SUBSEA AMERICAS

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Isolated Hydraulic Power Unit and Intensifier 3:1 - Lease Tool Set.

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Isolated Hydraulic Power Unit and Intensifier 3:1 (IHPU131) O & M Manual

Document No: IHPU131-003

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DISCLAIMER

This technical manual has been drafted by Sub-Sea Tooling (SST) at the request of Subsea Americas, and in no way leaves SST liable for the accuracy contained herein. Furthermore, SST bears no responsibility for the safety and operation of the Isolated Hydraulic Power Unit and Intensifier.

This technical manual contains information required to successfully operate and maintain the Isolated Hydraulic Power Unit and Intensifier System as of the date of publication. It is assumed that trained and experienced technicians will exercise judgment concerning the operating conditions and provide constant inspection and maintenance whilst operating the system. By delivery of this manual, SST makes no statement of assurance of its completeness or accuracy with respect to the delivered equipment. SST assumes no responsibility to modify, update, or change the manual content at any time beyond its initial delivery. Such changes or modifications are the subject of separate contractual agreements and not part of this manual delivery.

SST herewith provides notice that the Isolated Hydraulic Power Unit and Intensifier System design is based on assumed operating conditions and loads with included design margins. It must however, be understood by technicians that actual offshore operating conditions cannot be completely defined and that primary responsibility for the safe and successful use of the Isolated Hydraulic Power Unit and Intensifier System is the responsibility of the technicians. It is further the responsibility of the technicians to identify any and all damage or wear to the system and to take action to return the equipment to serviceable condition prior to continued operation.

SST and Subsea Americas disclaims any liability for safety, damage to third party equipment, life of the system or its components beyond those areas specifically discussed herein.

1.0 INTRODUCTION

1.1 Description

This document is a Technical Manual for the Isolated Hydraulic Supply, HP Directional Control Valve and Reservoir as a complete system to pump water based fluids such as Castrol Trans Aqua HT and Marston Bentley HW540.

The heart of the system is the IHPU 131. When configured with the correct seal types, the IHPU 131 is capable of pumping;

- ISO Fluids,
- Water,
- Water Glycols,
- Methanol
- and, Pulling a Partial Vacuum (up to 11,044 lbs of suction force)

The Technical Specification provides the necessary information required by the prospective user to install and operate the IHPU System on a standard work class ROV. The ROV will be required to supply at a minimum, hydraulic capabilities of up to 3000 psi at 8 gpm and two pilot lines from the ROV valve pack which must be open centre to the HP DCV at 3000 psi.

1.2 Scope

The Isolated Hydraulic Supply System has been fabricated for the supply of aggressive fluids within the Sub Sea Tooling Industry. In its current configuration, it is designed as a pump for these aggressive fluids. However, it may also be configured as a vacuum pump to be used within a Variable Buoyancy System.

Subsea Americas Responsibility

Subsea Americas shall provide the IHPU System complete with;

- The IHPU131,
- The HP Directional Control Valve (DCV),
- The Reservoir

And the interconnect plumbing between the abovementioned components.

Operator Responsibility

The Operator will supply;

- The hydraulic power and the interconnection to the IHPU,
- The Pilot pressure and the interconnect to the Pilots (must be piloted from open centre valves) of the HP DCV,
- The Output lines from the HP DCV to the Operator supplied, or third party equipment.

The Operator shall also be responsible for the most effective way of mounting the equipment.

Design Life

The design life of the Isolated Hydraulic Supply System is up to a maximum of 5-years from November 2005. Components must be removed from service after November 2010.

1.3 Definitions

DCV	Directional Control Valve
gpm	gallons per minute
HP	High Pressure
IHPU	Isolated Hydraulic Power Unit
IHPU 131	Isolated Hydraulic Power Unit / Intensifier 3:1 Intensification Ratio
ISO	International Standards Organisation
JIC	Joint International Conference
LP	Low Pressure
MSDS	Material Safety Data Sheets
NAS8	National Aeronautical Standards cleanliness level 8
P1	Output Pressure Port Number 1
P2	Output Pressure Port Number 2
PPE	Personnel Protective Equipment
psi	pounds per square inch
Reservoir	Isolated Fluid Reservoir
ROV	Remotely Operated Vehicle

1.4 Specifications

The IHPU System is designed to interface onto a Remotely Operated Vehicle (ROV) via the ROV hydraulic valve packs or switchable hydraulic supply. The ROV will also be required to supply two pilot lines from the valve packs to control the HP Directional Control Valve (DCV). The following specifications are described such that interface may be achieved.

- **IHPU131**

Length x Width x Height	26.25” x 6” x 10.5”
Weight (in air)	75 lbs
Weight (in water)	Approximately 49 lbs
Intensification Ratio	3:1
Primary Fluid	ISO 32 or equiv
Secondary Fluid	Water/Glycols, ISO Fluids, Water, Methanol
Suction Force	11,044 lbs
Max Input Pressure	3,000 psi
Max Input Flow	8 gpm
Primary Seals	Cast
Primary Cylinder Material	Steel
Primary Manifolds	T6 6061
Primary Controls	Steel
Primary Piston and Rod	316 SS
Max Output Pressure	9,000 psi
Max Output Flow	2.6 gpm
Secondary Seals	Turcon-T24 and XV043
Secondary Housing	316 SS
Secondary Piston	Drawn Aluminium Bronze
Primary Input Fitting	No 6 JIC
Primary Output Fitting	No 8 JIC
Secondary Input Fitting	No 6 JIC
Secondary Output Fitting	No 4 JIC
Tie Rods	4 x ½ x 20 UNF ASTM A311
Tie Rod Torque	70 ft-lbs
Check Valve Cracking Pressure	6 psi each

