W.O. 8387

LINEAR CHAIN JACK
MOORING SYSTEM

INSTALLATION, OPERATIONS
AND MAINTENANCE MANUAL
FOR THE
JACK BATES MOORING SYSTEM UPGRADE

PREPARED FOR
TRANSOCEAN OFFSHORE DEEPWATER DRILLING, INC.

P.O. No. P973587

BARDEX CORPORATION
6300 LINDMAR DRIVE
GOLETA, CA 93117
U.S.A.

09 FEBRUARY, 2007
NOTE 1

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NOTE 2

FAILURE TO INSTALL, OPERATE, OR MAINTAIN THE SYSTEM IN ACCORDANCE WITH THIS TECHNICAL MANUAL MAY INVALIDATE THE WARRANTY.

NOTE 3

FOLLOW ALL ESTABLISHED SAFETY PRECAUTIONS AND REGULATIONS AT ALL TIMES.

NOTE 4

The system shall be operated and maintained by trained personnel only. Bardex Corporation may be contacted with questions, requests for information, or for spare or replacement part orders at:

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1.0 INTRODUCTION

This manual contains installation, operations, and maintenance information for the Bardex Linear Chain Jack Mooring System Upgrade to be used on the Jack Bates Vessel. Proper operation and maintenance procedures are essential to the continued safe and reliable performance of the equipment. It is extremely important that all supervisors and operators are properly trained and familiar with the procedures and instructions contained in this manual. If questions arise regarding any aspect of this document or the equipment, contact Bardex Corporation.

1.1 SYSTEM DESCRIPTION

The vessel is installed in the Gulf of Mexico and will have additional mooring system capacity by means of four (4) taut leg anchor lines. The anchor lines are pulled in, tensioned, and held by the Bardex Chain Jack Mooring System consisting of four (4) Linear Chain Jack and Turndown Sheave sets with associated Control Consoles and Hydraulic Power Units. Each Control Console station allows manual operation of the Chain Jack hydraulics and provides the operator with both hydraulic pressure monitoring and chain tension readout. Each Chain Jack is powered by a dedicated Hydraulic Power Unit.

Mooring Chain Size: 3-9/16 inch RQ3S Stud link Anchor Chain with a breaking strength of 1685 kips
The mooring chain travels through the lower hull fairlead (provided by others) then up along the hull to the Chain Jack Assembly and associated mooring line equipment. Each mooring station consists of one Bardex Linear Chain Jack, with integral chain stopper, and one Chain Turndown Sheave. The chain passes through the Chain Jack and over the Turndown Sheave into the chain hawse pipe. Each Chain Jack Assembly provides the force required to “HAUL IN” or “PAY OUT” the mooring chain. The integral chain stopper mechanically holds the chain during idle periods of operation. When moored, the chain rests on the stopper assembly.

The chain jacks are arranged in four (4) groups with each group containing one (1) Chain Jack. The entire system consists of the following equipment and components:

1.2 SCOPE OF SUPPLY

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<tr>
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<th>QTY</th>
<th>DESCRIPTION</th>
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<tr>
<td>1.</td>
<td>4</td>
<td>Linear Chain Jack Assemblies - 550 kips stall capacity /600 kips mechanical hold capacity on the Traveling Latch Assembly, Integral 1685 kip capacity Chain Stopper, Two Lift Cylinders, and one shared Load Holding Valve Assembly.</td>
</tr>
<tr>
<td>2.</td>
<td>4</td>
<td>Control Console Assemblies – Control Valve Manifold Assembly with Manual Capability, Load Indicating Pressure Gauge for Load Monitoring when chain is being held by lift cylinders; Redundant electrical Instrumentation for Load Monitoring (with digital serial link output) when chain is resting on the fixed stopper.</td>
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<tr>
<td>ITEM</td>
<td>QTY</td>
<td>DESCRIPTION</td>
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<tr>
<td>3.</td>
<td>4</td>
<td>Turndown Sheave Assemblies - Complete with Chain Wheels sized for 3-9/16 inch diameter Mooring Chain, Deck Mounting Structure, Temporary Sheave Anti-rotation Pins and one set of removable inserts for 1-1/2 inch maximum messenger wire rope.</td>
</tr>
<tr>
<td>4.</td>
<td>4</td>
<td>Hydraulic Power Unit Assembly - Complete with Dual 60 HP TEFC Electric Motors and dual 18 GPM Variable Displacement Piston Pumps (total 36 GPM), 7.5 HP TEFC Electric Motor for heat exchanger fan, HPU Electrical Control Enclosure, Interconnecting Supply &amp; Return Interface for Chain Jack/Control Console</td>
</tr>
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1.3 LINEAR CHAIN JACK ASSEMBLY

Refer to drawings DWG-102118-Chain Jack Assembly-3-9/16", DWG-102122-Fixed Crossarm Assembly & DWG-102140-Traveling Crossarm Assembly

The major components of the Linear Chain Jack Assembly are: two (2) double acting hydraulic tension cylinders, a traveling lower crossarm with synchronous acting latch system and a fixed upper crossarm with integral, synchronous chain stopper latches.
Each Bardex Chain Jack can “HAUL IN” or “PAY OUT” the mooring chain in a series of coordinated operations of latching, jacking, and unlatching. The latches do not rely on friction to hold the load. Latching devices contact the bottom surface of the chain link to support the load by cradling it in a pocket on both sides of the latch or stopper.

The Chain Stopper (fixed latches) is located on the fixed upper crossarm and holds the chain between power strokes. The traveling latches are located on the lower crossarm which is attached to the lift cylinder rod ends.

Both latch sets are hydraulically actuated and are mechanically interlocked. Transfer of the load onto the latches is made only after the latches are engaged. Once the latches are loaded there is not sufficient hydraulic pressure available to inadvertently disengage them. Each latch mechanism is designed to be self-locking during normal operation. This prevents inadvertent latch disengagement resulting from hydraulic failure or operator error.

Latches are manufactured from high strength alloy steel having a surface hardness that is less than the chain surface hardness. The Chain Jack is designed to jack on and pass the 3-9/16 inch Mooring Chain and appropriate sized Kenter and Pear links.

The chain links may be fed into the chain jack crossarm(s) in either orientation during installation.
1.4 TURNDOWN SHEAVE

Refer to DWG-102106-Chain Sheave Assembly

After the chain is pulled in by the chain jack, it passes over a turndown sheave and into a chain hawse pipe. The turndown sheave is designed to allow the common studlink and Kenter and Pear connecting links to pass over it in either orientation.

1.5 CONTROL CONSOLE

Refer to DWG-102181-Control Console Assembly

The Control Console assembly includes manually operated hydraulic control valves, a load indicating pressure gauge and an electrical enclosure with instrumentation for load monitoring.

1.6 HYDRAULIC POWER UNIT ASSEMBLY

Refer to DWG-102194-Hydraulic Power Unit Assembly

The hydraulic system has been designed with one dedicated hydraulic power unit operating each Chain Jack at approximately 3.1 ft/min haul in or 2.5 ft/min pay out for a load of up to 275 kips. This speed is based on use of a dual motor/pump arrangement; half speed is obtained if one motor/pump is not running. Load capacity is unaffected by the number of pumps running.
Component arrangement has been kept as simple as possible to minimize the total number of components and to assure maximum reliability. Pumps and valves are mounted outside the tank (reservoir) for easy access in the event of the need for service or maintenance.

The reservoir is fabricated from painted stainless steel and contains internal baffles to facilitate heat dissipation and prevent oil starvation at pump inlet due to vessel motion. The reservoir is mounted above the pump(s) to maximize pump suction head extending pump life. Access to the reservoir interior for cleaning is from the side through a removable cover.

1.7 MOORING CONTROL SYSTEM SUMMARY

Bardex’s Mooring Control System conforms to all requirements for reliable performance and operation in the offshore marine environment.

Each Chain Jack Assembly must be manually operated from the hydraulic control console panel. The operator shifts levers to actuate each step of the jacking sequence.

Refer to the Operations Section of this manual for a detailed description of the jacking sequence.

Redundant compression load cells are provided in the Chain Jack fixed crossarm plate under opposing stopper latches. The load cells are connected to the control console digital display to indicate the average chain tension in kips. The reading is only accurate when the chain is resting on the fixed stopper latches.
2.0 INSTALLATION

The following section outlines the recommended steps to be performed to properly install the equipment on the vessel.

2.1 HYDRAULIC POWER UNIT (HPU)

2.1.1 Disassembly of Shipping Crate

The HPU shipping arrangement was configured for fork lifting only. Removal of the top wooden sheets will allow access to the four lift eyes located within the frame corners, as required for crane lifting.

1. Prior to removing the wooden skid base steel bands, position the HPU in a location that can be accessed by a crane with the required lift capacity.

2. Remove the steel bands to separate the skid from the HPU frame. Leave all other packing in place to protect gauges and panels during installation.

