Check all electrical cable connections (where applicable)
 against the system diagrams. Ensure that the connections are
 correctly mated and locked.
- 4. Check the precharge of the accumulators (refer to Subsection 3.3, Accumulator Maintenance).
- 5. Turn on the HPS in low pressure mode. Refer to the applicable HPS product manual and the system operation manual for the correct procedure.
- 6. Turn on the system electrical power. Select Load control mode. Adjust the Set Point level to zero dc error. For HSM units with control functions, select the Low pressure mode at the control panel or control unit. Check for leaks at all hose connections, and on the HSM. With pressure turned off, tighten fittings as necessary.
- 7. Increase the HPS output pressure to the level to be used for normal operation. Check again for leaks.
- 8. For HSM units with control functions, select the High pressure mode. Check again for leaks. Check the reading on the HSM output pressure gage by pressing the gage valve button. Select the Low pressure mode and check the output pressure again. Then select the Off mode and check the output pressure once more. If any reading is not as expected, determine the cause and refer to the appropriate subsection in Section III, Service.
- 9. Remove any specimen in the test area. Select the High pressure mode at the HSM (if control is available). Operate the system for at least ten minutes using a high frequency (above 10 Hz) square wave drive signal to bleed air from the system. Turn off the system hydraulic and electrical power. Refer to the HPS product manual for instructions on checking the fluid level and replacing fluid.

Section V Theory of Operation

This section contains a detailed description of the functions of the Series 290 HSM. These functions include basic line pressure regulation, optional pressure regulation with on-off control and slow turn-on/turn-off, load abort, and a pilot pressure supply circuit.

5.1 Basic Function

The basic function of the HSM is to provide line pressure regulation. This is partially accomplished by using accumulators to absorb excess fluid during pressure peaks and return the fluid during low pressure periods. Consider, for example, a system configuration where the HPS is located some distance from the servovalve and actuator. As the servovalve opens, line pressure drops immediately at the connection to the servovalve. This pressure drop travels through the line toward the HPS, but flow restriction of the line itself, plus inertia of the fluid, delays and decreases the severity of the drop as it travels. The HPS and its accumulators therefore are required to compensate for a less severe decrease in pressure over a longer period of time. At certain operating frequencies, this may cause the actuator to be "starved" for adequate fluid flow or pressure.

Inserting the HSM in the hydraulic lines permits some fluid to be stored under pressure a short distance from the servovalve and actuator. This has the effect, above a certain frequency, of keeping fluid in the lines in motion and reducing the inertia and line restriction considerations. When the servovalve opens and line pressure begins to drop, the accumulator in the HSM supplies part of the fluid volume and maintains the line pressure. Then, when the servovalve closes, the accumulator recharges, causing fluid in the lines to remain in motion.

The pattern and frequency of the signal which drives the servovalve will have considerable effect on the HSM accumulator function efficiency. Square wave signals, for example, will cause a greater demand than sine wave signals or ramp signals. At low frequencies, fluid flow in the lines may stop completely, and fluid inertia may become an operational factor.

An accumulator in the return line damps the pulsing effect caused by "slugs" of fluid being injected into the line as the actuator moves. Movement of hoses and/or hammering of hard lines is thus reduced. The schematic in Figure 5-1 illustrates the components and fluid flow circuits contained in a basic 290 HSM. This unit operates essentially automatically. Fluid enters the unit at the HPS pressure port. It passes through an inlet check valve which provides backflow and explosion protection for the main filter element when supply pressure drops as the HPS is turned off. Fluid then passes through a 74 micron absolute filter. After filtration, the fluid passes through a bypass manifold which couples the pressure and pressure output lines together. A pressure gage and gage isolation switch are connected to the pressure output line. When the button on the isolation switch is pushed, the gage is connected to the pressure output line. When released, the switch connects the gage to the drain line. A pressure accumulator is also connected to the pressure output line.

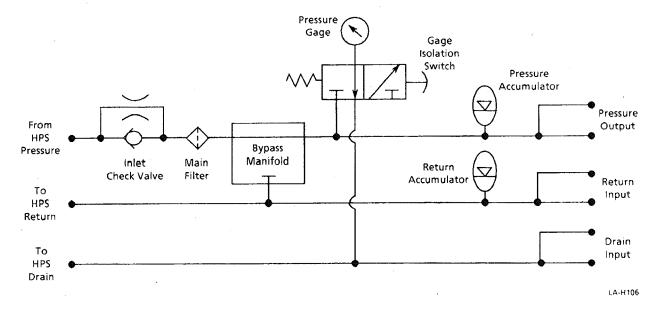


Figure 5-1. Basic HSM Schematic

Fluid returns from the actuator servovalve through the return input. It passes directly through the HSM and exits to the HPS via the return port. A return accumulator is connected to the return line. The bypass manifold blocks a port to the return line which is used in units containing a control manifold. The drain line is used to provide a path for collecting fluid which seeps past the high pressure seals in the actuator, for dumping the HSM pressure gage, and similar functions. This line is connected back to the HPS.

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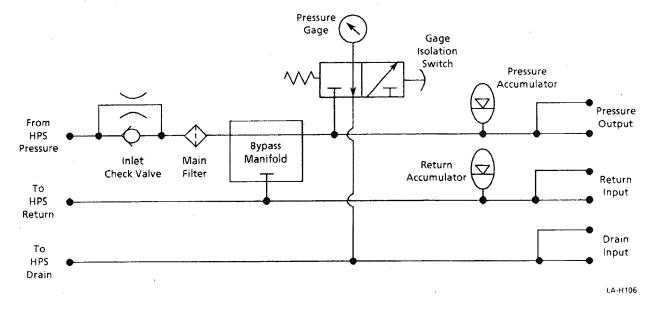


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5.2 Expanded Control Functions

Most Series 290 HSM units are equipped with control functions beyond those in the basic unit described in Subsection 5.1. These control functions include electro-hydraulic circuits to permit selection of pressure off, low pressure and high pressure operating modes, slow pressure turn-on and turn-off, fast pressure unloading and pilot pressure. The following subsections describe each function in detail.

5.2.1 High-Low-Off Pressure Control

Certain HSM units are equipped with a control manifold. This manifold permits the application and removal of hydraulic pressure to the servovalve, and controls whether the pressure is high or low at the HSM pressure output ports. Figure 5-2 illustrates these functions.

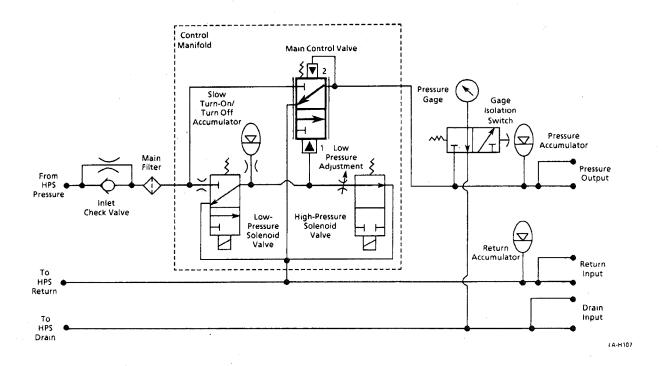


Figure 5-2. HSM with Control Manifold

All devices in the HSM outside the control manifold function the same as those in the basic unit described in Subsection 5.1. However, in units equipped with the control manifold, the flow of fluid through the HSM is blocked by the main control valve and the low-pressure solenoid valve. The HSM is therefore in the off mode. When the low-pressure solenoid is energized, a restricted flow of fluid at HPS pressure is ported to the slow turn-on/turn-off accumulator, which begins to charge. Pressure in this line rises until the input flow equals the output flow through the low pressure adjustment and the high-pressure solenoid valve. Rising pressure is applied to control port 1 on the main control valve which causes the main control valve to open. HPS pressure is thus ported through the main control valve to the pressure output. As pressure increases in the pressure output line, rising pressure at control port 2 causes the main control valve to close until the two control ports are balanced. The valve now adjusts itself automatically to maintain the low pressure level set by the low pressure adjustment, stabilizing the HSM in low pressure mode.

Energizing the high-pressure solenoid causes its associated valve to close. Pressure in the control circuit is now able to rise to the HPS pressure level. This is applied to control port 1, causing the main control valve to open completely and remain open. The HSM is now operating in high pressure mode. De-energizing the highpressure solenoid opens its associated valve, allowing pressure to bleed off until the control circuit input and output flow rates are again balanced. As control circuit pressure at control port 1 drops, HPS pressure at control port 2 causes the main control valve to close until the pressure at the two control ports is again balanced, and the HSM is again in low pressure mode. energizing the low-pressure solenoid causes its associated valve to switch, disconnecting HPS pressure from the control circuit. The control circuit is now connected to the return line, and pressure drops rapidly. As control circuit pressure drops at control port 1, HPS pressure at control port 2 and a control spring close the main control valve. The HSM returns to the pressure off mode.

5.2.2 Load Abort

HSM units equipped with a control manifold have the capacity to abort load by dumping the high or low hydraulic pressure. In either mode, if the low-pressure solenoid is turned off, supply pressure into the control circuit is interrupted. The control circuit is connected to the return line and pressure in the control circuit drops rapidly (see Figure 5-2). This reduces pressure at control port 1, allowing HPS pressure at control port 2 and a control spring to close the main control valve. HPS pressure is thus disconnected from the pressure output. At the same time, the pressure output is connected to the return line by the main control valve, and the pressure accumulator is drained.

5.2.3 Slow Turn-On/Turn-Off

The control manifold contains components which affect the rate at which the control circuit operates. These include the slow turn-on/turn-off accumulator, and its fixed fluid port orifice, the fixed control circuit inlet orifice, and the variable low pressure adjustment orifice. When the on-off solenoid is energized, HPS pressure fluid is allowed to flow through the control circuit inlet orifice. As fluid passes through the orifice into the control circuit, the initial pressure is decreased substantially. As the control circuit fills, the slow turn-on/turn-off accumulator begins to fill, extending the pressure rise time and slowing the rate at which the main control valve operates. Control circuit bleed-off through the low pressure control further augments the time required for the main control valve to balance. The result is a controlled gradual increase in pressure as indicated in Figure 5-3A.