- **HP DVC.**

Length x Width x Height	5.25” x 7.25” x 3.5”
Weight (in air)	14 lbs
Weight (in water)	12.5 lbs
Fluid	Water/Glycols, ISO Fluids, Water
Max Input Pressure	5,000 psi
Max Input Flow	4 gpm
Max Pilot Pressure	3,000 psi
Housing Material	303 SS
Shear material	Polished Tool Steel
Seal Type	Shear
HP Input Fitting	No 4 JIC
HP Output Fittings	No 4 JIC
Pilot Fittings	No 4 JIC
Return Fitting	No 6 JIC
Mounting Pattern	4 x 1/4x20 @ 2.75” x 2.0”

- **Reservoir**

Length x Diameter	25” x 8.75”
Weight (in air)	16 lbs
Weight (in water)	3.5 lbs
Fluid	Water/Glycols, ISO Fluids, Water
Max Volume	4.5 gallons
Output Connection	No 8 JIC
Fill Connection	No 4 JIC
Bladder Material	Buna
Bladder Dim	8” OD x 24”
Mounting Fixture	2 x 1.25” Cargo Straps

1.5 Theory of Operation

The heart of the IHPU System is the IHPU 131. This is a self-reciprocating, double acting piston pump, powered by the ROV's ISO hydraulic fluid system. The IHPU 131 is designed to isolate the pumped fluids (from the Reservoir) from the ROV hydraulic system. Therefore, cross contamination should not occur.

The IHPU is a 3:1 intensifier i.e., it will amplify the input pressure by three times. For an output pressure of 3000 psi, the input pressure must be limited to approximately 1000 psi. Refer to performance curves in Appendix C.

The HP side of the IHPU131 has been designed to operate at pressures up to 9,000 psi. However, the limiting factor in the IHPU System will be the HP DCV which is designed to switch fluid directions at operating pressures up to 5,000 psi.

The suction side of the IHPU131 draws fluid from the 4.5 gallon reservoir via the ½" supply line. This supply line is also Tee-ed into the return side of the DCV.

The HP Directional Control Valve (DCV) is only a means of switching direction of flow to the third party user without contaminating the ROV ISO supply. The HP DCV is a 4-way, 3-position Shear Seal type Valve with centre-blocked configuration, encased in a stainless steel housing. It is capable of operating at pressures up to 5000 psi. The DCV must be piloted from the ROV valve pack with open centre solenoid valves. Failure to do so will stop the DCV from returning to centre position.

The Reservoir is a Buna Elastomer Bladder Reservoir (collapsible bladder type, **not** positive pressure), encased in a PVC housing for protection. Fluid from the 4.5 gallon bladder is drawn by the IHPU via the ½" supply line. The bladder is

filled via the ¼" Toggle Valve located at the bladder stem. It is assumed that the Reservoir will be filled with fresh, clean, uncontaminated fluid at a cleanliness level of NAS 8.

NOTE: This reservoir bladder is not designed for use with Methanol

The HP output of the IHPU is plumbed directly into the input of the HP DCV. The HP DCV will direct the input pressure to either P1 or P2 when piloted by the ROV. The return fluids will be recovered via the opposite line (either P2 or P1), and filtered by the 25 micron in-line filter prior to returning to the Reservoir or suction side of the IHPU.

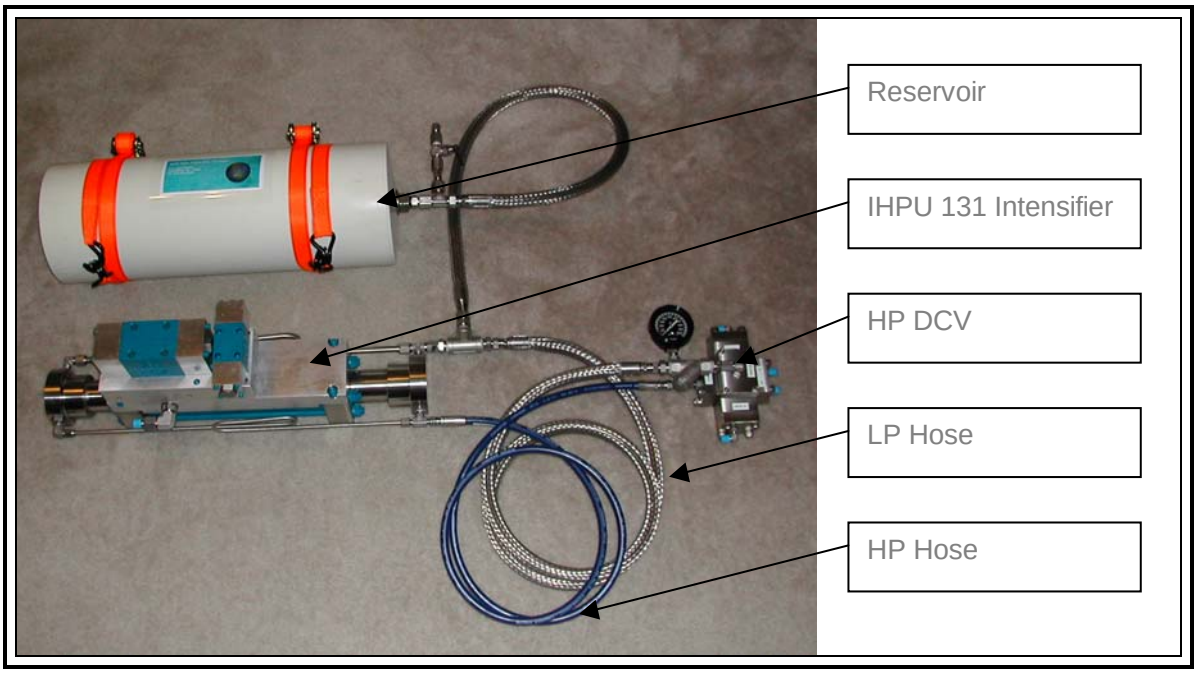


Fig 1.5 IHPU131 System

2.0 SETUP AND OPERATION INSTRUCTIONS

2.1 Mechanical Installation

Mechanical installation will be broken down into three parts.

1. Mounting of the IHPU 131,
2. Mounting of the DVC,
3. Mounting of the Reservoir,

Within the confines of the ROV.