3. Connect a lift sling to each of the four lift points located on the frame. The sling length should be selected so that the sling angle does not exceed 30 degrees from the vertical axis.

4. Refer to TB-2013 “Instructions for Lifting and Transportation of Bardex Equipment”
2.1.2 Hydraulic Power Unit Flushing for Pre-commissioning

During the pre-commissioning phase, verify that all hoses to be connected to the HPU have been cleaned and flushed per Bardex PS-1008.

CAUTION: FAILURE TO PROPERLY FLUSH THE SYSTEM PRIOR TO INTERCONNECTION MAY RESULT IN COMPONENT MALFUNCTION.
2.1.3 Hydraulic Fluid Selection

Bardex has approved the use of Chevron Clarity ISO AW 46 mineral based hydraulic fluid for use in this system. All hydraulic components were factory tested using this fluid and will contain some residual oil. If another fluid is selected, the user must verify compatibility with Chevron Clarity prior to use. Refer to TB-2018, Hydraulic Fluid and Maintenance Guidelines, for important information regarding hydraulic fluid selection. In the event that the fluid selected is an Environmentally Evaluated fluid, note that strict guidelines may be required for the production, installation, and maintenance of this different fluid type. These guidelines are not within the scope of this manual and must be obtained from the fluid supplier.

IMPORTANT: BARDEX SHOULD BE CONTACTED PRIOR TO USE OF ANY ENVIRONMENTALLY EVALUATED VEGETABLE BASE FLUID OR ENVIRONMENTALLY ACCEPTED (EA) SYNTHETIC ESTER FLUID IN THIS SYSTEM.

All Chain Jack Assemblies, latch cylinders, and HPU pump cases were drained prior to shipping; however, some residual mineral based ISO AW 46 grade hydraulic fluid may remain. If this fluid is not compatible with the chosen fluid for the system, it must be drained and disposed of properly. Refer to Section 3.2 for procedures on draining the hydraulic fluid from system components if Chevron Clarity AW 46 is not used.
CAUTION: SPECIAL COLD WEATHER STARTING PRE-
CAUTIONS ARE NECESSARY WHEN THE AMBIENT 
TEMPERATURE IS LESS THAN 5º CELSIUS (41º 
FAHRENHEIT). REFER TO TB-2018 IN THE APPENDIX.

After draining hydraulic fluid, fill with the proper fluid prior to 
operation in accordance with Section 3.2.

2.1.4 HPU Electrical Installation

Refer to Hydraulic Power Unit Assembly, DWG-102194, and 
Electrical Schematic, DWG-102180, for proper connection of cables 
and wiring to the HPU electrical enclosure.

CAUTION: CORRECT MOTOR ROTATION MUST BE 
CONFIRMED PRIOR TO INITIAL START-UP OF THE HPU. BE 
sURE INLET SUCTION VALVES ARE OPEN AND THE 
HYDRAULIC PUMPS ARE PRIMED FOR START-UP PRIOR TO 
“JOG STARTING” OR “JOGGING” THE MOTORS TO CHECK 
ROTATION. PROPER ROTATION IS INDICATED VIA AN 
ARROW ON THE PUMP HOUSING.

2.2 CHAIN JACK AND CONTROL CONSOLE ASSEMBLY INSTALLATION

Refer to drawing DWG-102159-Mooring System Interface-3-9/16”
Each Chain Jack Assembly and Turndown Sheave is installed on a Chain 
Jack Foundation plate, which is structurally integral to the hull. Refer to 
the Mooring System Interface Drawing, DWG-102159 to obtain the 
foundation geometry and loading requirements.
2.2.1 Preparation for Chain Jack Installation

1. Remove the steel bands and the bolts to the wooden support beam attaching the chain jack to the shipping skid.

2. Protect the exposed lift cylinder rod surface from mechanical damage during handling by wrapping with heavy rubber or other suitable material. A split piece of large diameter low pressure hydraulic hose secured with duct tape or tie wraps is suggested. Note: the chain jacks were shipped with the cylinders fully retracted.

2.2.2 Chain Jack Installation

1. The hull foundation plate must be flat under the Chain Jack. If it is not, a chocking compound may be used to ensure that the Chain Jack is evenly supported. All mounting holes should be pre-drilled. The hull foundation mounting surface must be checked for proper interface using the Bardex supplied interface template (Part number DWG-102208-4) prior to installing the Chain Jack and/or Turndown Sheave.

2. Lift the Chain Jack off of the shipping base using the appropriate lifting eyes. Refer to TB-2013 as required.
CAUTION: THE CYLINDER RODS MAY EXTEND DUE TO GRAVITY IF THE CHAIN JACK BECOMES PARTIALLY VERTICAL WITH THE ROD END DOWN. BE SURE SUFFICIENT RESTRAINT IS IN PLACE ACROSS THE TWO CROSSARMS TO PREVENT INADVERTENT EXTENSION OF THE LIFT CYLINDER RODS. RESTRAINTS SHOULD BE LOCATED NEAR THE RODS OR ON THE OUTBOARD EDGE OF THE CHAIN JACK TO PREVENT INTERFERENCE WITH THE FOUNDATION STRUCTURE.

CAUTION: ALWAYS USE AT LEAST TWO EYES FOR LIFTING.

3. The Chain Jack is designed to be installed as one unit. However, if the lower crossarm must be removed for installation, the Chain Jack must be in the vertical position prior to removal (disassembly). Refer to Section 6.2.1.

4. Position the Chain Jack near the foundation as shown on the Mooring System DWG-102158. Insure the bearing pads, item 16 on the Traveling Crossarm Assembly (DWG-102140) enter the guide tracks. Lower the Chain Jack until the contact surfaces on the underside of the Fixed Crossarm are flush with the foundation base.

5. Lubricate then install the Chain Jack Assembly mounting bolts (by others) and hand tighten.

6. Torque the bolts to 25% of the recommended value as specified on DWG-102158.
NOTE: BARDEX RECOMMENDS THAT ALL MOUNTING HARDWARE BE COATED WITH A RUST PREVENTATIVE LUBRICANT OR AN APPROPRIATE THREAD SEALER/LOCKER SUCH AS LOCTITE # 242 OR EQUIVALENT.

7. Re-install the traveling crossarm to the Chain Jack (if disassembled). See Section 6.2.1 if necessary.

8. With the Chain Jack traveling cross arm completely retracted the following fit and alignment checks should be performed:

A. Fixed cross arm support contact surface is flat and fully supported on the foundation structure.

B. Side load bearing pads should be centered in the guide tracks.

C. Chain cutout on the Chain Jack fixed cross arm is clear of the support structure below.

D. Chain Jack centerline should be in line with the chain hawse pipe and fairlead below.

E. Tighten all mounting hardware. Torque mounting bolts per DWG-102158 with Loctite 242 (or equivalent) applied to the bolt threads.
F. Ensure there are no interferences when the Chain Jack Traveling Crossarm is lowered (cylinders extended).

If the system hydraulic fluid is not compatible with Chevron Clarity petroleum based AW 46 grade fluid, refer to Section 3.2 Commissioning, to remove the existing residual hydraulic fluid left in the System from Factory Testing.

2.2.3 Control Console Mounting and Interconnection to Chain Jack and Hydraulic Power Unit.

Refer to Mooring System 3-9/16” DWG-102158, and Hydraulic Schematic DWG-102186.

Locate the Control Console near the Chain Jack to enable the operator full view of the Chain Jack fixed stopper and traveling latches. Secure the console to the deck via bolting or welding. Route hydraulic piping/hose connections to and from the HPU and Chain Jack Manifold. Ensure that all piping/hose runs have been flushed. Double check that all connections have been made per the hydraulic schematic and that they are tight. Figure 1 shows labeling for the Control Console Interfaces, less the large HPU supply and return 4-bolt flange connections. These are located on the opposite side of the console (right hand side as viewed from the operator's position).
2.2.4 Chain Jack Load Monitoring

Route the Load Cell cables (2 each) from the Chain Jack fixed cross arm to the Control Console Electrical Enclosure. Secure the cables with clamps or wire ties as required to keep these out of high traffic areas.
Holes must be drilled in the bottom of the enclosure for the selected gland size(s) for the load cell cables (2X .88 inch diameter cable), input power and load cell serial communication uplink (by others). Use caution in drilling the holes for these glands such that interior components are not damaged. The enclosure door can be opened to assess available space. Be sure and close the door when finished to keep the electronics dry. A desiccant is supplied inside each enclosure and should be replaced on a yearly basis or sooner if any signs of moisture intrusion are seen.

Refer to the Electrical Schematic-Mooring System DWG-102180 for wiring diagram and details.

2.3 Turndown Chain Sheave Installation

Refer to DWG-102159 (Mooring System Interface), DWG-102158 (Mooring System, 3-9/16") and DWG-102106 (Chain Sheave Assembly).