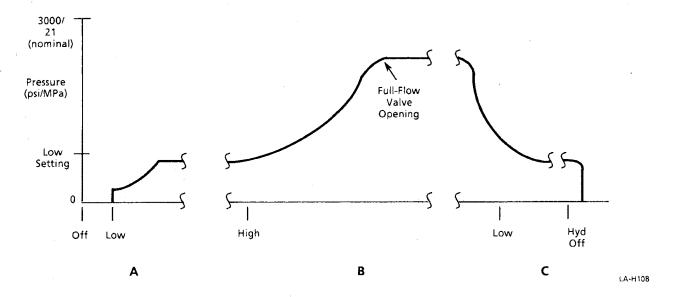


Figure 5-3. Pressure Versus Time for Specific Pressure Modes

A similar gradual increase occurs during the upward shift from low to high pressure. This is shown in Figure 5-3B. When a shift from high to low pressure is initiated by de-energizing the high-pressure solenoid, the slow turn-on/turn-off accumulator extends the time required to reach low pressure in the control circuit. Figure 5-3C illustrates the resulting pressure curve. De-energizing the low-pressure solenoid results in a rapid decrease in pressure, as is shown in Figure 5-3C.

5.2.4 Pilot Pressure

Most 290 HSM models contain a pilot pressure circuit to supply pressure to the pilot stage of high performance servovalves. These models may or may not be equipped with a control manifold. Figure 5-4 is a schematic of an HSM with both pilot pressure and control manifold circuits.

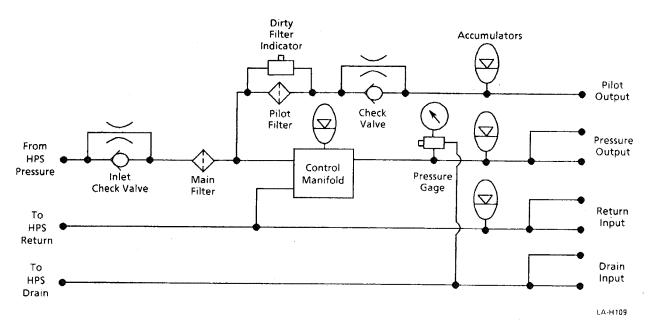


Figure 5-4. HSM with Pilot Circuit

Fluid is tapped from the HPS pressure line between the main filter and the control manifold inlet. It passes through the 3 micron absolute pilot filter, and through the check valve which protects the filter from backflow. A dirty filter indicator senses the pressure differential across the filter and provides indication when the differential pressure increases to a level which implies a dirty filter. The accumulator connected to the pilot output line serves the dual function of stabilizing line pressure fluctuations caused by servovalve pilot stage demands and stabilizing the pilot output against pressure fluctuations in the HPS pressure line.

Section VI Illustrated Parts Breakdown

The illustrated parts breakdown (IPB) is structured to provide a pictorial reference for the subassemblies and parts in the Series 290 Hydraulic Service Manifolds (HSM). Figure 6-2 illustrates the parts orientation for the 290.1X HSM. The numbers on the figure are reference designators used to identify specific 290.1X parts in the Table 6-1 parts list. HSM structure varies depending on the specific model. Table 6-1 lists the parts by the reference designator in ascending numerical order. Each entry gives the reference designator, MTS part number, and description. Where appropriate, the vendor part number is also listed. Figures 6-3 and 6-4, and Tables 6-2 and 6-3 are similarly configured for 290.2X and 290.3X manifolds, respectively.

Each parts list is broken into several assemblies. The first assembly lists the parts found in the main HSM assembly. Successive assemblies list parts which are added to the main HSM assembly. To determine which assemblies have been included in a specific system, refer to the System Reference Manual table of contents.

Figure 6-1 illustrates the subassemblies in a typical 290 HSM. The part numbers listed in this figure are the subassembly numbers in the following parts lists. Part numbers for a specific subassembly are listed under the appropriate subassembly number.

Various spare parts kits are available for the Series 290 HSM. Expendable items, seals, and filters are some of the parts included in the spare kits. For additional information on spare parts kits contact MTS Systems Customer Service Department.

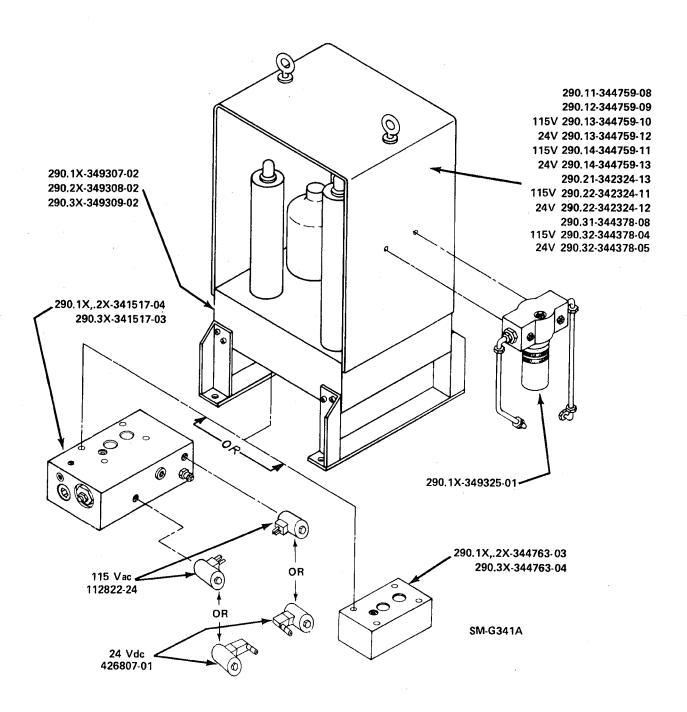


Figure 6-1. Typical 290 Hydraulic Service Manifold

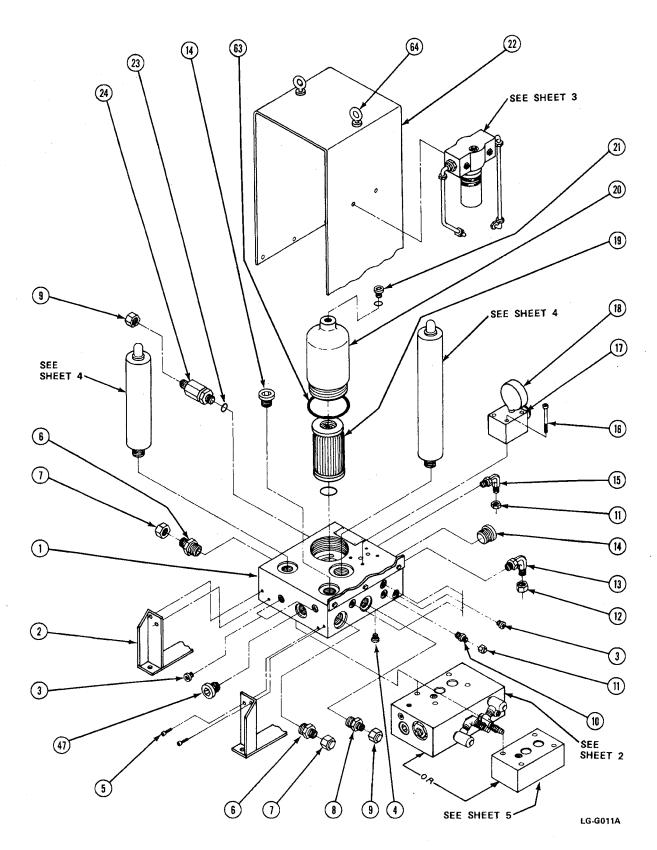


Figure 6-2. 290.1X Illustrated Parts Breakdown (sheet 1)

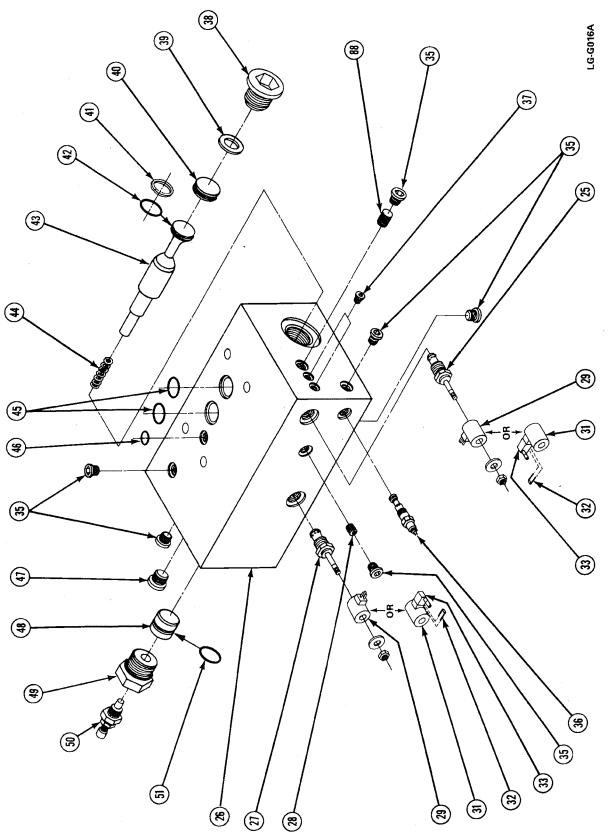


Figure 6-2. 290.1X Illustrated Parts Breakdown (sheet 2)