2.1.1 The IHPU 131. The IHPU131, should be mounted reasonably close to the front of the ROV and attached via the four 1/4 x 20 UNC mounting holes at the base of the endcaps. Note: the tie rods for the end caps for the IHPU must not be removed in order to install mounting brackets. The tie rods must remain torqued to the values as described in the specification.

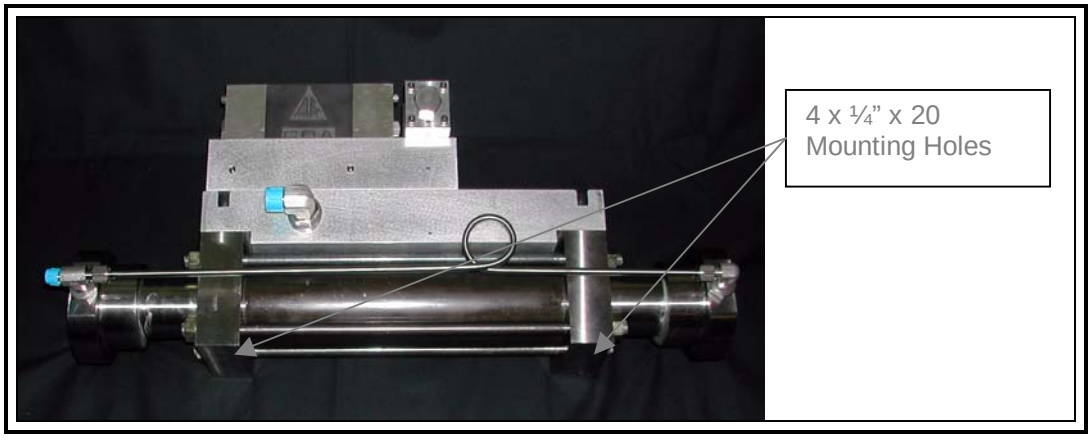


Fig 2.1.1 IHPU131 Mounting Pattern

2.1.2 HP DCV. The HP DCV must be mounted at the front of the vehicle using the four mounting holes on the underside of the HP DCV. The HP DCV should not be mounted any further than 2 metres from the IHPU. Consideration should be made to minimise the hydraulic run between the HP DCV pilot valves and the ROV valve pack.

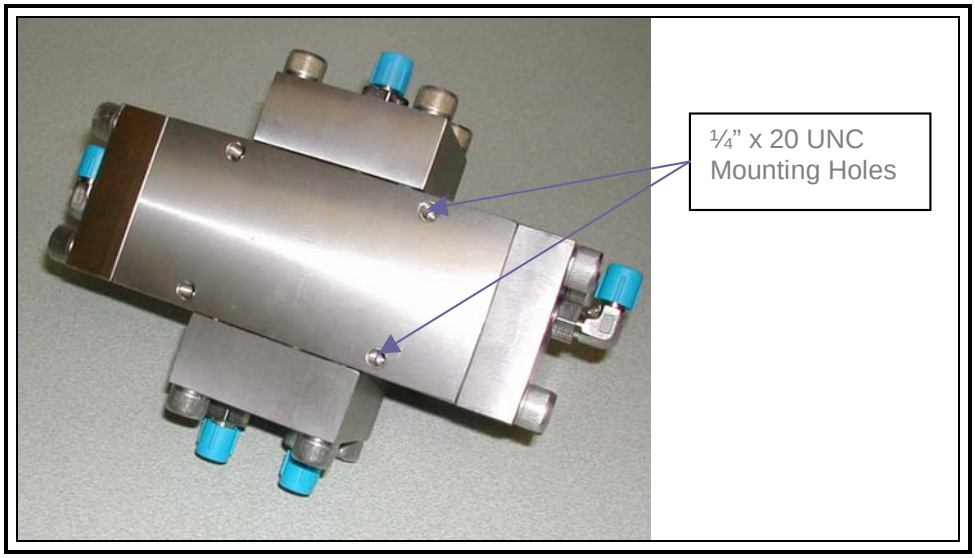


Fig 2.1.2 DCV Mounting Pattern

2.1.3 The Reservoir. The Reservoir should be mounted via the Tie Down Straps (Cargo Straps) supplied. The reservoir must not be mounted any further than 3 feet from the intensifier.

Fig 2.1.3 Reservoir Mounting Hardware

2.2 Hydraulic Installation

Once the mechanical installation of the IHPU 131, HP DCV and Reservoir is complete, the hydraulic interconnect hoses may be installed.

- The pressure and return line to the IHPU 131, will be operator furnished and plumbed directly to the IHPU 131 from the ROV switchable valve with variable pressure capability or a proportional valve set. The supply line should be a 3/8" hydraulic hose while the return line should be ½" hydraulic hose.

NOTE

The ROV switchable valve with variable pressure capability or a proportional valve must be able to return to tank in order for the system to remain compensated during transit to working depth.

2.2.1 IHPU 131 HP output; The IHPU 131 HP output line must be the HP ¼" line supplied. This output line will be connected from the No 4 JIC fitting at the IHPU 131 to the No 4 JIC fitting at the input of the DVC (via a T-piece and pressure gauge at the HP DCV, if installed).

2.2.2 IHPU 131 LP input/suction; The IHPU 131 LP input/suction line will be the 3/8" line supplied. This line must be connected from the No 6 JIC fitting at the output of the return filter (at the HP DCV) directly to the No 6 JIC fitting at the input to the IHPU 131. Note this is via a t-piece for the Reservoir connection.