**NOTE: VERIFY PROPER FOUNDATION INTERFACE USING THE FOUNDATION TEMPLATE (DWG-102208-4) PRIOR TO TURNDOWN SHEAVE INSTALLATION.**

1. Make sure the foundation is prepared to receive the Chain Sheave Assembly. See DWG-102159 for interface information.

2. Disassemble the shipping skid and remove the steel bands and protective covers.

3. Lift the Chain Sheave Assembly using the lifting eyes located on the frame.
CAUTION: ALWAYS USE AT LEAST TWO EYES FOR LIFTING.

4. Position the Chain Sheave Assembly over the foundation, then using the mounting bolt holes, align it onto the foundation. Install fasteners as detailed on DWG-102158.

5. Tighten the fasteners until the Sheave base is flush with the foundation. Torque the bolts per DWG-102158 when lubricated with Loctite 242 (or equivalent).
3.0 COMMISSIONING

3.1 Equipment Inspection and Setup

This section defines the steps to be performed after initial installation. This section presumes that no physical damage has occurred during transportation.

3.1.1 Mechanical Equipment

1. Visually inspect all Chain Jacks for mechanical damage or the presence of debris. Replace or repair any components that are damaged.

2. Check the hydraulic circuit for external damage. Hydraulic hoses should be replaced if the wire braids are visible.

3. Remove all temporary supports used for transport or sea fastening of the Chain Jacks and/or Control Consoles including any mechanical covers and hose tie down straps that may have been installed for transportation.

4. Verify that all fasteners remain intact and are in good condition. Re-torque any fastener that may have loosened during transport per DWG-102158.

5. Ensure that all rig piping/tubing has been flushed and pressure tested.
6. Ensure that all interconnecting hydraulic fittings and flange bolts are properly tightened.

3.2 Hydraulic Fluid Filling and Draining / Air Purging

Refer to drawings DWG-102194 (HPU), DWG-102181 (Control Console Assembly) and DWG-102188 (Chain Jack Piping & Electrical).

3.2.1 Draining the System

NOTE: THIS STEP IS NOT REQUIRED DURING INITIAL START-UP UNLESS TANK BECOMES CONTAMINATED DURING TRANSPORT OR A FLUID IS BEING USED THAT IS INCOMPATIBLE WITH THE FLUID USED IN THE FACTORY TESTING. REFER TO SECTION 2.1.3 IF A DIFFERENT HYDRAULIC FLUID IS PROPOSED.

The following procedure defines the steps necessary to drain the system of fluid for replacement. It presumes that the complete system, including piping, has been filled and that the vessel is in its normal (floating) orientation.

NOTE: ALWAYS TAKE PRECAUTIONS TO CAPTURE AS MUCH FLUID AS POSSIBLE TO MINIMIZE ENVIRONMENTAL CONTAMINATION. NEVER RE-USE DRAINED, USED, OR UNKNOWN FLUID IN THE HYDRAULIC SYSTEM.

1. Drain the fluid in the reservoir using the drain fitting provided.
2. Remove the reservoir cover and use a scraper attached to a rod to scrape oil in the bottom of the reservoir over to the drain hole. Replace cover when finished.

**CAUTION: BE CAREFUL NOT TO INTRODUCE CONTAMINANTS INTO THE RESERVOIR WHEN REMOVING FLUID.**

3. Remove and replace the return and pressure filter elements.

4. At the HPU, disconnect the pump hoses at the lower end in order to drain. Drain the fluid from the pump by removing the lowest drain plug from the case. Be sure that the suction line ball valves are open. Select a fitting that is as low as possible to maximize the amount of fluid which is drained.

5. Try to locate areas in the equipment and piping where fluid may be trapped (i.e., a low point in the piping). These low areas may need to be separately drained. Use dry and filtered compressed air, with maximum pressure of 150 psi, if necessary to force oil down the tubing to remove as much oil as possible.

6. Reconnect all hoses and fittings at the HPU.
7. Drain all fluid from the interconnecting piping/hoses between the power unit and the chain jack by connecting compressed air to one end (dry and filtered) while holding the other end into a suitable container to catch the escaping fluid. An alternate method for hoses is to use gravity by hanging one end into a suitable container from a sufficient height and crack open the fitting until the fluid escapes. Note that the high end must be open to drain the hose properly.

8. Disconnect the supply tubing to the cylinder blind end at the Manifold Assembly on the chain jack (open the extend port fitting). Catch the fluid as it escapes from the manifold extend fitting in the drip pan provided. Drain the drip pan as necessary during the draining sequence.

NOTE: THERE ARE APPROXIMATELY 20 GALLONS OF FLUID IN THE LIFT CYLINDERS (10 GALLONS EACH). THE FLUID SHOULD BE DRAINED INTO A SUITABLE CONTAINER. CAUTION SHOULD BE OBSERVED WHEN DRAINING CYLINDERS. BEGIN BY CRACKING THE FITTING(S) AND LETTING THE FLUID DRAIN SLOWLY.

NOTE: IF THE TRAVELING CROSS ARM IS NOT PHYSICALLY RESTRAINED IT WILL EXTEND AS FLUID IS DRAINED. DO NOT OPEN FITTINGS ALL THE WAY OR FLUID WILL BE EXPELLED IN AN UNCONTROLLED MANNER.
9. Drain fluid from the Chain Jack lift cylinders at each Chain Jack by disconnecting the load indicating gauge tube fitting at the Chain Jack and/or per the next step.

10. Disconnect the Extend and Retract connections to the Control Console Assembly at the Interface Panel. Catch the fluid as it escapes from the tubing in the drip pan provided. Drain the drip pan.

11. Disconnect the fixed latch cylinder from the assembly with the hoses still connected. Lower the cylinder assembly to a position as low as possible. Disconnect the hose connections at the cylinder and allow it to drain into a suitable container.

12. Disconnect the traveling latch cylinder from the assembly with the hoses still connected. Lower the cylinder assembly to a position as low as possible. Disconnect the hose connections at the cylinder and allow it to drain into a suitable container.

13. Extend and retract latch cylinders by hand to push any fluid out that may remain inside.

14. Reconnect all hoses and fittings and reassemble to insure no contaminants are introduced or damage is incurred.

3.2.2 Filling the System
CAUTION: ALWAYS FILL THE SYSTEM WITH CLEAN PRE-FILTERED OIL THAT MEETS ISO 18/16/13 (NAS CLASS 7) FLUID CLEANLINESS REQUIREMENTS. REFER TO PS-1008 AND TB-2018 IN THE APPENDIX FOR MORE INFORMATION. WHEN FILLING THE SYSTEM ALWAYS FILTER THE NEW OIL THROUGH A 3 TO 5 MICRON FILTER AS IT IS ADDED TO THE RESERVOIR. NOTE THAT NEW OIL USUALLY DOES NOT MEET CLEANLINESS REQUIREMENTS.

1. Verify that all ports are connected and the Reservoir drain valve is closed. (Ref: DWG-102194)

2. Fill the reservoir with oil using a fill system which has an inline 5 micron absolute filter. The reservoir is filled using a hose connected to the tank breather port on top of the reservoir or the return port (Refer to DWG-102194). Filling the tank through the return line port routes the new oil through the return filter. The quantity of oil required for the system is approximately:

NOTE: ENSURE THAT HPU RETURN LINE IS CONNECTED TO THE CONTROL CONSOLE AND FITTINGS ARE TIGHTENED AS IT WILL FILL UP AT THE SAME TIME THE RESERVOIR DOES.
ITEM	QUANTITY (GALLONS)
Reservoir	120
Chain Jack (with cylinders retracted)	20
Misc.	5
TOTAL	145

3. Fill the HPU pump cases with the new system fluid by removing the pump case fill plugs and filling with clean, pre-filtered fluid. The pump cases may fill due to gravity. Check that these are filled by disconnecting the case drain hoses and observing oil.

CAUTION: FAILURE TO FILL THE PUMP CASE(S) WITH FLUID PRIOR TO OPERATION MAY RESULT IN SERIOUS PUMP DAMAGE AND/OR FAILURE.

4. Open the pump suction line ball valves (DWG-102194)

CAUTION: FAILURE TO OPEN THE PUMP SUCTION LINE BALL VALVES MAY RESULT IN SERIOUS PUMP DAMAGE AND/OR FAILURE. IT IS RECOMMENDED THAT THESE VALVES BE TAGGED AS “KEEP OPEN EXCEPT FOR SERVICE” DURING NORMAL OPERATIONS.
5. If not previously done, perform electrical checks per Section 3.4.

6. Jog start the pump motor and verify direction of rotation (marked on motor frame).

NOTE: TRY TO FILL SYSTEM WITH FLUID AS COMPLETELY AS POSSIBLE WITHOUT USING THE HPU PUMPS. ALLOW AIR TO EXIT THROUGH OPEN HOSES OR PORTS AND NOT BE RETURNED TO THE RESERVOIR IF THE PUMPS ARE RUNNING.