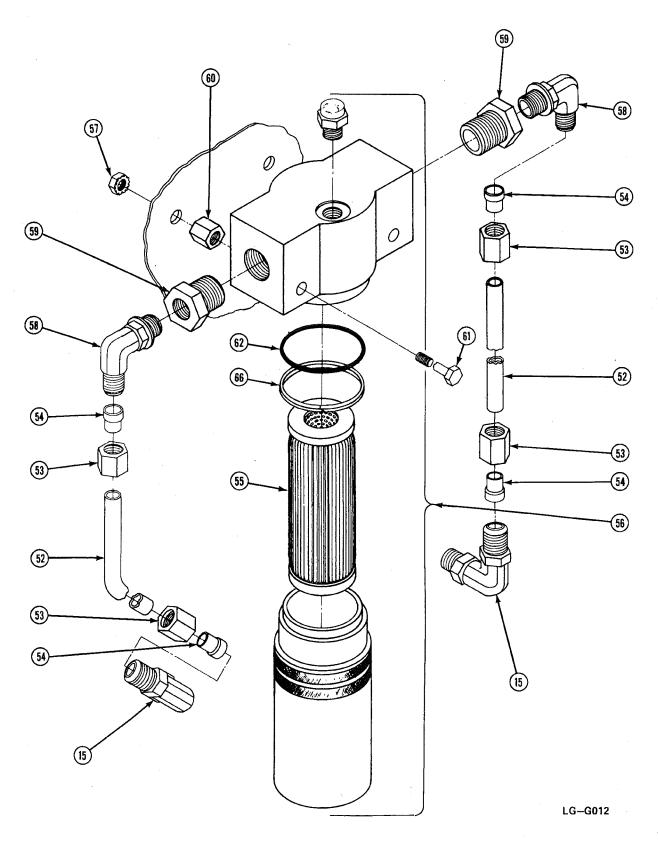


Figure 6-2. 290.1X Illustrated Parts Breakdown (sheet 3)

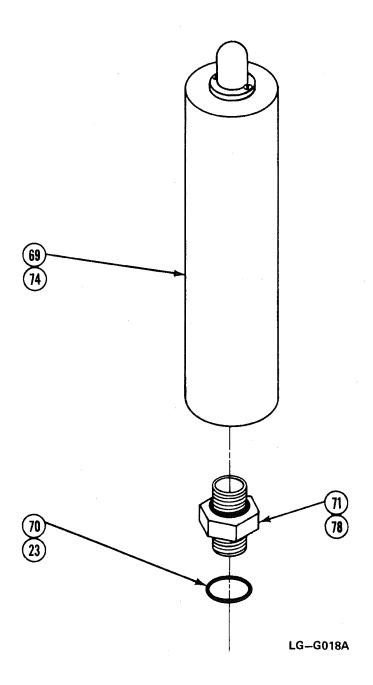


Figure 6-2. 290.1X Illustrated Parts Breakdown (sheet 4)

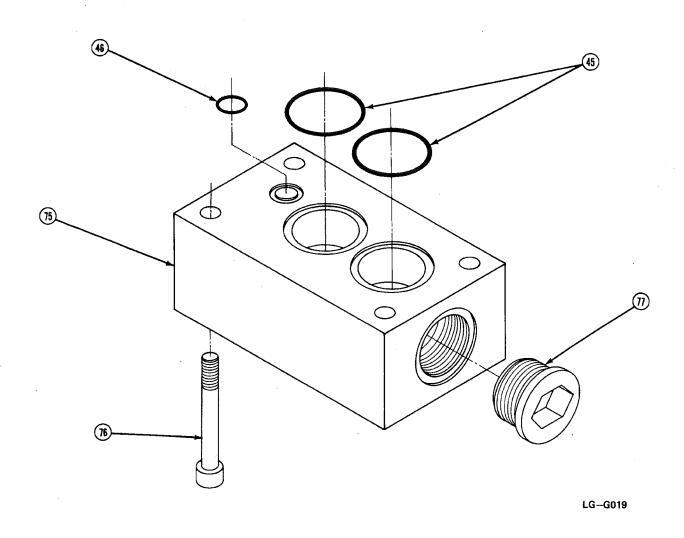


Figure 6-2. 290.1X Illustrated Parts Breakdown (sheet 5)

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PAGE NUMBER - 6-09

ITEM - 290.11 HYDRAULIC SERVICE MANIFOLU, NO PP PART NC. - 3447590.P A

PART NC 34475908	A 3 LP 1 L L			
REF. DESIGNATOR	MTS PART	אַני•	DESCRIPTION	VENDOR PART NO.
	34930702 34476303	MAIN MANIFOLD ASSY 290.1X BYPASS MANIFOLD KIT	MUDELS 290.2X AND 290.1X	
ITEM - 290.12 HYDPAULI Part NC 344759C9	C SERVICE	MANIFULD, K/FP		
REF. DESIGNATOR	MTS PART NC	NC.	DESCRIPTION	VENDOR PART NO.
	34932501 34930702 34476303	PILOT PRESSURE PARTS MAIN MANIFCLD ASSY 290.1X BYPASS MANIFOLD KIT	PGDELS 290.2X AND 290.1X	
ITEM - 290.13 HYDF AUL PART NL 34475912	IC SERVICE	MANIFULD, NO PP, 24 VDC		
REF. DESTGNATOR	MTS PART	NG.	DESCRIPTION	VENDOR PART NO.
	34930702 34151704 42680701	MAIN MANIFCLD ASSY 290.1X MANIFCLD ASSY - CUNTROL CUIL ASSEMBLY 24 VDC	MCDEL 290.1X, 290.2X	
ITEM - 290.14 HYDRAUL PART NU 34475913	JLIC SERVICE A	MANIFOLD, W/PP, 24 VCC		
REF. DESIGNATOR	MTS PAPT	NO.	DESCRIPTION	VENDOR PART NO.
	3493U702 34151704 42680701 34932501	MAIN MANIFCLD ASSY 290.1X MANIFCLD ASSY - CONTRCL CCIL ASSEMBLY 24 VDC PILCT PRESSURE PARTS	MCCEL 290.1X, 290.2X	
ITEM - 290.13 HYDFALL PAHT NC 34475910	LLIC SERVICE	MANIFULD, NG PP, 115 VAC		
REF. DESIGNATOR	MTS PART	NG.	DESCRIPTION	VENDOR PART NO.
	34930702 34151704 11282224	MAIN MANIFOLD ASSY 296.1X MANIFCLD ASSY - CCNTRCL COIL-ELECTRIC 115VAC	MCDEL 290.1X, 290.2X DIN CONNECTION #43650	6366115
ITEM - 290.14 HYDPAUL PAKT NO 34475911	ULIC SEPVICE A	MANIFOLD, W/PP, 115 VAC		
REF. DESIGNATOR	MTS PAPT	NG.	DESCRIPTION	VENDOR FART NO.

NOTE... ASTERISKED ITEMS MAY BE FOUND IN SPARES PARTS KIT MIS PART NUMBER ---

MAIN MANIFCLD ASSY 290.1X

34930702

TAELE 6-1 290.IX HYDRAULIC SERVICE MANIFULD CCMPUNENT PARTS LIST 11225663 B

ITEM - 290.14 HYDRAULIC SERVICE MANIFULD, M/PP, 115 VAC PARI NC. - 34475911 A

REF. DES IGNATOR	MTS PART	» GN	DESCRIPTION	VENDOR PART NO.
	34151704 11282224 34932501	MANIFCLD ASSY - CONTROL CUIL-ELECTRIC 115VAC PILCT PRESSURE PARTS	PCDEL 290.1X, 290.2X DIN CCNNECTION #43650	6366115
ITEM - 250.1X HSM MAIN PART NC 34930702	MANIFOLD B	ASSEMBLY		
REF. DESIGNATOR	MTS PART	NC.	CESCRIPTION	VENDOR PART NG.
1	34476002	MANIFOLD - 290.1X S/M		
?	34476602		MODEL 290.1X	
w ·	10026902		-06 BUSS, 9/16 SAE	6 HPSCN-S
4 1	10026903	PLUG-BOSS, INTL WR	SAE	
n ·	10015802	SCREW-CAP, HEX HU	-16UNC X	GR-5, ZINC PL
,	10024111	ADAPTER-BCSS/TUBE		20F50X-S
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oo	10024108	ADAPIEK BUSS/108E	-16 ABUSS A -16 TUBE	5400-16 148444-8
	10024303	ADA 0 1 E.O. C. ATHUR.	2001	014 NIOT
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77	10024303	100 L TOOL TOOL TOOL TOOL TOOL TOOL TOOL		りしていている。
13	10025703	ELBCW-90.BCSS/TUBE		8 C50X-S
14	10026906	PLUG-BUSS, INTL WR	8055,1 5/16	16 HPSCN-S
1.5	10025702	ELBCW-90,8CSS/TUBE	-06 MEDSS X -06 MTUBE	6 C50X-5
16	10013812	SCREM-CAP, SKT HD, SER 1960	1/4"-20UNC X 2 1/2" LG	GR-8+BLK CXD
17	11388501	VALVE-PRESS GAGE ISOLATUR	1/4 NPT, SUB PL MTD	AF6EP2.0/X
30 H	11076001	GAUGE-PRESSURE, 0-5000 PSI	BCTTCM MTG, 2,50 DIAL	
19	11130208	FILIER-ELEMENT, 8*		25-P-74WH
	100 10 524	PACK ING-PREFURMED, O-RING	.070X 90D BUNA-N 1.301 ID	ARP568-027
20		FILTER-HSG,6000 PSI		25-P(922638)
	10026810	PLUG-BCSS, HEX HD		5 P50N-S
Ç	10011511	PACKING-PREFORMED.O-PING	.072X 50D BUNA-N .414 ID	ARP568-905
27	34476402	CGVER-HYD SERVICE		
72	10611001	PACKING-PREFORMED OF THE	*II6X 90D BUNA-N I.I/I ID	ARP568-916
17	10036001	SALVELONEON + MUDINER SALES SA	.005 +/003 URIFICE	CV 1000+22
7.4	1001001	PLOG-ECOSO INCL. WR.	TZU DUSSEI SZO SAT	100540-0356
5 4	1007001	PACKING FRONTONE COFOLKING	STORY VOD BONATN STAGS TO	ARFJ001.422
· · ·	10022001	AUTOLIC CONTOUR	5/0"-141MC	
)	10022001	MAN LEGATINISHED	3/6:- TGOWC 976 OO X 126	
69	36414004	ACTUAL ATOR ASSESSED	2.500 BORE SIA.58 CLLIN.	10010
731	14411508	DACK TOPE TOPE TOPE OF THE COMMENT OF THE COMENT OF THE COMMENT OF	TIRK CON PENNAN 1 AVE TO	ADD548-920
11	10024111	ADAFTER-BOSS/TUBE	-20 MBOSS X -20 TUBE	20F50X+S
14	36414003	ACCUMULATOR ASSY-PISTON	2.500 BCRE DIA, 29 CU.IN.	
78	10024108	AUAPTER-BOSS/TUBE	-16 MBGSS X -16 TUBE	6400-16
05	10022907	WASHER-LCCK, SPL 1T	3/8" SIZE	SPR STL, ZINC PL