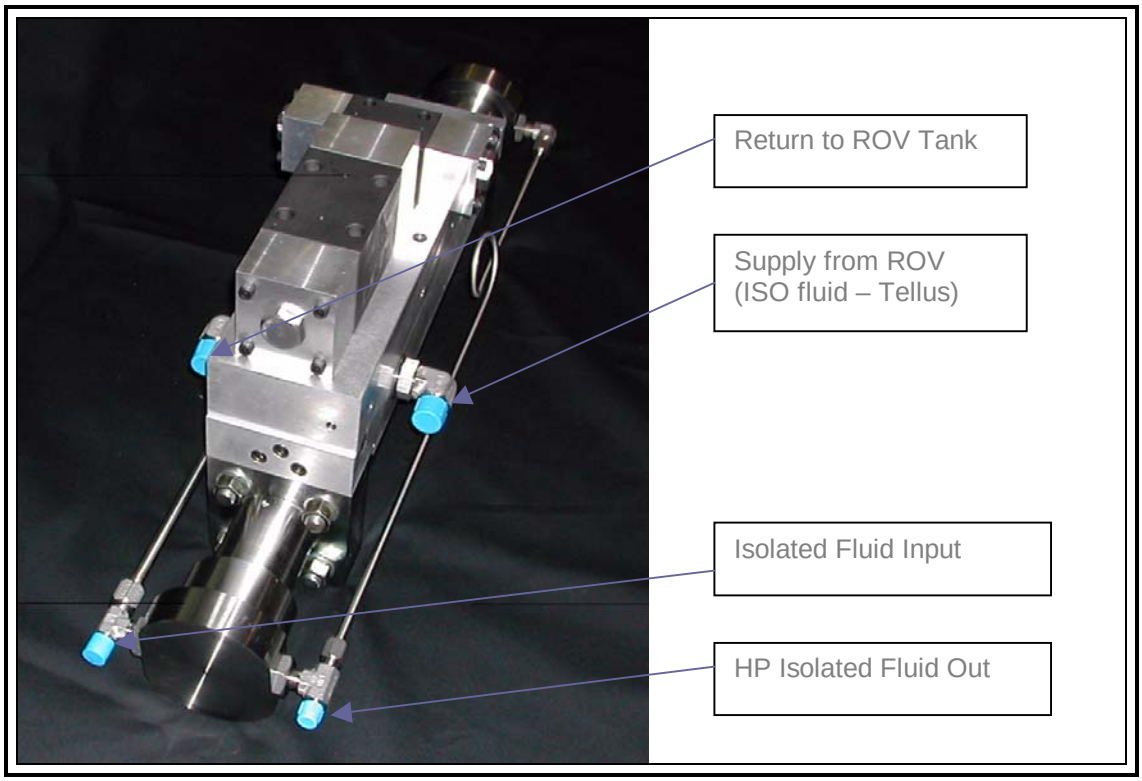


Fig 2.2.1 IHPU 131

2.2.3 Reservoir LP line; The Reservoir LP line is the ½" line supplied. This line must be connected directly from the No 8 JIC fitting at the t-piece of the bladder stem, directly to the No 8 JIC at the t-piece of the IHPU 131 input/suction side.

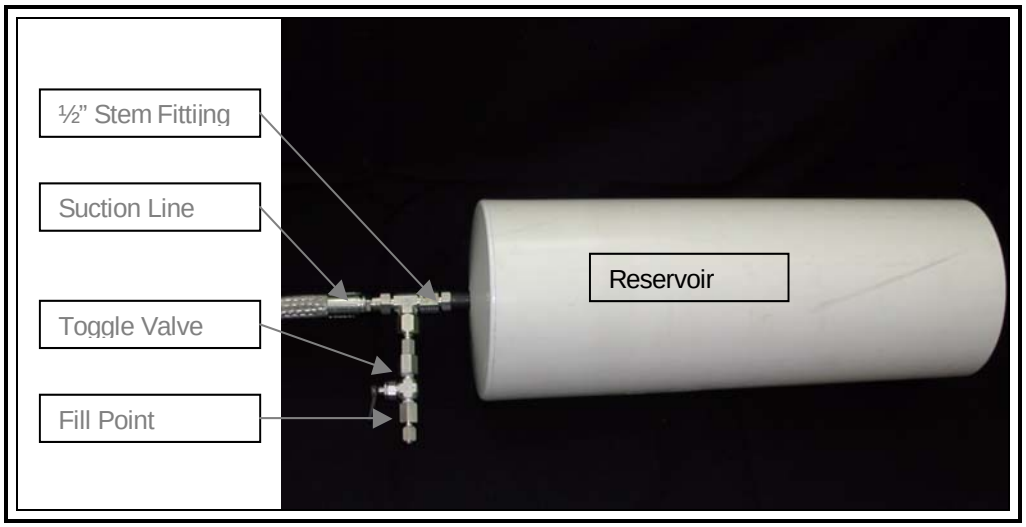


Fig 2.2.3 Reservoir

2.2.4 HP DCV pilot lines; The HP DCV pilot lines will be operator furnished and plumbed via ¼" lines directly from the ROV valve manifold to the No 4 JIC fittings at the HP DCV (the valves must be open centre to enable the DCV to return to centre once the pilot command is released). The HP output of the HP DCV, P1 and P2, will also be operator furnished and plumbed via ¼" lines directly from the No 4 JIC fittings to the operator supplied 3rd party tool/equipment.