WARNING: WHEN THE HPU IS BEING USED TO FILL THE SYSTEM, THE FLUID LEVEL IN THE TANK WILL DROP. THE FLUID MAY ALSO BECOME FOAMY, INDICATING ENTRAINED AIR IN THE FLUID. DO NOT RUN THE PUMP USING FOAMY FLUID OR FLUID WITH EXCESSIVE AIR ENTRAINMENT.

CAUTION: PUMP OPERATION WITH AN AIR/FLUID MIXTURE WILL CAUSE PUMP CAVITATION AND POSSIBLE PUMP FAILURE. STOP MOTOR AND ALLOW TIME FOR AIR TO SEPARATE FROM FLUID BEFORE RESTARTING.

7. Continue to start and stop the HPU pumps until all air is purged out of the lines.
8. Arrange two containers (5 gallon buckets) and a package of absorbent pads near the chain jack to be commissioned to catch excess hydraulic fluid in case of a leak during air purging.

9. Slowly shift Ball Valve BV3 from “UNLOAD” to “LOAD”. This will shift the flow of oil to the chain jack and control console. It is recommended that the valve be opened (shifted to “UNLOAD” when starting or stopping the pump motors and while idling, i.e. not jacking chain)

10. With the power unit set at low pressure, cycle both the fixed latches (Stoppers) and traveling latches at least 10 times. Add fluid to the reservoir if necessary.

CAUTION: DO NOT APPLY MORE THAN 500 PSI PRESSURE FOR THIS AIR PURGING PHASE.

CAUTION: PUMP OPERATION WITH AN AIR/FLUID MIXTURE WILL CAUSE PUMP CAVITATION AND POSSIBLE PUMP FAILURE. STOP MOTOR AND ALLOW TIME FOR AIR TO SEPARATE FROM FLUID BEFORE RESTARTING.

11. Refill the reservoir with fluid as required. Increase the pump pressure compensator(s) to 1000 psi. Check the piping for any leaks.

12. Shift Chain Jack Control Console directional control valve to "CYL RAISE", continue to hold the valve handle until the chain jack is fully retracted.
13. Shift Chain Jack Control Console directional control valve to "CYL LOWER". Extend the cylinders completely. Next shift the DCV to “CYL RAISE”. The Chain Jack will retract and entrapped air will then be discharged through return piping. Extend and Retract the Chain Jack cylinders as necessary to work the air out of the system at least 10 times. Because of the fluid regenerative circuit within the manifold, the fluid is only returned to tank (and heat exchanger) during retract.

14. Check the reservoir level gauge for foaming, which indicates the presence of air. If foaming or cavitation of the pump(s) occurs, stop motor(s) and allow time for air to separate from oil (no foaming present).

15. Repeat Steps 6 thru 13 for all HPU and Chain Jack Assemblies.

16. Cycle the cylinder raise / lower directional control valves a minimum of ten (10) times to purge all air out of the lines. Operate the lift cylinder valve in both directions to full extend and retract until no air is present.

17. Gradually increase the HPU pressure compensator to its normal set point (turn clockwise until reaching 4900 psi on the HPU pressure gauge, with the bypass valve in the closed “LOAD” position) and continue to extend and retract the cylinders. Check for leaks at every 1000 psi interval. Refer to section 6.6 for detailed instructions on pressure control adjustments.
18. Manually operate the Chain Jack raise/lower and latch circuits again to verify smooth operation. The Load Indication Pressure Gauge on the Control Console should build to 4900 PSI when the lift cylinders are fully retracted.

NOTE: THE LOAD INDICATION GAUGE READS HYDRAULIC PRESSURE SO THE LOAD INDICATED WILL ONLY BE VALID WHEN THE CHAIN JACK IS NOT FULLY EXTENDED (HELD MECHANICALLY) OR FULLY RETRACTED (AT FULL OPERATING PRESSURE). THE MOST ACCURATE LOAD READING WILL BE WHEN THE JACK IS MID STROKE, HOLDING THE CHAIN AND NOT MOVING. WHEN THE JACK IS MOVING, THERE ARE HYDRAULIC DYNAMICS SLIGHTLY AFFECTING THE PRESSURE.
3.3 Recommended Procedures for Chain Installation

IMPORTANT NOTE: BARDEX RECOMMENDS USING TWO (2) CHAIN JACK OPERATORS FOR ALL CHAIN JACKING AND INSTALLATION PROCEDURES. ONE OPERATOR SHALL OPERATE THE CONTROL CONSOLE AND THE OTHER MUST WATCH THE CHAIN JACK OPERATION TO ENSURE BOTH LATCHES ARE CLOSED WHEN LIFTING OR HOLDING THE CHAIN.

IMPORTANT NOTE: THE MOORING CHAIN MUST ENTER THE CHAIN JACK IN THE SAME ORIENTATION AS IT EXITS THE FAIRLEAD. ONCE THE CHAIN ENTERS THE CHAIN JACK IT IS IMPOSSIBLE TO TWIST OR ROTATE.

IMPORTANT NOTE: EXCEPT FOR ELECTRICAL POWER TO OPERATE THE HPU MAIN AND HEAT EXCHANGER MOTORS, NO OTHER ELECTRICAL POWER OR CONNECTIONS ARE NECESSARY FOR INITIAL CHAIN INSTALLATION. CHAIN LOAD CAN BE READ ON THE PRESSURE GAGE. FOR LOAD CELL DISPLAY AND EXTERNAL OUTPUT MONITORING, ELECTRICAL POWER MUST BE SUPPLIED TO THE CONTROL CONSOLE. SEE SECTION 2.2.3.

REFER TO SECTION 4 FOR MOTOR POWER REQUIREMENTS.
SPECIAL NOTE: THE CHAIN JACK LATCHES ARE EQUIPPED WITH A SYNCHRONOUS LATCH MECHANISM CONSISTING OF A HYDRAULIC ACTUATOR, A SPRING RETURN AND MECHANICAL LINKS. THIS DESIGN RESULTS IN THE LATCHES OPERATING IN UNISON TO INSURE EQUAL LOADING. THIS MECHANISM DOES NOT RELIEVE THE OPERATORS OF THE RESPONSIBILITY TO ENSURE BOTH LATCHES ARE CLOSED WHEN THEY LIFT THE CHAIN.

This Section defines the special instructions required of the Mooring System during the installation of the chain. Complete chain installation procedures which must incorporate all equipment used for installation are outside the scope of this IOM manual.

3.3.1 Initial Set-Up

The following steps shall be performed prior to reeving chain through the mooring equipment.

1. Verify that all transportation sea fastenings are removed.

2. Refer to Drawing 102158. Completely extend the chain jack lift cylinders. This will minimize the resistance to twisting of the chain when the chain is rotated into alignment by the chain star or cruciform cutout in the traveling crossarm when entering the jack.
CAUTION: ONCE THE CHAIN IS BROUGHT INTO THE JACK AND THE CHAIN WEIGHT PREPARED TO BE TRANSFERRED TO THE LATCHES, CONTINUOUSLY MONITOR THE CHAIN AS IT IS LOWERED INTO THE LATCH POCKETS. BE SURE BOTH LATCHES ARE ALLOWED TO CLOSE BEFORE THE CHAIN WEIGHT IS TRANSFERRED.

3.3.2 Load Transfer to Chain Jack

1. In order to unload the messenger wire, the first mooring chain link must be set onto the fixed crossarm (stopper) at the earliest possible link.

NOTE: BOTH THE FIXED AND TRAVELING LATCHES ARE "RATCHETING TYPE" SO ACTIVATION OF THE LATCHES IS NOT REQUIRED WHEN HAULING IN CHAIN. THE TRAVELING LATCHES WILL "RATCHET" ALONG THE CHAIN AND WILL FALL IN BETWEEN LINKS FOR FAILSAFE OPERATION.

2. After the mooring chain has been pulled in as far as possible by the messenger wire, start the Chain Jack sequence for manual chain haul-in while maintaining sufficient tension to pull the chain over the sheave. Refer to the Operations Section of this manual for a detailed description of the jacking sequence.
3. As the chain is hauled up to the turndown sheave, remove the temporary wire rope inserts from the bottom of the chain wheel to make room for the chain. Note: the wire rope sheave insert consists of four equal “pie-shaped” sections, which are intended to be re-used by all four corner mooring systems. Remove and re-install the chain sheave wire rope inserts as needed to initially haul in the (messenger) wire rope and change over to the mooring chain.

4. When enough chain has been hauled in over the Turndown Sheave to release the wire rope, insert the chain anti-rotation pin into the location provided on the frame of the Sheave to hold it while the wire rope is being slackened. Note: there are two anti-rotation pins supplied to be used as required between any of the four mooring stations.