NUTE ... A STERISKED ITEMS MAY BE FOUND IN SPARES PARTS KIT MIS PART NUMBER

TAELE 6-1 296.1X HYDRAULIC SERVICE MANIFOLD COMPUNENT PARTS LIST 11225603 8

ASSENBLY
.2X BYFASS MANIFULD
BYFASS 3 A
1X, .2X 34476303
- 290.1X
ITEM PAPT

REF. DESIGNATOR	MTS PART NC.	NC•	DESCRIPTION	VENDOR PART NG.
45 46 15 16	100 10 525 100 10 513 344 76202 10014607 10026906	PACKING-PREFORMED, O-RING PACKING-PREFORMED, O-RING MANIFCLD - BYPASS SCREW-CAP, SKT HO, SER 1960 PLUG-BOSS, INTL WR	.070X 90D BUNA-N 1.364 ID .070X 90D BUNA-N .614 ID MODELS 290.1X AND 290.2X 1/2"-13UNC X 2" LG -16 BCSS,1 5/16 SAE	ARP568-028 ARP568-016 GR-8, BLK CXD 16 HP5CN-S
ITEM - 29G.1X HSM PTLI PAPT NC 34932501	CI PRESSURE E	PARIS		
REF. DESIGNATOR	MTS PART	NC.	DESCRIPTION	VENDOR PART NO.
15 23 52 53 54 55 56 60 60 60 62 66 74 17 EM — 290.1X, .2X HS PART NC. — 34151704 REF. DESIGNATOR 25 25 26 27 28 335 36	10025702 10011507 10027102 10027702 10088309 10088310 10025710 10025710 10027304 10015512 1001057304 10015512 10010735 10011913 36414003 100264108 FMTS PART 11282227 34220002 11282228 09405221 10026901	ELBUW-90,BGSS/TUBE PACKING-PREFORMED,O-RING TUBING-304 SST, HYD FLUID NUT-TLBE CPLG SLEEVE-TUBE FILTER-ELEMENT, 4" FILTER-ELEMENT, 4" FILTER-ASSY,BP,3000 PSI NUT-HEX,ASSEMBLED WASHER ELBCW-90,BCSS/TUBE REDUCER-BOSS,M/F NUT-TUBE CPLG SCREW-CAP,HEX HD PACKING-PREFORMED,O-RING RETAINER-PACKING,BACK-UP ACCUMULATOR ASSY-PISTON ADAPTER-BOSS/TUBE MANIFULD ASSEMBLY NC. NC. VALVE-CARTRIDGE WANIFCLD - CUNTROL VALVE-CARTRIDGE PLUG-CRIFICE PLUG-CRIFICE PLUG-CRIFICE PLUG-CRIFICE PLUG-CRIFICE PLUG-CRIFICE	-06 PBGSS X -06 MTUBE -116X 90D BUNA-N 1.171 ID -38 GD X .035 WALL -06 TUBE -06 TUBE -06 TUBE -106 PWGSS X -06 MTUBE -12 PBGSS X -06 MTUBE -12 PBGSS X -08 FBGSS -04 TUBE -12 PBGSS X -08 FBGSS -04 TUBE -14 PBGSS X -16 TUBE -16 PBGSS X -16 TUBE -04 BGSS X -16 TUBE -04 BGSS X -16 TUBE -04 BGSS X -16 TUBE	6 C50X-S ARP568-916 ASTM-A269 6BTX-S 6 TX-S HH9020A12UPRBP STL, ZINC PL 6-8 C50X-S 12-8 F50G5-S 4BTX-S GR-5, ZINC PL ARP568-136 ASS8774-136 6400-16 VENDUP PART NO. SVIO-31-0-N-00 SVIO-21-0-N-00
37 38 39	10026910 10026907 11042606	PLUG-BOSS,INTL WR PLUG-BOSS,INTL WR SPRING-WASHER,WAVE,STEEL	-02 BCSS,5/16 SAE -20 BGSS,1 5/8 SAE 1.05 ID/1.35 GD/.015 THK	2 HP5CN-S 20 HP5GN-S W1351-015
4 4 4 4 5 4 4 5 5 6 6 6 6 6 6 6 6 6 6 6	34221501 10012502 10010805 34220801 10077461	PING-RETAINER GLYD RING-C.D. SEAL GRYLING-PREFORMED.C-RING SPULL-PRESSURE REDUCEING SPRING-HELICAL.CPRSN PACKING-PREFORMED.C-RING	1.250 GD .103X 7GD BUNA-N .987 ID 250.22 .970 GD X .105 X 3.0 FL .070X 50D BUNA-N 1.364 ID	S-12547-121 ARP568-120 LC-105L-7-WW ARP568-028
OHE CONSTRUCTOR SECTION	70 244 045	S DIM TRY STORE STORES AT STICE	DADT MINDED THE PROPERTY.	

NOTE... ASTEPISKED ITEMS MAY BE FOUND IN SPARES PARTS KIT MIS PART NUMBER --

TABLE 6-1 290.1X HYDRAULIC SERVICE MANIFULD CGMPCNENT PARTS LIST

c u	ASSEMBLY
11225603	- MANIFULE ASSEMBLY
	ITEM - 290.1X, .2X HSM CCNTPOL PART NC 34151704 B

	ı			
REF. DESIGNATOR	MTS PART NC.	• •	DESCRIPTION	VENDOR PART NO.
46 77 48 48	10010513 10026906 33989001	PACKING-PREFORMED, O-RING PLUG-BOSS, INTL WR PISTON-ACCLMULATOR	.070x 50D BUNA-N .614 ID -16 BCSS,1 5/16 SAE	ARP568-016 16 HP5CN-S
50 51 88	55989501 11012402 11177506 09405220	FLUG-20 MODIFIED VALVE-GAS SEAL-1,PISTON PLUG-GRIFICE,.094 DIA	ACCUMULATOR-CHARGE 1 IC X 1.250 CD X .125W	MS28889-2 TP015
ITEM - 290.XX CCNTRCL COIL ASSY 24 VUC PAPT NC 4268C701 A	L COIL ASSY	24 VUC		
REF. DESIGNATOR	MTS PART NO.		DESCRIPTION	VENDOR PART NG.
31 32 33	11282223 10008604 11282226	CUIL-ELECTRIC 24 VDC SEMICOND DEVICE-CIO+PECT CONNECTOR-CIN TO AMPHENDL	DIN CCNNECTION #43650 PIV.200V-IO75A USED EN 24VDC COILS W/DIN	6356024 1N4003 JF860619A
ITEM - 290.XX CONTRCL (PART NG 11282224 A	ou.	115 VAC		
REF. DESIGNATOR	MTS PART NC.	٠	DESCRIPTION	VENDOR PART NO.
52	11282224	CCIL-ELECTRIC 115VAC	DIN CONNECTION #43650	6366115
NCTEASTERISKED ITEMS		MAY BE FOUND IN SPARES PARTS KIT MTS PART NUMBER	RT NUMBER	

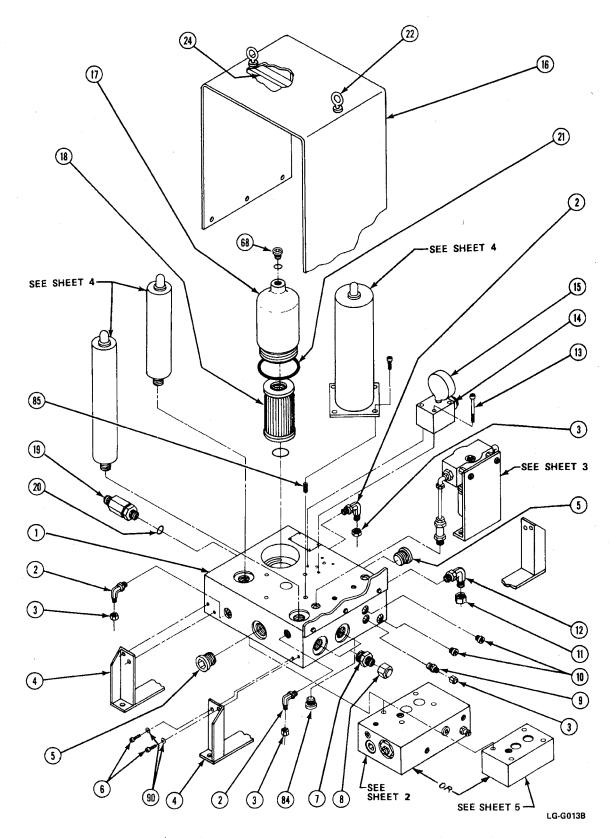


Figure 6-3. 290.2X Illustrated Parts Breakdown (sheet 1)