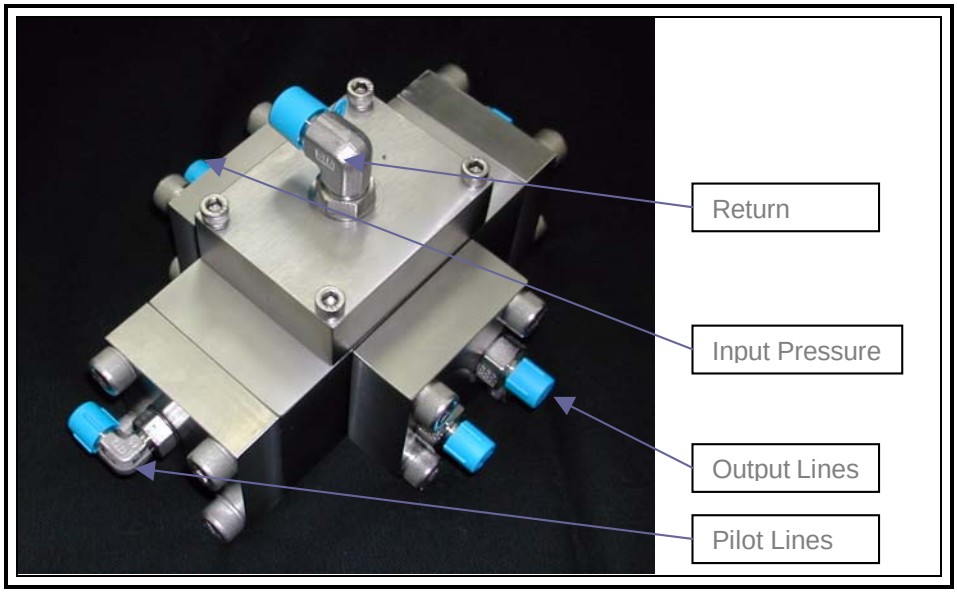


Fig 2.2.4 DCV

NOTE

The ROV directional control valve used to supply the pilots must be centre return to tank in order for the function to turn off once the pilot command is removed. This system will not function on a boosted return system.

2.3 Hydraulic Setup

WARNING

This IHPU System is capable of producing pressures up to 9,000 psi. The operator is responsible for ensuring the safety of all personnel and equipment associated in the installation, setting-up, testing and operation of this equipment. Personnel Protective Equipment (PPE) must be worn by all personnel associated in the installation, setting-up, testing and operation of this equipment. PPE must include, but not limited to Safety Glasses, Full heavy material Coveralls, Hard Hat, Safety Boots and Protective Gloves. It is also the operators responsibility to obtain and read the MSDS sheets associated with the fluids intended for use with this equipment.

CAUTION

Excessive oil temperature can severely damage system components. Do not let oil temperature exceed manufacturer's limits. If overheating occurs, shut down operation and wait for components to cool before proceeding.

2.3.1 Pilot Tests; Once the mechanical and hydraulic installation is complete, the pilot lines to the HP DCV will be tested allowing fluid to flow from the reservoir through either P1 or P2. This is achieved by pushing on the bladder; increasing the internal pressure enough to overcome the IHPU 131 internal check valve spring pressures of

12 psi (6 psi each check valve). Fluid will then flow out from either P1 or P2 depending on which pilot is selected.

CAUTION

This circuit will not function as designed on a boosted return hydraulic power supply.

2.3.2 IHPU131 Tests; The input pressure to the primary side of the IHPU 131 must be limited to 1/3rd of the required output pressure i.e. the ROV operator **must** ensure the correct input pressure is set to the intensifier. The input flow to the primary side of the IHPU 131 must initially be set to zero. Once the IHPU is turned on hydraulically, the input flow to the primary side may be increased to a maximum of 6 gpm.

NOTE

The IHPU 131 is capable of operating pressures up to 9,000 psi. Damage to other components may occur if the input pressure is not verified prior to operation.

CAUTION

When testing the system on deck using a purge cart, pay attention to the return line. Returning oil through a purge cart directional control valve could result in return pressures exceeding manufacturers recommendations with respect to equipment installed. If in doubt, always connect the return line directly to tank. Also, be aware that at higher flow rates, the pressure drop across a directional control valve on the purge cart supply and may result in a lower delivery pressure than required for normal operation. It may be necessary to connect directly to the purge cart pump output to reduce these pressure drop losses.

2.3.3 **Pressure Monitoring Tests;** With the pressure gauge connected at the input to the HP DCV, monitor the pressure build up prior to switching the HP DCV. The desired output pressure of the IHPU 131 should be approximately three times the pressure supplied by the ROV. Once the desired output pressure is reached, the IHPU 131 should stop stroking.

NOTE

The input flow to the intensifier must be limited to a maximum of 6 gpm as the return filter is rated to a maximum of 2 gpm.

CAUTION

Operating IHPU System with contaminated fluids can result in component damage. Ensure that the reservoir fluid is at a cleanliness level of NAS 8 before operating the system. If water contamination occurs, purge the contaminated fluid and replace with fresh fluid.

2.3.4 **Pressure Output at P1 & P2:** Switch the output for the HP DCV from the closed centre position to pressure out at P1. The IHPU 131 should recommence stroking until the desired output pressure is achieved again. Repeat this for output port P2 on the HP DCV. **Note**: Do not drain the reservoir as the pump will suck the elastomer into the suction line.

This completes the hydraulic setup procedures for the IHPU 131.

3.0 SYSTEM MAINTENANCE

System maintenance shall be broken into three sections. Post Dives, Post Operation and General Maintenance.

3.1 Post Dives

After each dive the IHPU system should be washed down with fresh water. The mechanical attachment points and hydraulic interconnects should be inspected for loose fittings and leaks. Should the IHPU not be required for more than 24 hours, the IHPU131 and HP DCV must be flushed internally with an ISO fluid. Storage of water glycol fluids in the reservoir is not recommended for more than 24 hours. The Reservoir should be flushed with fresh water and dried prior to storage.

3.2 Post Operations

Once the hydraulic circuit is no longer required, the circuit should be washed down with fresh water and flushed with an ISO fluid as per section 3.1. The hydraulic interconnects should be flushed and plugged. Each individual component should be capped. Also, the reservoir should be flushed with fresh water similar to Post Dives. The components should then be removed from the ROV and placed in the shipping container supplied for long-term storage.

3.3 General Maintenance

Should there be any noticeable deterioration in the IHPU output pressure for the given input pressure or fluid cross contamination, the IHPU 131 HP End Caps may be removed and the glide rings and HP seals replaced as described below. Should there be any problems with HP Seal End Check Valves, the Check Valves or Housing should be replaced. Once replaced, the IHPU should be tested on standard charge cart with ISO fluids. Should there be any problems with the IHPU131 control circuit, the Manifold Directional Control Valves (DCVs) should be replaced. Note: The IHPU 131 Manifold DCVs are not field

serviceable. They must be returned to the manufacturer for refurbishment/replacement.