**WARNING:** *DO NOT PLACE MOORING LINE LOAD ONTO ANTI-ROTATION PIN. ALWAYS SUPPORT THE MOORING LINE LOAD ON EITHER THE CHAIN JACK CHAIN STOPPERS OR TRAVELING LATCHES.*

5. Guide the chain into the hawse pipe and disconnect the wire rope.

6. Verify that the tail chain weight is sufficient to move the chain off of the anti-rotation pin. The anti-rotation pin on the sheave can be removed when the jack begins hauling in its next cycle.
WARNING: DO NOT LEAVE THE ANTI-ROTATION PIN IN PLACE AFTER HAULING THE CHAIN OVER THE SHEAVE AND INTO THE HAWSE PIPE.

3.4 Electrical System Verification

3.4.1 Electrical Equipment

1. Visually inspect equipment to assure that no damage has occurred during transport.

2. Thoroughly inspect all cables and conduits for damage.

3. Check all terminations in the various enclosures to insure that they conform to the latest revision of the electrical schematic, DWG-102180.

Refer to DWG-102180, DWG-102178 and DWG-102246 for location of electrical components and specific wiring details.

3.4.2 Prior to Applying Power

1. Visually inspect all cable terminations for integrity and tightness, including ground connections.

2. Verify motor coil contactor on/off functions for both pump motors and heat exchanger motor.
3. Verify proper voltage, polarity and phase is correct per DWG-102180 and motor nameplates.

4. Check HPU enclosure door to insure lockout feature is working, as applicable (i.e. cannot open HPU electrical enclosure door with power switch “ON”). Do not defeat this.

5. Once the proper power is available at the HPU, refer to Section 3.2.2. Once power is available at the Control Console Instrument Enclosure, switch unit on to confirm display illuminates. If it does not illuminate, refer to Section 8.5. Switch the power off until required for Operations, Section 5.0.
## 4.0 EQUIPMENT SPECIFICATION

### Linear Chain Jack Assembly

- **System Rated Capacity**: 275 Kip Lifting Load / 550 Kip Stall Load
- **Chain Jack Speed Under Normal Operating Conditions (Haul-In / Pay-Out)**: 3.1 / 2.5 ft / min
- **Hold on Traveling Latches**: 600 kips
- **Holding on Fixed Latches (Stopper)**: 1,685 kips
- **Chain Size / Type**: 3-9/16” RQ3S Stud Link
- **Chain Minimum Breaking Load**: 1,685 kips
- **Operating Pressure at Capacity**: 4,900 psi
- **Maximum Design Pressure**: 4,900 psi
- **Proof Pressure**: 7,350 psi
- **Effective Lift Per Stroke**: 24 inches
- **Weight**: 7,360 lbs

### Chain Sheave

- **Rated Chain Tension (Back Tension in Hawse Pipe)**: 20 Ton
- **Rated Wire Rope Tension** @ 165 degree wrap and 3 degree fleet angle, worse case: 50 Ton
- **Leader Wire Rope Size**: 1.5 inch
- **Stud Link Chain Size**: 3-9/16 inch
- **Estimated Weight**: 2,360 lbs
Hydraulic Power Unit Assembly

Number of Motors 2
Type TEFC
Rated Power 2 x 60 HP
Required Electrical Utility 460 VAC, 3 Ph, 60 Hz
Starting Direct On Line
Full Load Amperage (per motor) 77 Amps
Speed 1,780 RPM

Hydraulic Pump Assembly

Number of Pumps 2
Type Axial Piston, Pressure Compensated, Horse Power Limited

Controls – Pressure Compensated / Horsepower Limited

Displacement (each pump) 2.93 in.³/rev
Maximum Intermittent Pressure Rating 5,800 psig
Maximum Continuous Pressure 5,000 psig
Theoretical Flow @ 1,780 RPM and full pressure 2X 18 gpm

Heat Exchanger

Design Heat Dissipation Capacity (Nominal): @ 90 HP
100°F Air Temperature and 160 °F Oil Inlet Temperature
Fluid Type Chevron Clarity ISO 46
Hydraulic Oil
Maximum Operating Pressure 200 psig
Design Flow Rate (Minimum) 25 gpm

**Reservoir**

Nominal Capacity 120 gal.
Low Oil Shut-Off, approx. 50 gal.
High Temperature Warning Set Point (Warning Light and Heat Exchanger fan turn on) 140º F
High Temperature Shut-Off Set Point 160º F

### 5.0 OPERATION

The following steps should be performed every time the Hydraulic Power Unit is started and run. Additional precautions are necessary when starting the power unit for the first time or after draining and refilling the system fluid. Refer to Section 3.2.

#### 5.1 Hydraulic Power Unit

1. Verify the fluid level in the power unit reservoir is above the minimum level.

   **NOTE: VERIFY THE MAIN PUMPS ARE PRIMED AT INITIAL START UP. AFTER INITIAL START UP, THE PUMPS WILL ALWAYS BE PRIMED UNLESS THE SYSTEM IS DRAINED FOR MAINTENANCE.**

2. Assure that the temperature of the fluid is within the acceptable operating range for the system hydraulic fluid. Refer to Bardex TB-2018.

3. Ensure the pump suction valves are open.
CAUTION: FAILURE TO OPEN THE PUMP SUCTION LINE BALL VALVES MAY RESULT IN SERIOUS PUMP DAMAGE AND/OR FAILURE. IT IS RECOMMENDED THAT THESE VALVES BE TAGGED AS “KEEP OPEN EXCEPT FOR SERVICE” DURING NORMAL OPERATIONS.

4. Open the bypass valve, BV3 to “UNLOAD” the pumps. This valve is located on the right hand side (as viewed facing the electrical control panel) down low near the interface 4-bolt flange Supply and Return connections. See Figure 2

5. Check the main pump suction gauge. Because the reservoir is above the pump there should be a positive head (pressure) reading on the gauge (approximately 0.5 to 2.0 PSI).

6. Start each pump. Immediately check the suction gauge and verify that it is not pulling a vacuum. If the gauge reads too much vacuum (lower than –0.5 PSI), stop the pump. **Stop motor immediately if a loud cackling sound is emitted from the pump indicating that cavitation is occurring.** Jogging the pump on and off several times may be necessary to purge the air out during initial start-up.

**CAUTION: CAVITATION IN THE PUMP CAN LEAD TO CATASTROPHIC PUMP FAILURE.**

7. In anticipation of using the Chain Jacks, close the bypass ball valve slowly to “LOAD”. Pressure will increase to full operating pressure and flow will cease to pass through the heat exchanger until the Chain Jack is cycled.

8. Verify that the pump pressure gauges read 4900 psig.

Figure 2
HPU “LOAD/UNLOAD” Bypass Ball Valve (BV3)
5.2 Chain Jack Operation

IMPORTANT NOTE: BARDEX RECOMMENDS ALWAYS USING TWO (2) CHAIN JACK OPERATORS FOR ALL CHAIN JACKING. ONE OPERATOR SHALL OPERATE THE CONTROL CONSOLE AND THE OTHER WATCHES THE CHAIN JACK OPERATION TO ENSURE BOTH LATCHES ARE CLOSED WHEN LIFTING OR HOLDING THE CHAIN. DO NOT ATTEMPT TO LATCH, JACK, LIFT OR HOLD THE CHAIN WITH ONE LATCH OPEN AND ONE LATCH CLOSED. FAILURE TO CONFIRM BOTH LATCHES ARE CLOSED WHEN HOLDING OR JACKING THE CHAIN MAY RESULT IN DAMAGE.

5.2.1 General

The Chain Jacks are operated at the control console by using the control valve handles in the proper sequence. Refer to Figures 3 and 4 which illustrate the Chain Jack Assembly “Haul In” and “Pay Out” sequential steps, respectively.

Chain Jack Operating Speed:

The mooring system has been designed with one dedicated hydraulic power unit operating one jack at the speed listed below. Except for regular maintenance to confirm the speed settings no adjustments of the flow controls are required for normal operation. Because the hydraulic power unit has two redundant pumps, half speed can be attained if only one pump is operational without damage or reduction in load capacity.
The Chain Jack operates at 3.1 ft/min for “Haul In” or 2.5 ft/min for “Pay Out”.

Steps required for Chain Jack operation:

1. Connect HPU to control console and chain jack per DWG-102186, Hydraulic Schematic.

2. Connect 460VAC and 120 VAC power to the HPU per DWG-102180, Electrical Schematic. Perform checkout per Section 3.4.

3. Connect 120 VAC power to the electrical enclosure per DWG-102180, Electrical Schematic. Perform checkout per Section 3.4. Turn the power switch to “ON”. The display will illuminate and show the load on the stopper. Note: Refer to Section 6.9.1 which describes additional display features.

4. Ensure pump suction line ball valves are open and the bypass ball valve BV3 is in the “UNLOAD” position, then start HPU motor/pumps.