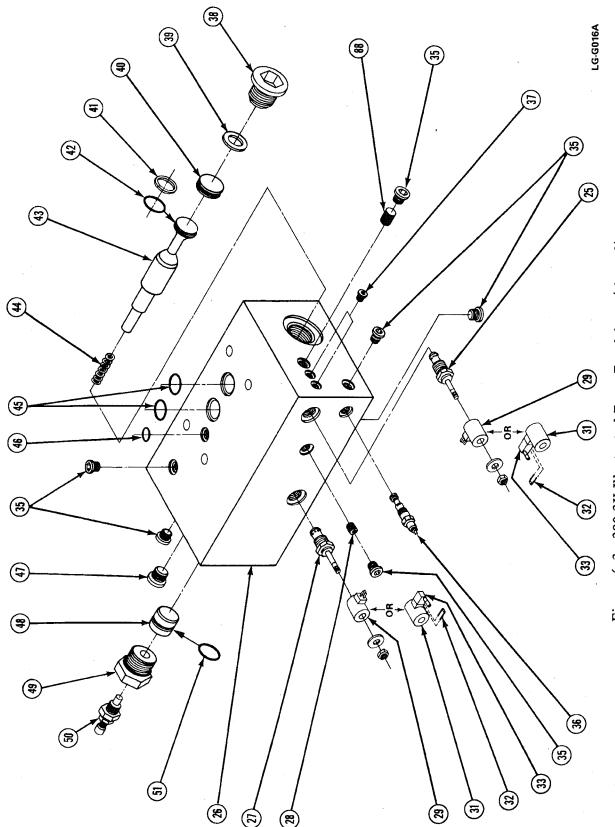


Figure 6-3. 290.2X Illustrated Parts Breakdown (sheet 2)

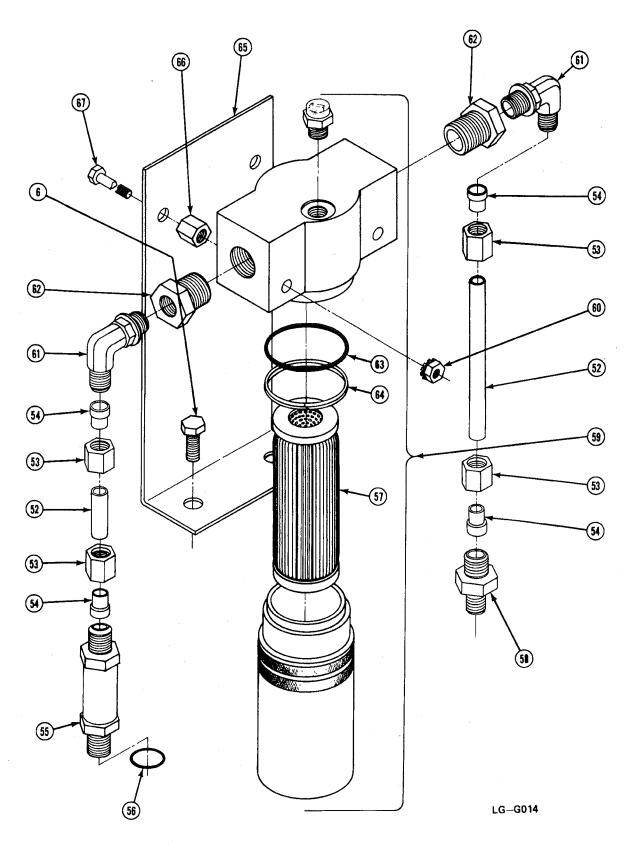


Figure 6-3. 290.2X Illustrated Parts Breakdown (sheet 3)

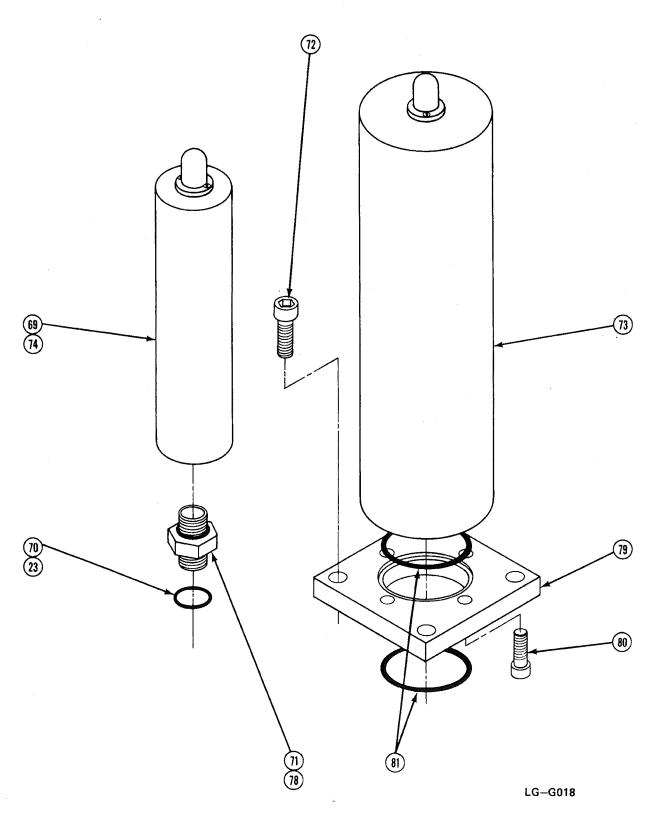


Figure 6-3. 290.2X Illustrated Parts Breakdown (sheet 4)

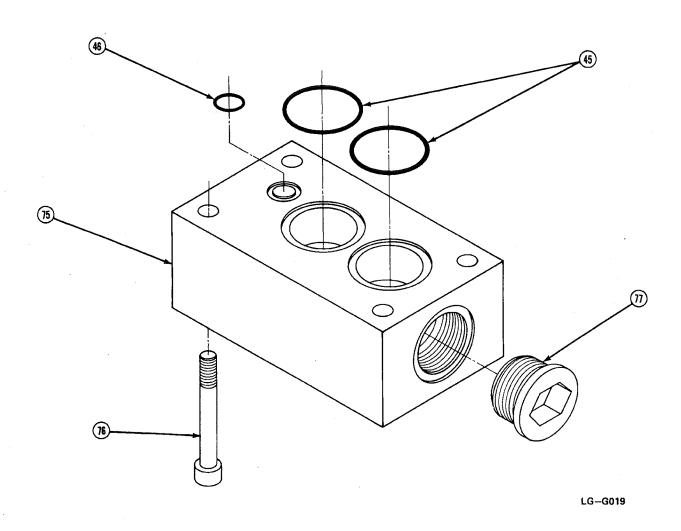


Figure 6-3. 290.2X Illustrated Parts Breakdown (sheet 5)

VULIC SERVICE MANIFOLD APTS LIST				
اب.	اب.	MANIFOLD		
	8 9 8		_	

PAGE NUMBER - 6-19

	VENDOR PART NO.			VENDCR PART NO.	£.		VENDOR PART NO.	6366115		VENDOR PART NO.	6 C50X-S 6FNTX-S 20 HP5GN-S GR-5, ZINC PL SPR 5TL, ZINC PL 20FSOX-S 6F5OX-S 6F5OX-S 6 HP5GN-S 8 G 50X-S 8 C 50X-S 6R-S B C 50X-S 8 C 50X-S
	DESCRIPTION	MCDELS 290.2X AND 290.1X		DESCRIPTION	MGDEL 290.1X, 290.2X		DESCRIPTION	MCDEL 290.1X, 290.2X DIN CENNECTION #43650		DESCRIPTION	-06 MBCSS X -06 MTUBE -06 TUBE -06 TUBE -20 BDSS,1 5/8 SAE 3/8"-16UNC X 5/8" LG 3/8"-16UNC X 5/8" LG 2/8" SIZE -20 MBCSS X -20 TUBE -20 TUBE -06 PBGSS X -06 TUBE -06 BGSS,9/16 SAE -08 RBGSS X -08 MTUBE 1/4"-20UNC X 2 1/2" LG 1/4"-20UNC X 2 1/2" LG 1/4 NPT,SUB PL MTD BCTTGM MTG,2.50 DIAL MANIFOLC MODEL 290.2X
MANIFGLD	NG.	MAIN PANIFCLD ASSY 290.2X EYPASS MANIFOLD KIT	MANIFULD, 24 VDC	NG.	MANIFOLD ASSY 290.2X MANIFOLD ASSY - CONTROL CUIL ASSEMBLY 24 VDC	MANIFULD, 115 VAC	NC.	MAIN MANIFOLD ASSY 290.2X MANIFCLD ASSY - CONTROL CCIL-ELECTRIC 115VAC	ASSEMBLY	NO.	MANIFCLD-290.2X S/M ELRCM-90,BCSS/TUBE CAP-TUBE EASE - BRACKET PLUG-EGS,INTL WR SCPEW-CAP, FEX MD WASHER-LUCK,SPLIT ADAFTER-BOSS/TUBE CAP-TUBE AUAPTEK-BOSS/TUBE PLUG-BOSS,INTL WR CAP-TUBE ELBGW-90,BCSS/TUBE ELBGW-90,BCSS/TUBE SCREW-CAP,SKT MD,SER 1960 VAL VE-PRESS GAGE ISCLATGR GAUGE-PRESSURE, 0-5000 PSI CUVER - HYD. SERVICE FILTER-HSG,6000 PSI
IC SERVICE	PTS PART	34930802 34476303	IC SERVICE	MTS PART	34930802 34151704 42680701	IC SERVICE	MTS PART	34930802 34151704 11282224	N MANIFOLD B	MTS PART	34227102 10024362 34227602 10026907 10015802 10022411 10024103 10024103 10024103 10024103 10024103 10024103 11025703 111388501 111388501 11130266
11EM - 290.21 HYDRAULI Part nc 34232413	REF. DESIGNATOR		ITEM - 250.22 HYDRALLIC PART NG 34232412 A	PEH. DESIGNATOR		ITEM - 290.22 HYDFAULI PART NC 34232411	REF. DESIGNATOR		ITEM - 290.2X HSM MAIN PART NO 34930802	REF. DESIGNATOR	1