Should there be contamination between the control fluid and ISO fluid via the HP Directional Control Valve (HP DCV), the HP DCV should be removed and returned to the manufacturer for overhaul. **Note:** This item is not a field serviceable unit.

3.3.1 HP End Cap Removal. The HP End Cap on either side of the IHPU 131 may be removed in the same manner. First, the Hydraulic Jumpers must be removed, followed by the DCVs. The DCVs are removed by removing the four SHCS on each DCV. The D05 Manifold may then be removed in the same manner, followed by the Main Manifold. Once the IHPU131 has been stripped down to the Primary Cylinder, the nuts on the four tie rods may be removed. The HP End Caps may then be removed, exposing the Piston Rod and HP Seal End complete with Seals

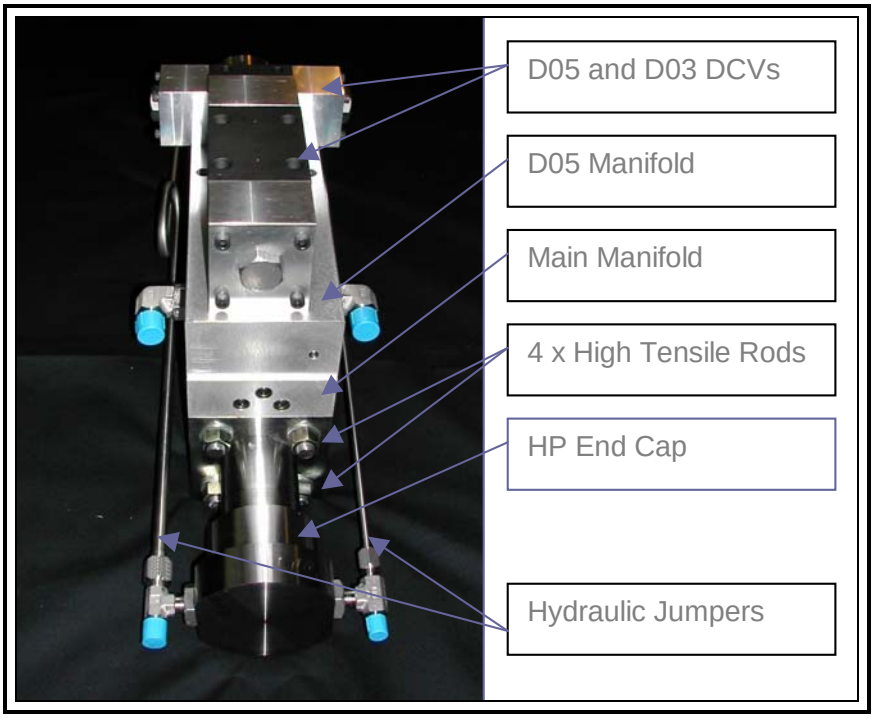


Fig 3.3.1 HP End Caps

3.3.2 Piston Removal. The piston should then be removed from the remaining HP End Cap and Cylinder, exposing the other HP Seal End. At this stage, the piston centre section is exposed showing the machined flats between the two halves of the primary drive piston.

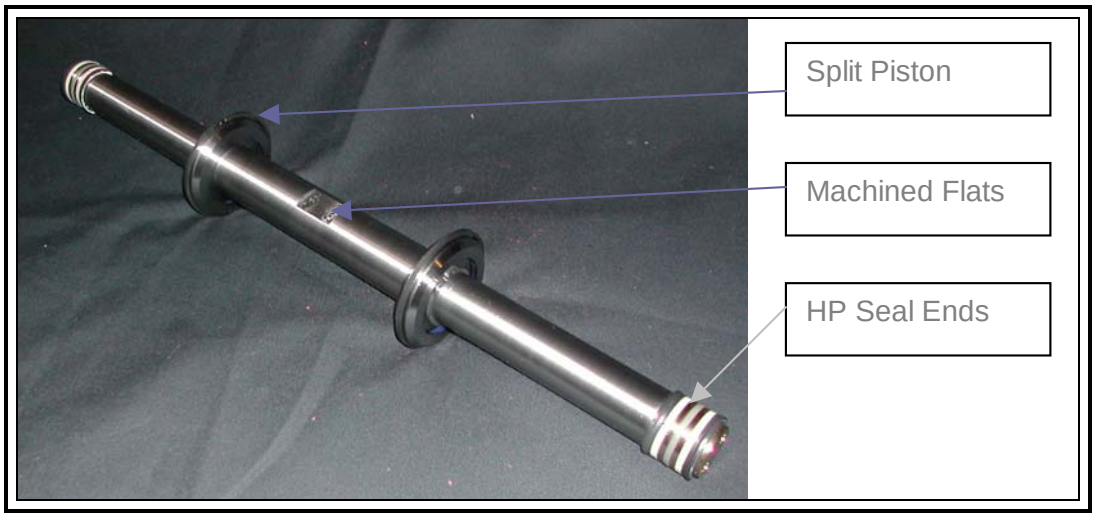


Fig 3.3.2 Piston

3.3.3 HP Seal End Removal. The HP Seal End may be removed by placing a spanner wrench in the two holes at the ends of the HP Seal End, placing an adjustable wrench on the Piston Rod flats and unscrewing the HP Seal Ends (should Loctite Temporary Threadlock have been used during installation, it may be necessary to heat the Piston Rod at the HP Seal End to soften the Threadlock). Once removed, the Turcon Variseal Suction Seals may be removed. The Glide Ring should be inspected and replaced only if noticeable wear or damage has occurred (the primary sealing is achieved by Variseals only). The Pressure Seal at the end of the HP Seal End may need to be removed with the aid of an O-Ring Pick. NOTE: Care must be taken not to damage the seal beds as the surface finish is essential for the seal to hold pressure. Replace seals as necessary.