5. Slowly shift bypass ball valve, BV3 to “LOAD”. Operate the Chain Jack as described in Sections 5.2.2 through 5.2.4.

5.2.2 Chain Jack Assembly Latch Positions
The Chain Jack Assembly is designed to “Haul-In” or “Pay-Out” mooring line by moving the chain one chain pitch (2 links) at a time. This is accomplished by stroking the Chain Jack Lift Cylinders and operating latches, successively, at four defined stroke positions.

There are two positions for operating the traveling latches (designated as traveling latch windows) when the load is on the fixed latches (position 2 and position 4). In these positions, the chain is held clear of the traveling latches allowing them to be opened or closed without interference.

There are two positions (designated as fixed stopper windows) for operating the fixed latches while the load is on the traveling latches (position 1 and position 3). In these positions, the chain is held clear of the fixed latches allowing them to be opened or closed without interference.
Figure 3-“Haul In” Sequence
Figure 4-“Pay Out” Sequence
CAUTION: ALWAYS LEAVE THE CHAIN ON THE CHAIN STOPPER (FIXED LATCHES) DURING IDLE PERIODS OF OPERATION.

5.2.3 HAUL-IN (Raise Chain)

Refer to Figure 3

The raise sequence given below may be started at any position in the sequence. The steps given below are based on starting from the Chain Jack Park position (lift cylinders fully retracted with the chain resting in the fixed latches). See Section 5.1 for HPU starting instructions.

Refer to DWG-102181; View A-A for Control Console nomenclature.

1. Shift the lift cylinder Directional Control Valve (DCV) to "CYL LOWER" and extend the cylinder to the fully extended position. Release valve handle. (Position 4 in Figure 3)

2. The traveling latch DCV is spring offset to close latches without operator intervention. Ensure visually that BOTH latches fully close before continuing.
NOTE: DURING THE “HAUL IN” SEQUENCE, IT IS NOT NECESSARY TO MANUALLY OPEN THE FIXED (STOPPER) LATCHES AS THEY WILL RATCHET OPEN DURING CHAIN PASSAGE. IT IS ONLY NECESSARY TO ENSURE THAT THEY ARE CLOSED (BY OPERATING THE MANUAL VALVE) AND IN THE PROPER POSITION BEFORE LANDING THE CHAIN.

3. Shift the lift cylinder DCV to “CYL RAISE” and retract the Chain Jack to Position 1 (Fully retracted). This lifts the chain one pitch (two links).

4. The stopper DCV is spring offset to “CLOSE STOPPER” so the stoppers (fixed latches) will close without operator intervention. Release the lift cylinder DCV handle when the stoppers are fully engaged. Verify both stoppers are closed before releasing the handle.

5. Push the “CYL LOWER” DCV lever to extend the lift cylinders. The chain tension will transfer to the stopper (fixed latches) as the lift cylinder continues to extend to the next chain pitch. It is not necessary to shift the Latch DCV to “OPEN” as they “ratchet” along the chain links. Extend the cylinders all the way to Position 4.

6. Repeat Steps 1 through 5 to continue hauling in (lifting) chain.
IMPORTANT: THE CHAIN JACK ASSEMBLY SHOULD ALWAYS BE PLACED IN THE PARK POSITION (LIFT CYLINDERS FULLY RETRACTED WITH THE CHAIN LOAD ON THE FIXED STOPPER AND THE TRAVELING LATCHES RESTING ON THE CHAIN) WHEN JACKING OPERATIONS HAVE BEEN COMPLETED.

CAUTION: ALWAYS LEAVE THE CHAIN ON THE CHAIN STOPPER (FIXED LATCHES) DURING IDLE PERIODS OF OPERATION.

IMPORTANT: SHIFT THE BYPASS BALL VALVE ON THE HPU TO “UNLOAD” DURING IDLE PERIODS OF OPERATION.

5.2.4 PAY-OUT (Lower Chain)

Refer to Figure 4

The lowering sequence may be started at any position in the sequence. The steps given below are based on starting with the Chain Jack in the “Park” position (Chain jack fully retracted with the chain resting in the fixed stopper), Position 1 in Figure 4.
1. Shift the lift cylinder DCV to "CYL LOWER" to extend the Chain Jack lift cylinder approximately 6 inches. When the traveling cross arm reaches Position 2, both traveling latches will close without operator intervention. Release the lift cylinder DCV lever. If position 2 has been reached, the traveling latches will be closed.

2. Verify that both traveling latches are closed by visual examination before continuing.

**WARNING:** ALWAYS BE SURE BOTH LATCHES ARE CLOSED ON THE UNDERSIDE OF THE CHAIN LINK BEFORE CARRYING THE LOAD.

3. Retract the Chain Jack lift cylinders to Position 1, (cylinder fully retracted), by pulling the lift cylinder DCV lever to "CYL RAISE". Hold the valve in the “CYL RAISE” position until the chain clears the stopper latches.

4. Open the Chain Stopper by shifting the DCV lever to “OPEN STOPPER”. Verify both fixed latches are open by visual observation. Hold control lever to maintain stoppers open.

**WARNING:** STOPPER LATCHES WILL CLOSE IF THE CONTROL LEVER IS RELEASED.

5. Extend the Chain Jack and pay out chain until chain is past the stopper by shifting the DCV lever to “CYL LOWER”
6. When the first chain pitch (2 links) has moved down enough to clear the stopper latches, Position 3 close the Chain Stopper (release the stopper lever so it springs back into the “CLOSE STOPPER” position).

7. Continue to extend the Chain Jack until the chain is held in the stopper and the traveling latches are free to open (Position 4), by shifting the DCV lever to "CYL LOWER". Verify chain is supported by the stopper.

8. Open the Traveling Latches by shifting the lever to “OPEN LATCH”. Hold latches open.

9. Retract the Chain Jack lift cylinder by shifting the DCV lever to “CYL RAISE”. Continue to Position 2 while maintaining the lever in the “LATCH OPEN” position.

10. Release Traveling Latch DCV lever to “CLOSE LATCH” to close latches.

11. Repeat Steps 3 through 10 to continue the pay-out sequence.
IMPORTANT: THE CHAIN JACK ASSEMBLY SHOULD ALWAYS BE PLACED IN THE PARK POSITION (LIFT CYLINDERS FULLY RETRACTED WITH THE CHAIN LOAD ON THE FIXED STOPPER AND THE TRAVELING LATCHES RESTING ON THE CHAIN) WHEN JACKING OPERATIONS HAVE BEEN COMPLETED.

CAUTION: ALWAYS LEAVE THE CHAIN ON THE CHAIN STOPPER DURING IDLE PERIODS OF OPERATION.

IMPORTANT: SHIFT THE BYPASS BALL VALVE ON THE HPU TO “UNLOAD” DURING IDLE PERIODS OF OPERATION.

6.0 MAINTENANCE

6.1 General Maintenance and Schedule

Maintenance in the field should be limited to general assembly maintenance, trouble shooting, and component replacement. Component overhaul or refurbishment is best left to the Bardex factory shops which are equipped with the necessary machinery and qualified personnel.

IMPORTANT:
ALL MAINTENANCE SHOULD BE PERFORMED BY TRAINED AND QUALIFIED PERSONNEL ONLY.
Whenever the system is opened for any replacement or repair of components, the following general precautions should be taken to avoid contamination.

1. Plug, cap or cover any open piping, hose or valve mounting surface to prevent the ingress of foreign substances.

2. Thoroughly clean all adjoining surfaces before disassembly.

3. New or repaired parts must be cleaned prior to re-assembly, especially mating surfaces and areas around seals and gaskets. Solvent cleaning followed by compressed air (dry and filtered) drying of the parts works well.

NOTE: USING RAGS TO DRY PARTS USUALLY RESULTS IN SMALL LINT PARTICLES ON THE SURFACES WHICH MAY BE DETRIMENTAL TO PROPER SEALING AND MAY CONTAMINATE HYDRAULIC FLUID.

4. Use drain pans and oil absorbing pads whenever possible to minimize fluid spillage into the environment.

IMPORTANT: GOOD MAINTENANCE RECORDS AND PROCEDURES ARE IMPORTANT TO ASSURE CONTINUOUS TROUBLE FREE OPERATION.