NOTE... ASTEPISKED ITEMS MAY BE FOUNC IN SPARES PARTS KIT MIS PAPT NUMBER --

ITEM - 290.2X HSM MAIN MANIFOLD ASSEMBLY PART NC. - 34930802 B

REF. DESIGNATOR	MTS PART	۸C•	OF SCR I BT TON	TOTAL BOOM SA
9	,			VENOUR PARI NO.
	11130205	FILTER-ELEMENT, 11"	74 MICRON. 2000 PSTD	31P-744H
5	10010936	PACKING-PREFORMED, O-RING		ADDISAB-228
	06847916	VAL VE-CHECK, MOD PCPPET		11CF 100230-21
0.7	10011568	PACKING-PREFORMED.O-RING	TIRK GOD BINA-N 1 A75 TO	AD 054 0-030
17	10010947	PACKING-PREFURMED.D-BING		AKT 200-320
22	10049601	BGLI-EYE. SHIDR	DOING - 40404	AK P308-246
23		PACKING-PREFINENCE	ķ	EB-231
54	35260002	BAR-LIFTING SUPPORT	* 11ch you bonna-n I.475 IU	AKP568-920
52		TUBING-304 ACT. HAD STILL	,	
53		ALITHTIBE COLC.	-38 CU X .035 WALL	ASTM-A269
54		STEVELTIBE	100 10BE	68TX-S
55		SECTORE NO. DODGE	-06 TUBE	6 TX-S
56		DATE VENCHECK TO PURPLE		
57	100603001	PACK ING-PREFORMED, O-RING	.078X SQD BUNA-N .468 ID	ARP568-906
. x	10088309	FILTER-ELEMENT, 4"	B3=75, 150 PSID, 12 GPM	
) v	10024103	AUAFTER-BOSS/TUBE	-06 MBCSS X -06 TUBE	6F50 x-5
V 0	10088310	FILTER-ASSY, BP, 3000 PSI	83=75,10GPM, 4", VIS IND	HHOOSTATORED
00	10022206	NUT-HEX, ASSEMBLED WASHER	1/4"-20UNG	CTF 2 TAC OF
10	10025710	ELBCW-90,8CSS/TUBE	-OR PRICA Y -OA MTHRE	315821NC 75
79		REDUCER-BOSS, M/F	12 FRONK X -08 FRONK	
m .	10010735	PACKING-PREFORMED. D-RING	200 X	12-0 F3U63-3
70	10011913	RETAINER-PACKING BACK-UP	01 196 •1 N-WING GOV VC01	AKFUOGILUO
65		BRACKET - PALL TYPE HTM	C 11 TCO 400V	MS28114-136
99			FILTER ASST	,1 ; ;
67	10015512	のは、このでは、このでは、このでは、このでは、このでは、このでは、このでは、この	-04 -108E	
68	10026810	01 VIII 0100 10110	1/4"-Z0UNC X 3" LG	GR-5, ZINC PL
	10011511	DE VERSON DE L'ESCALE DE L'ESC	-05 BUSS+ 1/2 SAE	5 P50N-S
. 59	36616003	DELY-DAG HAR BLOAD AND A STORE THE STORE S		ARP568-905
70	10011501	SECUMEL A LOK ASSY-PISTON	2.500 BERE DIA, 29 CU.IN.	
71	10011001	PACK I NG-PKEFORMED + O-R ING	.116X 90D BUNA-N 1.171 ID	ARP568-916
7.2	10024108	ADAFTER-BOSS/TUBE	-16 MBGSS X -16 TUBE	6400-16
- F	10951001	SCREW-CAP, SKI HD, SER 1960	1/2"-13UNC X 2" LG	GR-8-BIK OXD
" ~	38660402	ACCUMULATOR ASSY-PISTON,	4-060 BCRE DIA: 106 CU. IN.	
+ C		ACCUMUL ATOR ASSY-PISTON	BURE	
0 -		ADAFTER-89557TUBE	-20 MRESS X -20 THRE	300000
*	37148702	BLOCK-ACAPTEP. ACCUMULATOR		200002
O a	10014605	SCREW-CAP.SKT HD. NER 1960	1/2H_13HMF V 1 1/2# +C	
100	10010908	PACKING-PREFIRMED C-RING		SA-SPEIN UAU
94	10026903	PLUG-80.SS-INTI WR	-1237 300 000A-N 1-134 10	AX
85	10083507	INSERT-THIS D	100 00004574 UAR	S HFUUN-S
06	16022907	EANERD CON NO. 14	1/2"-13UNC A ./3U LG	
	107700	MASHER-LUCK SPL 11	3/8" SIZE	SPR STL, ZINC PL
ITEM - 290.1X2X BY	a	> 10MH 20KH		
476303	₹ 4			
REF. DESIGNATOR	MTS PART NO		DESCRIPTION	VENDOR PART NO.
40	10010525	PACKING-PREFORMED,O-RING PACKING-PREFORMED,C-RING	.070X 90D BUNA-N 1.364 ID .070X 90D BUNA-N .614 ID	ARP568-028 ARP568-016
NOTE ASTERISKED ITE	FMS MAY RE FIN	FOUND IN COADES DAGTE VIT MIS		
•		ATTRION TAN USE THE CONTROL OF THE STREET	ATT NUMBER THEFFEET	

TABLE 6-2 290.2X HYDRAULIC SERVICE MANIFOLD COMPUNENT PARTS LIST 11225703 B

ASSENBLY
MANIFOLD
.2X BYPASS
- 290.1X+ .2X NC 34476303
PART P

REF. DESIGNATOR	MTS PART	NC.	DESCRIPTION	VENDOR PART NO.
75 76 77	34476202 10014607 10026906	MANIFCLD - BYPASS SCREW-CAP,SKT HD,SER 1960 PLUG-BOSS,INTL WR	MODELS 290.1X AND 290.2X 1/2"-13UNC X 2" LG -16 BOSS,1 5/16 SAE	GR-8, BLK CXD 16 HP5CN-S
ITEM - 290.1X, .2X HS PART NO 34151704	SM CONTROL	MANIFOLD ASSEMBLY		
REF. DESIGNATOR	MTS PART	NO.	DESCRIPTION	VENDOR PART NO.
25 26 27 28	34220002 34220002 11282228	VALVE-CARTRIDGE MANIFGLD - CONTROL VALVE-CARTRIDGE	3-WAY 2-POS NC W/G COIL PCDELS 290.1X AND 290.2X 2-WAY NC POPPET W/G COIL	\$V10-31-0-h-00 \$V10-21-0-N-00
35 33 33 30 30 30 30 30 30 30 30 30 30 30	· ō m ō d		-04 BOSS, 7/16 SAE 3000 PSI, 5 TURNS, 0-3/32IN -02 BOSS, 5/16 SAE	4 HP50N-S NFCC-LON 2 HP50N-S
0 th 40 th 4	11042606	PLOCHEGSS, INIL WK SPRING-WASHER, WAVE, STEEL KING-RFIAINFR	-20 BUSS,1 5/8 SAE 1.05 IC/1.35 CD/.015 THK	20 HP361-015
41 42 43	004	GLYD RING-C.D. SEAL PACKING-PREFORMED,C-RING SEMENTE DEFECTION	1.250 CD .103X 70D BUNA-N .987 ID	S-12547-121 ARP568-120
2 4 4 4 4 5 4 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	700000	SPUCL-FRESSOR SPRING-HELICAL, CPRSN PACKING-PREFORMED, O-RING PACKING-PREFORMED, O-RING PLUG-BOSS, INTL WR	.970 CD X .105 X 3.0 FL .970 CD X .105 X 3.0 FL .070X 90D BUNA-N 1.364 ID .070X 90D BUNA-N .614 ID -16 BOSS,1 5/16 SAE	LC-105L-7-MW ARP568-028 ARP568-016 16 HP5CN-S
945 50 51 88	מ היה מי	PISTUN-ACCONTAINN PLUG-20 MODIFIED VALVE-GAS SEAL-1,PISTON PLUG-CRIFICE, U94 DIA	ACCUMULATOR-CHARGE 1 ID X 1.250 OD X .125H	MS28889-2 TP015
ITEM - 290.XX CCNTRC PARI NG 42680701	CL CGIL ASSY A	r 24 vbC		
REF. DESIGNATOR	MTS PAPT	NC.	DESCRIPTION	VENDOR PART NO.
31 32 33	11282223 10008604 11282226	CGIL-ELECTRIC 24 VDC SEMICOND DEVICE-DIC, RECT CUNNECTOR-DIN TO AMPHENOL	DIN CCNNECTION #43650 PIV.200V-IO75A USED IN 24VDC CCILS W/DIN	6356024 1N4003 JF860619A
ITEM - 290.XX CCNTRO PART NC 11282224	CL CC11.	115 VAC		
REF. DESIGNATOR	MTS PART	• 0	UESCRIPTION	VENDOR PART NO.
59	11282224	CUIL-ELECTRIC 115VAC	DIN CCNNECTION #43650	6366115
NOTE ASTEPISKED ITE	EKS NAY BE	FOUND IN SPARES PARTS KIT MTS R	PART NUMBER	