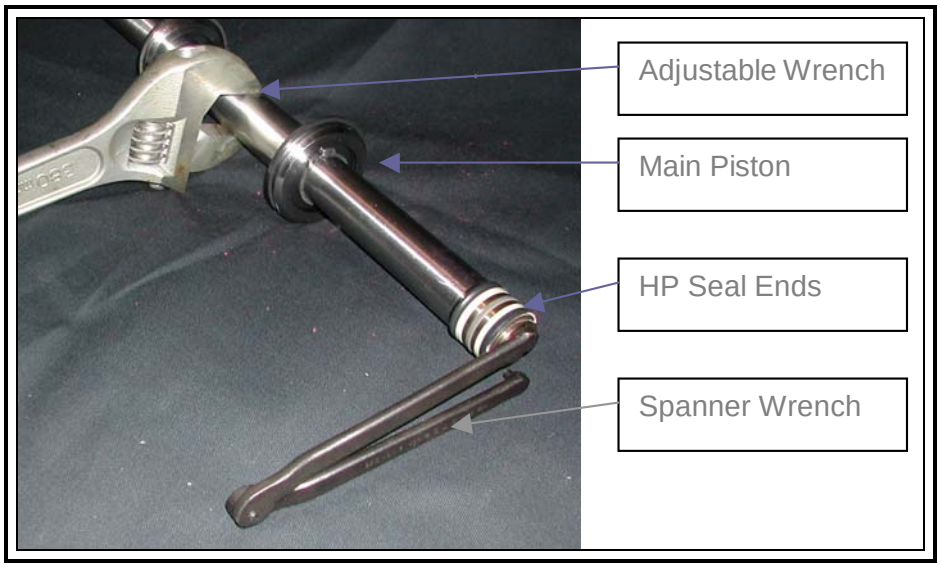


Fig 3.3.3 HP Seal End

3.3.4 Glide Ring Installation. The Glide rings are installed with the O-Ring first onto the seal bed, followed by the Glide Ring. The Glide Ring is then installed with the use of the Seal Loading Mandrel. The Mandrel is placed over the end of the HP Seal End and the Glide Ring is slid up the Mandrel with the Seal Pusher Tool. NOTE: if the Glide Ring is too stiff, the Glide Ring may be softened by placing it in hot water for a few minutes.

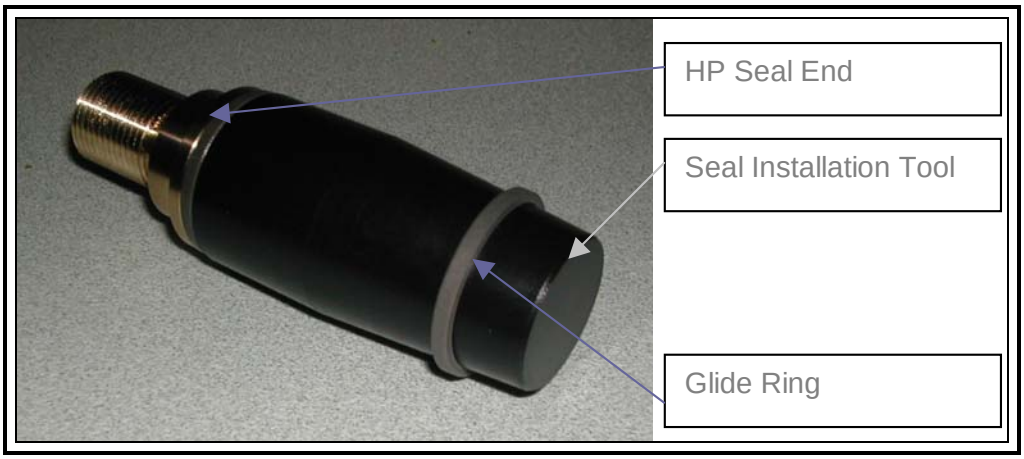


Fig 3.3.4 Glide Ring Installation

3.3.5 Glide Ring Re-Sizing. Once the Glide Ring has been installed, the Glide Ring will need to be re-sized with the Re-Sizing Tool. The Glide Ring must be coated with a light coating of Oil or Grease and the Re-Sizing Tool brought over the top of the Glide Ring, forcing the Glide Ring to compress into its original shape

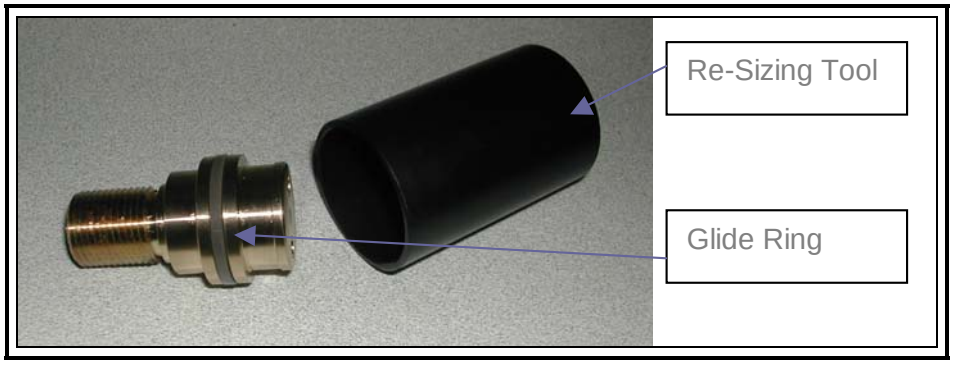


Fig 3.3.5 Glide Ring Re-Sizing

3.3.6 HP Seal Installation. Both the suction and Compression Variseals may be installed by hand with the use of a light coating of Oil or Grease. Once installed, the HP Seal Ends may be installed onto the Piston Rods (Loctite Temporary Threadlock should be used during installation).