The following maintenance schedule is provided as a guideline in establishing an effective maintenance program. The time periods indicated may be adjusted depending on the frequency of use, or additional experience gained through periodic equipment inspection.
## MAINTENANCE SCHEDULE

<table>
<thead>
<tr>
<th>MAINTENANCE TASK</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect return filters. Indicator gauge(s) to be in the operating region:</td>
<td>At start-up and weekly during operation. Note: read only when the Chain Jacks are retracting or with BV3 in “UNLOAD” position. Oil must be at a minimum temperature of 100°F. Replace filter as required</td>
</tr>
<tr>
<td>Green = OK</td>
<td></td>
</tr>
<tr>
<td>Yellow = Change filter</td>
<td></td>
</tr>
<tr>
<td>Red = Filter bypassing</td>
<td></td>
</tr>
<tr>
<td>Inspect suction gauges. Reading to have a positive pressure head. If a vacuum exists while operating it should be no more than 0.5 psi</td>
<td>At start-up and during operation while Chain Jacks are cycling or with BV3 in “UNLOAD” position</td>
</tr>
<tr>
<td>Inspect hydraulic tank fluid level.</td>
<td>Prior to starting, during air purging</td>
</tr>
<tr>
<td>Open reservoir drain valve and remove water condensation.</td>
<td>3 months Drain until only oil exits</td>
</tr>
<tr>
<td>Inspect hydraulic lines for leaks, cracked hoses and other mechanical damage</td>
<td>At start-up – Every 3 months</td>
</tr>
<tr>
<td>Verify manual DCV handles operate smoothly &amp; spring return automatically</td>
<td>At start-up – Every 3 months</td>
</tr>
<tr>
<td>Lubricate at pivot points</td>
<td></td>
</tr>
<tr>
<td>Lubricate clevis pins internally (zerk fittings) and/or externally</td>
<td>6 months</td>
</tr>
<tr>
<td>Lubricate electric motors</td>
<td>At 6 months, 1 year thereafter</td>
</tr>
<tr>
<td>Replace desiccant in enclosure</td>
<td>Whenever enclosure is opened</td>
</tr>
<tr>
<td>Grease Sheave Bearings and Bushings</td>
<td>Every 6 months</td>
</tr>
<tr>
<td>Inspect Lift Cylinder Rod Bolts, Cylinder Mounting Bolts, Chain Jack and Sheave Mounting Bolts for Corrosion or Damage</td>
<td>Every 3 months for the first year, every 6 months thereafter</td>
</tr>
<tr>
<td>MAINTENANCE TASK</td>
<td>Interval</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Inspect Fixed &amp; Traveling cross arms, Latch Contact Surfaces and Bearing Inserts</td>
<td>Every 3 months and after pulling a chain with heavy marine growth through the chain jack.</td>
</tr>
<tr>
<td>Surfaces to be free of debris and excessive peening</td>
<td></td>
</tr>
<tr>
<td>Extend and Retract Lift Cylinders and Latch Cylinders for 15 Minutes.</td>
<td>Cycle the chain jack cylinders at least once every 3 months.</td>
</tr>
<tr>
<td>Inspect Cylinder Rods for Excessive Rod Seal Leakage</td>
<td></td>
</tr>
<tr>
<td>Inspect Chain Contact Surfaces for Wear</td>
<td>6 months</td>
</tr>
<tr>
<td>Inspect hydraulic fluid by having a fluid sample analyzed by an independent laboratory</td>
<td>As recommended by the fluid manufacturer; every 3 months for first year. Adjust interval as necessary</td>
</tr>
<tr>
<td>HPU Motor &amp; connection Cable Megger</td>
<td>Every 6 months - Any time motor is disconnected. Always check motor rotation after disconnecting</td>
</tr>
<tr>
<td>Recalibrate HPU and Load indicating pressure gauges</td>
<td>Every 6 months</td>
</tr>
<tr>
<td>Check and/or Reset HPU system relief valve: RV1 = 5100 psi</td>
<td>Every 12 months</td>
</tr>
</tbody>
</table>
### MAINTENANCE TASK

<table>
<thead>
<tr>
<th>MAINTENANCE TASK</th>
<th>MAINTENANCE INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check and/or Reset HPU pump(s) pressure compensator setting 4900 psi max</td>
<td>Check at every start-up and reset every 12 months</td>
</tr>
<tr>
<td>Check and/or Recalibrate system pressure control valves: Cyl. Raise = 4900 psi Cyl. Lower = 1000 psi Load Handling Valve = 4900 psi</td>
<td>As required. Pressure can be checked using test points supplied on the control console and chain jack</td>
</tr>
<tr>
<td>Check HPU Temperature Switches with a calibrated thermometer and heatsink</td>
<td>Yearly</td>
</tr>
</tbody>
</table>

### 6.2 Chain Jack Disassembly and Reassembly

Refer to DWG-102119, Chain Jack Assembly Detail

#### 6.2.1 Traveling Crossarm Assembly Removal and Installation

1. The Chain Jack must be in the vertical position.

2. Remove and plug the hydraulic hose to the latch cylinder.

3. Support the weight of the traveling crossarm assembly (approx. 1600 lbs) with rigging.

4. Remove the split flange retainer bolts on the cylinder rod ends, then remove the retainer halves.

5. Lower the traveling crossarm assembly off the rod ends. Insure concentric bushings, item 4 on DWG-102119 are retained.
6. For reassembly reverse the above operations. Grease the rod-bushing interface, then torque the split flange retainer bolts per TS-1007.

6.2.2 Lift Cylinder Removal and Installation

NOTE: Removal of the lift cylinder(s) requires that the chain be supported by the stopper (fixed latches). This repair effort should be planned in advance when the chain jack is not in use.

1. Retract the cylinder completely. Use a cable rigging attached from the fixed crossarm (or structure) to the traveling crossarm to retract the cylinders by pulling up the crossarm.

2. Support the lower crossarm with a cable to secure it before a cylinder is to be removed. See Step 7.

3. Disconnect/Lockout HPU from power source.

4. Relieve trapped pressure in the lift cylinder and manifold by loosening the fittings on the Chain Jack tubing. Use a suitable container to catch the oil.

WARNING:
EXTREME CARE SHOULD BE TAKEN WHEN LOOSENING ANY HYDRAULIC LINE UNDER PRESSURE. ALWAYS RELIEVE PRESSURE BEFORE DISCONNECTING OR DISASSEMBLING ANY HYDRAULIC COMPONENT. FAILURE TO RELIEVE PRESSURE DURING DISASSEMBLY MAY RESULT IN PERSONNEL INJURY OR DEATH.

5. When the pressure is relieved, remove the rod end tubing and plug or cap the open ports to prevent further oil loss.

6. Remove, plug, and cap the piston side cylinder tubing.

7. Secure the traveling crossarm to the underside of the Chain Jack foundation to support the weight of the crossarm when the cylinder rod is disconnected. This rigging should be made to level the crossarm which will ease the removal and re-installation of the rod.

8. Remove the split flange retainer bolts, then the retainer halves.

9. Attach a lifting sling to the top of the cylinder using the lift eye provided.

10. Remove the lift cylinder mounting hardware at the fixed crossarm.
11. Slowly lift the cylinder assembly free of the crossarm assemblies. Note radial orientation of bolt pattern with respect to hydraulic lines for reinstallation later. (Note: mounting flange bolt pattern allows only two installation positions, correct and 180 degrees out).

**CAUTION:**

*LIFT THE CYLINDER SLOWLY AND STRAIGHT TO AVOID ROD PLATING DAMAGE OR DAMAGE TO OTHER CHAIN JACK COMPONENTS.*

12. To install the cylinder, reverse the above steps. Observe bolt torque recommendations in TS-1007.

13. After installation operate the Chain Jack at low pressure a few times to purge air and check for leaks. Refer to Commissioning Section 3.2.2 for more details on re-commissioning Chain Jacks.

6.2.3 Stopper and Latch Removal and Installation

**NOTE:** ONLY ONE SET OF LATCHES (FIXED STOPPERS OR TRAVELING LATCHES) CAN BE REMOVED AT ONE TIME SINCE THE CHAIN MUST BE SUPPORTED ON THE OTHER SET.

Refer to DWG-102122 (Fixed Crossarm Assembly) or DWG-102140 (Traveling Crossarm Assembly).
1. Transfer the chain to the latches not being removed. If the fixed latches are being removed, extend the Jack completely before starting. This will ensure that the mooring load is not held on hydraulic pressure but mechanically.

2. Remove the latch cylinder assembly, item 10 (on the Fixed Crossarm Assembly) or item 8 (on the Traveling Crossarm Assembly) rod end and piston end pins. Remove the entire latch cylinder with hydraulic hoses still connected.

3. Disengage the timing link arm, item 13 (on the Fixed Crossarm Assembly) or item 13 (on the Traveling Crossarm Assembly) by first removing the retaining ring from the pin at one end. Alternately, remove both pins and remove the link arm completely.

4. Remove the hex plug then install a lifting eye (1/2-13 thread) into the threaded hole on top of either style latch. Attach a lifting sling.

5. Remove the torsion spring arm (retainer), item 19 (on the Fixed Crossarm Assembly) or item 24 (on the Traveling Crossarm Assembly) from the latch shaft ends. Remove the torsion springs.

6. Remove the latch shaft dowel pin(s), item 24 (on the Fixed Crossarm assembly) or item 26 (on the Traveling Crossarm assembly).
A. For the Fixed Latches (Stoppers), remove the latch dowel retainer hardware then the retainer. Next, open the latch and use a punch to drive the dowel pin out from below. Note that there is a dowel pin on one ear of each latch only.