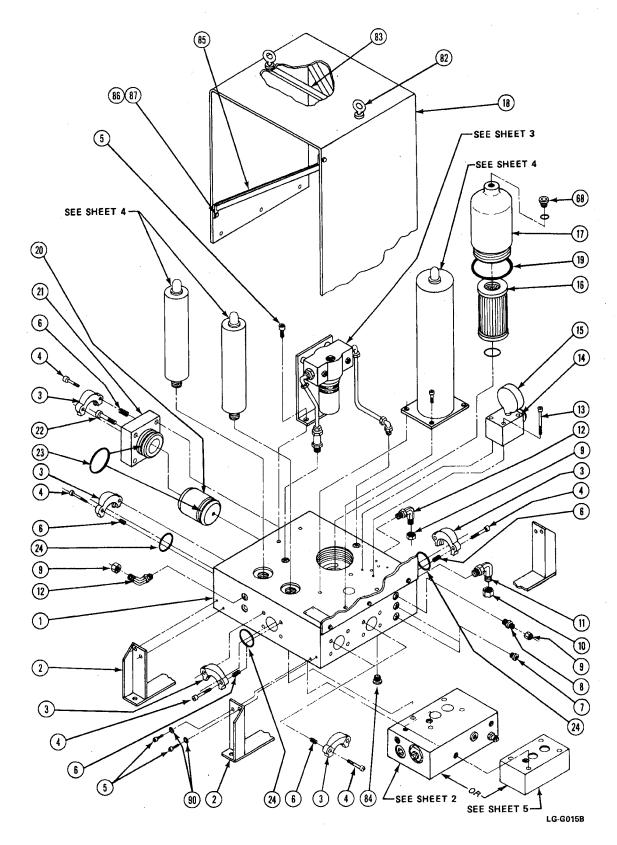


Figure 6-4. 290.3X Illustrated Parts Breakdown (sheet 1)

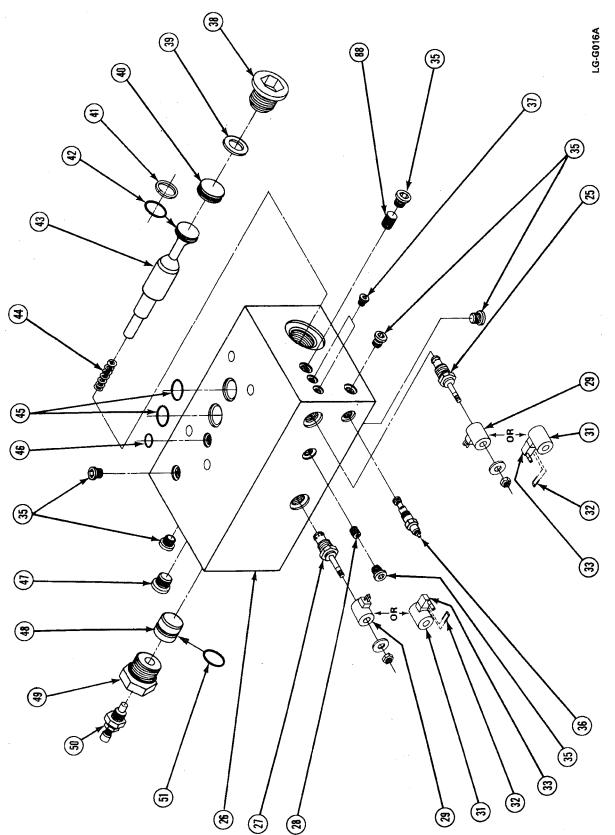


Figure 6-4. 290.3X Illustrated Parts Breakdown (sheet 2)

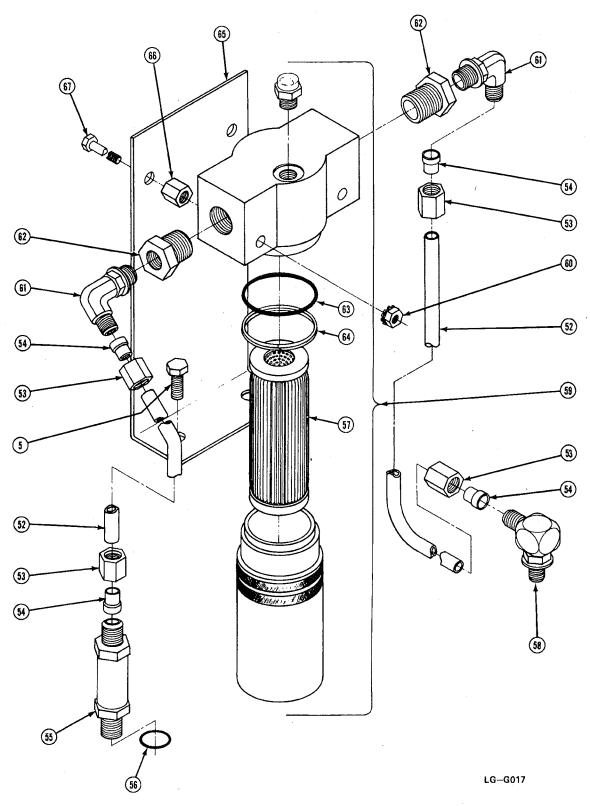


Figure 6-4. 290.3X Illustrated Parts Breakdown (sheet 3)

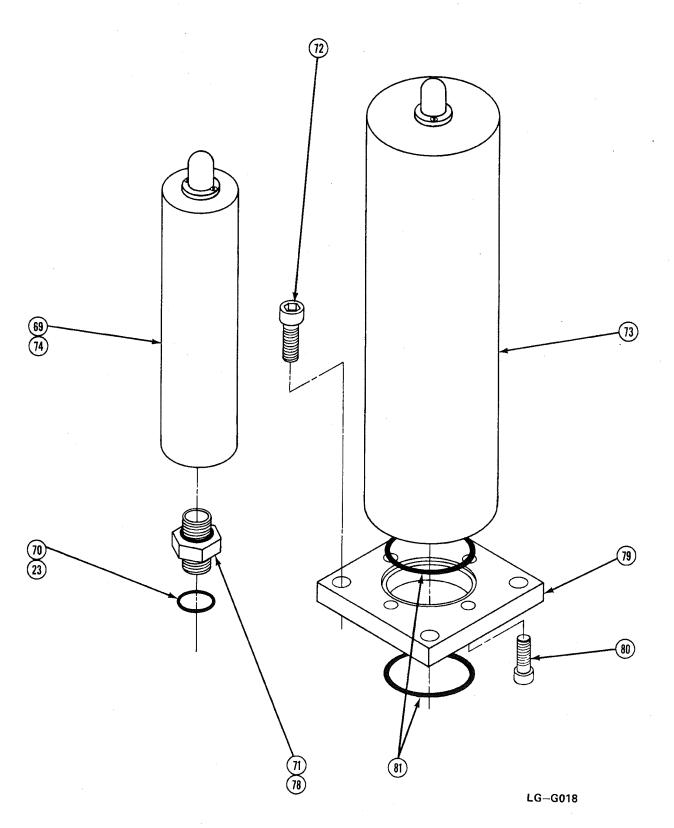


Figure 6-3. 290.3X Illustrated Parts Breakdown (sheet 4)

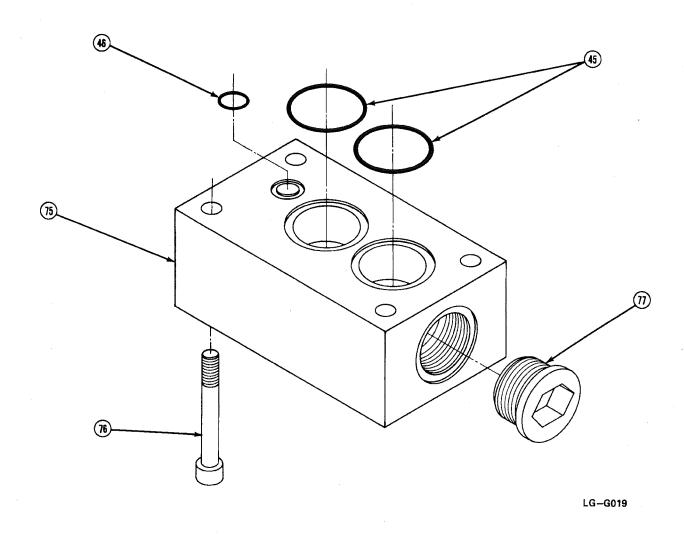


Figure 6-4. 290.3X Illustrated Parts Breakdown (sheet 5)