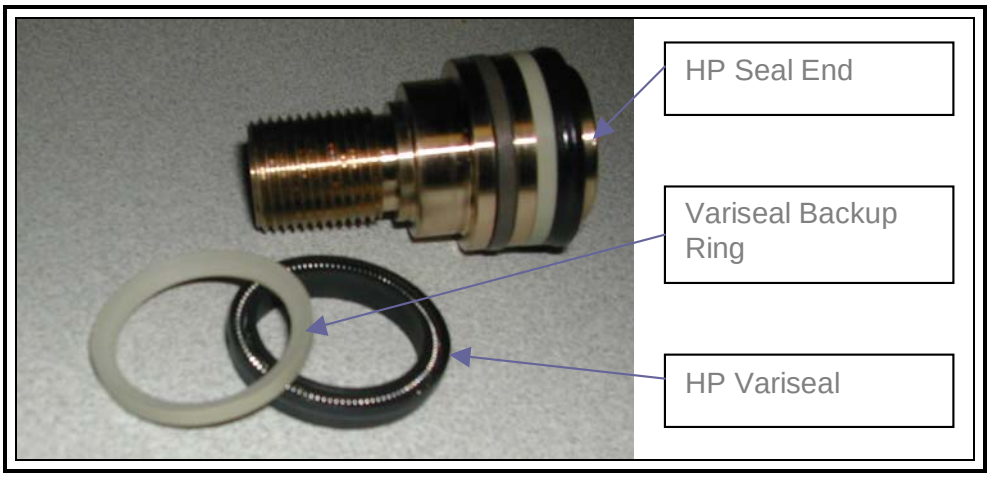
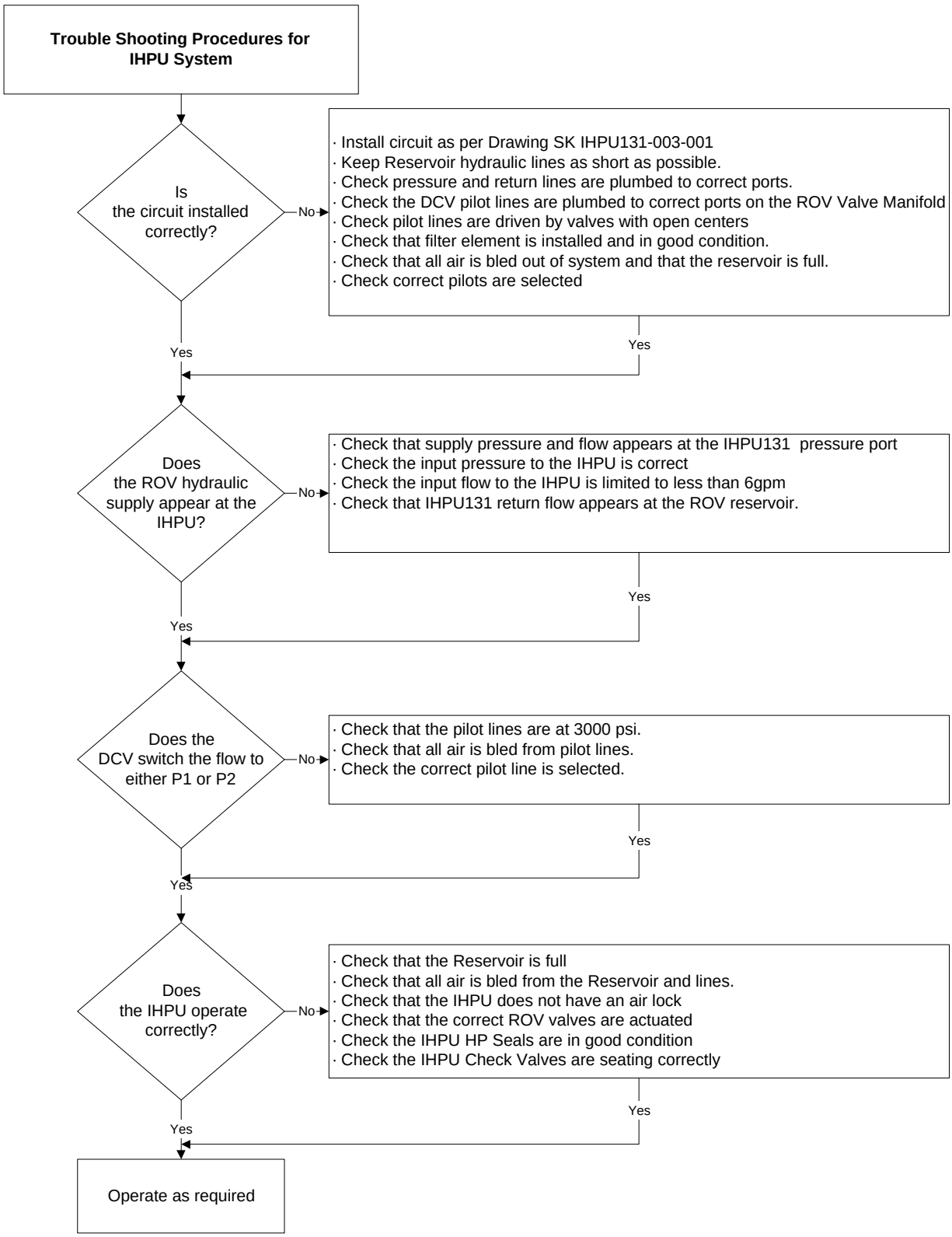


Fig 3.3.6 HPP Variseals

3.3.7 HP End Cap Assembly. Once the seals have been installed, the piston may be installed into the cylinder and the HP End Caps installed in the reverse sequence as described in the above**. NOTE: Care must be exercised not to damage the compression seal when installing the HP End Caps. The Variseal may sometimes fold over when passing through the lead into the HP End Cap.**

4.0 TROUBLE SHOOTING



APPENDIX A - Drawings

SK IHPU131-003-001	IHPU HYDRAULIC SCHEMATIC
SK IHPU131-003-002	IHPU FITTINGS SCHEMATIC
I-HPU131 BOM-C	I-HPU131 Bill of Materials
SK IHPU131-003-005	IHPU 131 SEAL LOADING MANDREL
SK IHPU131-003-006	IHPU 131 SEAL PUSHER TOOL
SK IHPU131-003-007	IHPU 131 SEAL RE-SIZING TOOL
SK IHPU131-003-009	IHPU 131 JUMPER TUBING

APPENDIX B - Vendors Information

APPENDIX C - Performance Curves