PAGE NUMBER - 6-29		VENDOR PART NO.			VENDOR PART NO.	6366115		VENDOR PART NO.	3255F-2 GR-8+BLK OXD GR-5+ZINC PL SPR STL+ZINC PL 1185-BCN-0750 6 HP5CN-5 6FNTX-5 8FNTX-5 8FNTX-5 8 C5 OX-5 GC-8+BLK OXD AF6EP2.0/X 31-P-74WH ARP568-228 31-P
		CESCRIPTION	PCDEL 290.3X		DESCRIPTION	PEDEL 290.3X DIN CONNECTION #43650		DESCRIPTION	MCDEL 290.3X 2 IN,3000 PSIW MAX 1/2"-13UNC X 1 1/4" LG 3/8"-15UNC X 5/8" LG 3/8"-15UNC X 5/8" LG 3/8"-15UNC X 5/8" LG 1/2"-13UNC X .750 LG -06 MEDSS 9/16 SAE -06 MEDSS X -06 TUBE -08 TUBE -08 TUBE -08 MEDSS X -06 MTUBE 1/4"-20UNC X 2 1/2" LG 1/2"-13UNC X 1 3/4" LG 1/2"-13UNC X 1 3/4" LG 1/2"-13UNC X 1 3/4" LG
TABLE 6-3 290.3X HYDRAULIC SERVICE MANIFULD CCMPCNENT PARTS LIST 11225803 B	MANIFULD, 24 VDC	NG.	MAIN MANIFCLD ASSY 290.3X MANIFCLD ASSY - CONTROL CUIL ASSEMBLY 24 VDC	MANIFOLD, 115 VAC	NO.	MAIN MANIFOLD ASSY 290.3X MANIFOLD ASSY - CONTROL CCIL-ELECTRIC 115VAC	ASSEMBLY	NG.	MANIFCLD - 290.3X S/M. BASE - BRACKET FLANGE FALF-SAE 4 BOLT SCREW-CAP, SKT HD, SER 1960 SCREW-CAP, FKT HD, SER 1960 SCREW-CAP, FKT HD, SER 1960 SCREW-CAP, FR IT INSERI-THD'D PLUG-BOSS, INTL WR ADAPTER-BCSS/TUBE CAP-TUBE CAP-TUBE ELBGW-90, BOSS/TUBE ELBGW-90, BOSS/TUBE ELBGW-90, BOSS/TUBE ELBGW-90, BOSS/TUBE ELBGW-90, BOSS/TUBE ELBGW-90, BOSS/TUBE FLCAP-TUBE ELBGW-90, BOSS/TUBE FLCAP-TUBE ELBGW-90, BOSS/TUBE FLCAP-TUBE ELBGW-90, BOSS/TUBE FLCAP-SKT HD, SEK 1960 VALVE-PRESSURE, 0-5000 PSI FILTER-ELEMENT, 11" PACKING-PREFORMED, C-RING PACKING-PREFORMED, C-RING MGD IFICATION-CHECK VALVE CUVER-CHECK VALVE SCREW-CAP, SKT HD, SER 1960 PACKING-PREFORMED, G-RING
	IC SERVICE A	MTS PART	34930902 34151703 42686701	IC SERVICE A	MTS PART	34930502 34151703 11282224	WANIFOLD	MTS PART	34438202 34438102 11011602 10014604 100128907 10022807 10024103 10024103 10025703 10025703 10025703 10025703 11388501 1130206 34437902 10010936 11130206 34437902 100109402 100109402
	ITEM - 290.32 HYCRAUL Part no 34437805	REF. DESIGNATOR		ITEM - 290.32 HYDRAUL! Pari nu 34437804	REF. DESIGNATOR		ITEM - 290.3X HSM MAIN PARI NC 34930902 B	REF. DESIGNATOR	1 2 3 3 4 4 4 6 6 7 7 7 110 113 114 115 117 118 118 118 118 119 120 22 22 23

NCTE... ASTERISKED ITEMS MAY BE FOUNC IN SPARES PARTS KIT MIS PART NUMBER ---

ITEM - 290.3X HSM MAIN MANIFOLD ASSEMBLY PART NC. - 34930502 B

784 NC+ = 34390305	x a			
REF. DESIGNATOR	MIS PART N	• DN	DESCRIPTION	VENDOR PART NO.
24	10010036	ONT OF CHANGE BOOK SALES	1267 GOD BILNA-N 2.224 ID	ADD569-238
52		THE NG-304 ANT HAD BUILD		ACT 100-250
וח ו		NUTTINE CPIG		ABTX-S
54		SCHEVETURE		5-X-5
55	06847911	VALVE-CHECK, MOD POPPET	i :	1
26	10011503	PACKING-PREFORMED, C-RING	.078X 90D BUNA-N .468 ID	AR P568-906
	10088310	FILTER-ASSY, BP, 3000 PSI	H3=75,106PM, 4", VIS IND	HH9020A12UPRBP
58	10025702	ELBCW-90, BCSS/TUBE	-06 MBDSS X -06 MTUBE	6 C50x-S
56	10088310	FILTER-ASSY,8P,3000 PSI	83=75,10GPM,4",VIS IND	HH9020A12UPRBP
9	10022206	NUT-HEX, ASSEMBLED WASHER	1/4"-20UNC	STL, ZINC PL
61	10025710	ELBCW-90.8CSS/TUBE	-08 MBGSS X -06 MTUBE	6-8 C50X-S
62	10027304	REDUCER-BGSS,M/F		12-8 F5065-S
63	100 10735	PACK ING-PREFORMED, Q-RING	.103X 90D BUNA-N 1.987 ID	ARP568-136
94	10011913			MS28774-136
₹.	34438002	BRACKET - PALL TYPE "T"	FILTER ASSY	
99	10026701	NUT-TUBE CPLG	-04 TUBE	
- :		SCREW-CAP, FEX HD	1/4"-20UNC X 3" LG	GR-5, ZINC PL
89		PLUG-ECSS, HEX HD	-05 BCSS+ 1/2 SAE	5 PSGN-S
	10011511	PACKING-PREFORMED.O-RING		ARP568-905
69	36414004	ACCUMULATOR ASSY-PISTON	2.500 BCRE DIA, 58 CU.IN.	1
φ.	10011508	PACKING-PREFORMED, O-RING	.118X 90D BUNA-N 1.475 ID	ARP568-920
	10024111	AUAPTER-BCSS/TUBE		20F50X-S
7.5	10014607	SCREW-CAP, SKT HD, SER 1960	30NC	GR-8, BLK GXD
· ·	38660403	ACCUMULATOR ASSY-PISTON,	BORE	
74	36414003	ACCUMULATOR ASSY-PISTON	2.500 BGRE DIA, 29 CU.IN.	
61	37148702	BLUCK-ADAPTER, ACCUMULATOR		
80	10014605	SCREW-CAP, SKT HD, SER 1960	1/2"-13UNC X 1 1/2" LG	GR-8.BLK OXD
18		PACKING-PREFORMED.C-RING	.139X 90D BUNA-N 1.734 ID	ARP568-224
82	10049601	BCLT-EYE, SHLDR	3/8"-16UNC X 1.25 LG	E8-23T
83	35260005	BAR - LIFTING SUPPORT		
4.0	10026903	PLUG-BOSS, INTL WR	-08 BGSS, 3/4 SAE	8 HP5GN-S
\$ 30 	35259902	BRACE - CCVER		
86	10013602	SCREW-CAP, SKT HD, SER 1960	#10-24UNC X 1/2" LG	GR-8, BLK OXD
, so	10022305	NOTHER PRINCES		ZINC PL
	10622001	MASHEW-LUCK SPL 1	378 2176	SPR SILIZING PL
ITEM - 290.3X HSM CCN PAPT NC 34151703	NTROL MANIFOLD B	D ASSEMBLY		
04 4 40 4 0 30 137				
REF. DESIGNATUR	MTS PART NO	• 00	DESCRIPTION	VENDOR PART NG.
25	11282227	VAL VE-CARTRIDGE	3-WAY 2-POS NC W/O COTL	SV10-31-0-N-00
o •		MANIFOLD - CONTROL		
228	09405221	VALVETO AKT KIDGE FIDGET KITTOF	Z-WAY NE PUPPET W/U CUIL	2410-Z1-C-N-00
35	10056901	PLUG-BOSS, INTL WR	-04 BOSS+7/16 SAE	4 HP SON-S
36	11329903	VALVE-NEEOLE, CARTRIDGE	3000 PSI,5 TURNS,0-3/32IN	NFCC-LON
THE CHAPTER TO THE		C UMP A S C C C C C C C C C C C C C C C C C C		

NUTE... ASTERISKED ITE'S MAY RE FOUND IN SPARES PARTS KIT PIS PART NUMBE"

TAULE 6-3

PAGE NUMBER - 6-31

290.3X HYDRAULIC SERVICE MANIFULD	CCMPCNENT PARTS LIST	11225803 B	

ITEM - 290.3X FSM CCNT PART NC 34151703		RCL MANIFCLD ASSEMBLY B		
REF. DESIGNATOR	MTS PART	• 01	DESCRIPTION	VENDOR PART NC.
~ B ~ O ~ C ~ C ~ C ~ C ~ C ~ C ~ C ~ C ~ C	10026919 110426969 11042605 33989201 10012524 10011012 11044610 11010940 10010940 10010940 10010940 10010940 10010940 100110710 10010940 11011010	FLUG-BOSS, INTL WR PLUG-BOSS, INTL WR SPRING-WASHER, WAVE, STEEL RING-RETAINER GLYD RING-D.D. SEAL PACKING-PREFCRMED, G-RING SPUCL-PRESSURE REDUCING SPRING-HELICAL, CPRSN PACKING-PREFORMED, C-RING PACKING-PREFORMED, C-RING PLUG-BOSS, INTL WR PISTCN-ACCUMULATGR FLUG-20 MODIFIED VALVE-GAS SEAL-T, PISTON	-02 BCSS, 5/16 SAE -32 BCSS, 2 1/2 SAE 1.66 ID/2.13 OD/.023 THK 1.750 OD .135X 700 BUNA-N 1.421 ID 1.460 OD X .187 X 4.25 FL .135X 900 BUNA-N 1.859 ID .103X 900 BUNA-N 1.859 ID -20 BCSS, 1 5/8 SAE ACCUMULATCR-CHARGE 1 ID X 1.250 CD X .125M	2 HP50N-S R 771-32 W2132-023 S-12547-222 ARP568-221 LHC-187R-5 ARP568-119 20 HP50N-S MS28889-2 TP015
ITEM - 29C.XX CONTPCL PART NC 4268G701 REF. DESIGNATOR		2.4 .C.	DESCRIPTION	VENDOR PAPT NO.
31 32 33	11282223 10008604 11282226	CUIL-ELECTRIC 24 VDC SEMICGND DEVICE-DIO, RECT CCNNECTOR-DIN TO AMPHENOL	DIN CONNECTION #43650 PIV,200V-IO, 15A USEC GN 24VDC COILS W/DIN	6356024 1N4003 JF860619A
ITEM - 290.XX CENTRCL PART NC 11282224	L CGIL,	115 VAC		
REF. DESIGNATOR	MIS PART NO.	ND.	DESCRIPTION	VENDOR PART NO.
29 II	282224 MAY 8E	CUIL-ELECTRIC 115VAC FCUND IN SPARES PARTS KIT MTS F	DIN CONNECTION #43650 PART NUMBER	6366115

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