B. For the Traveling Latches remove the latch dowel retainer hardware then the retainer. Open the latch and use a punch to drive the single dowel pin out from below.

6. Remove the Latch shaft by pushing it out from the torsion spring side while supporting the latch with a crane or block and tackle from above. Ensure the shaft and linkage hubs which are still attached are secured safely to the crossarm or deck.

7. Lift the latch clear.

8. Reverse the above steps to install. Grease bearings and dowel pins upon re-assemble.
6.3 Chain Jack Cylinder Seal Replacement

Refer to DWG-102170, Lift Cylinder Assembly. Lift cylinder is assumed to previously have been removed. See section 6.2.2.

Disassemble the cylinder in a clean location. An overhead crane is required.

Each part should be thoroughly cleaned. If the cylinder is to be dismantled for any length of time, coat the metal parts which are to be re-used, with good rust preservative and store in a protected area. The cylinder must be stored in its retracted position to prevent damage and corrosion to the critical surfaces.

1. Be sure to plug and protect all hydraulic connections opened during this activity.

2. Attach an appropriate sling to the lifting eye located on the cylinder blind end. Connect an overhead hoist to the lifting sling and remove slack. Note cylinder weight is approximately 1800 lbs.

3. Lift the cylinder off the crossarm and place on the deck. Move the cylinder to an appropriately clean work area.

4. Using filtered and dry compressed air, extend the cylinder completely and expel the residual oil from the rod end. Use hoses to direct oil to a suitable container. Do not re-use this oil. Using the compressed air, retract the cylinder completely and expel oil from the blind end.
5. Invert the assembly (rod end up) and support on blocking.

6. Remove the retaining hardware (18X Socket Head Cap Screws) from the gland and baseplate ends of the cylinder. Remove baseplate and gland using rubber mallet to tap out if necessary.

7. Remove the piston/rod assembly. With chrome protected, secure rod in clamping mechanism.

8. Using 3/8” center punch, remove the roll pin in the piston nut. Heat with a torch at low heat (325°F) to loosen thread sealer (Loctite 262). Remove piston nut and any excess loctite from piston and rod with a wire brush. Remove piston from rod.

9. Place on a clean flat surface covered with a clean lint-free cloth. Inspect all components for cracks, scratches and wear. Inspect all seal grooves. Clean each component thoroughly.

10. Remove all seals using a blunt, tapered tool of any material softer than aluminum (wood or plastic). Wedge beneath seal and pry off. Be careful not to score any sealing (sealing ring groove) surfaces.

11. Replace all seals and bearings in gland, base plate and piston. Ensure all seals are properly installed with respect to the direction of pressure shown on DWG-102170. Lubricate all seals and seal swept areas with clean hydraulic fluid. Do not install seals when there is any doubt as to seal or surface integrity.
12. With seals and bearings in place, install gland from piston end of rod. Slide stop ring, spacer and piston back on piston rod. Apply Loctite 262 to piston nut and rod threads. Tighten such that roll pin can be re-installed. Install piston seals and bearings.

13. Apply a thin coat of hydraulic fluid to the rod and piston assembly. Re-install rod assembly into gland end of cylinder tube. Lubricate the bolt threads with molybdenum disulfide anti-seize compound. Re-install bolts (7/8-14 UNF-2A Socket Head Cap Screws) in both the gland and baseplate. Torque to 670 ft-lbs. via a criss-cross pattern.

14. Connect the cylinder to the hydraulic power unit. Carefully extend and retract the cylinder several times to fill with (filtered) oil and expel air. Pressure required to stroke the cylinder should not exceed 300 psi.

Proof Testing

After a cylinder has been completely re-assembled, test it at low pressure in order to ensure that the rod is moving freely and is not scored. Cycle the cylinder at least five (5) times in each direction to ensure all air is purged out. Afterward increase the pressure to the maximum recommended value (operating) and check for leakage.

15. Pressurize each end individually to operating pressure while checking opposing end for leaks.

16. Re-install cylinder assembly onto Chain Jack. Connect all hydraulic lines previously disconnected.
CAUTION:
THERE MAY BE RESIDUAL PRESSURE TRAPPED IN THE CYLINDER. LOOSEN FITTINGS SLOWLY AND USE EYE PROTECTION.

6.4 Latch Cylinder Seal Replacement

1. The latch cylinders are standard small cylinders which operate at a relatively low pressure compared to the rest of the system.

2. Remove and plug/cap the hydraulic hoses to the rod end and piston end.

3. Remove the snap rings from one side of each clevis pin at the latches and timing hubs; push out pins to remove cylinder.

4. Using a spanner wrench (1/4” pin in gland) unscrew the gland (end cap at rod end); disassemble the remaining cylinder components.

5. Remove all seals using a blunt, tapered tool made of any material softer than aluminum (i.e., wood or plastic).

6. Clean all cylinder components using solvent, dry, filtered compressed air and lint free cloths. Inspect all sealing surfaces including O-ring grooves and cylinder bores for nicks and burnishing.
7. Apply a thin coat of hydraulic fluid to sealing surfaces and moving parts. Reassemble using new seals.

8. Replace hoses and leak test in both the extend and retract directions.

9. Install cylinder on chain jack linkage, install and lubricate pins. Replace chain jack hoses and repeat leak testing.

6.5 Hydraulic Power Unit Filter Maintenance (Return, Pressure and Suction)

**NOTE:** AFTER USING THE HYDRAULIC POWER UNIT OVER A PERIOD OF TIME, THE EQUIPMENT OPERATOR WILL GET A FEEL FOR THE NUMBER OF HOURS THE UNIT CAN RUN BETWEEN SUCCESSIVE OIL FILTER ELEMENT CHANGES BY OBSERVING THE FILTER INDICATORS.

While the HPU is idling in the “LOAD” condition (running but no equipment operating), the pump compensator has stroked the pump back to zero flow. There is output flow only when equipment is actually operating or when the bypass ball valve (BV3) is in the “UNLOAD” position. Therefore, the filter indicators must be checked while equipment is operating, or with the bypass valve, BV3 open in the “UNLOAD” position (and oil above 100°F).

**NOTE:** ALL FILTER INDICATORS READ HIGH WHEN THE OIL IS COLD. AS THE OIL WARMS UP TO THE PROPER OPERATING VISCOSITY, INDICATORS WILL READ LOWER VALUES.
6.5.1 Suction Strainer(s)

The suction strainers require servicing when one or both of the vacuum gages (Refer to Figure 5 below) on the HPU control panel reads continuously minus 1 psi or less after the oil is warmed up to operating temperature (viscosity). The gages will normally show a positive head but if one or both begin to indicate a vacuum when the chain jack is operating, the strainer(s) may require servicing.

Figure 5
HPU Control Panel
The strainers are located inside the reservoir tank and can be serviced by removing the access cover from the tank (Refer to DWG-102194). Note that the tank must be drained prior to removing the covers.

To service the strainer elements;

1. Drain the reservoir to below the access cover level.

2. Close the suction ball valves to the pumps.

3. Remove access cover from the reservoir.

4. Unscrew strainer elements to be replaced.

5. Replace with new elements.

6. Reinstall the access cover and gasket and refill the reservoir. Be sure to refill the reservoir using filtered hydraulic fluid. New fluid from the barrel usually does not meet cleanliness requirements.
7. With the power unit off, open the suction valve(s) and check the suction gauge(s). Because the reservoir is above both pumps there should be a positive head (pressure) reading on the gauge(s), of approximately 0.5 to 2.0 psi, dependent on the location of the suction indicator. However, since the suction gauges are above the pumps, the reading may be zero or slightly negative. The initial value should be noted for comparison to the value seen when pumps are at full flow with suction ball valves properly opened and clean strainers. Knowing the initial value can be used to trouble shoot clogged strainers or slightly closed suction valves for example (gauge reading would go more negative when pumps come on full stroke).

8. With the bypass ball valve, BV3 in the “UNLOAD: position, start each pump separately. Immediately check each suction gauge and verify that it is not pulling a vacuum. If the gauge reads too much vacuum (lower than –0.5 PSI below the initial value), stop the pump. **Stop motor immediately if a loud cackling sound is emitted from the pump indicating that cavitation is occurring.** Jogging the pump on and off several times may be necessary to purge the air out during initial start-up.

**NOTE: UPON INITIAL START UP OF THE MOTOR/PUMP ASSEMBLY AFTER AN ELEMENT SERVICE, JOG START EACH MOTOR THREE TO FOUR TIMES TO DRAW ALL AIR OUT OF THE LINE.**
CAUTION: OPERATION OF MOTOR/PUMP ASSEMBLY WITH SUCTION LINE BALL VALVE CLOSED WILL CAUSE SERIOUS DAMAGE TO THE HYDRAULIC PUMP. RECOMMEND RE-AFFIXING THE TAGS INSTALLED ON THESE VALVES PER SECTION 5.0

6.5.2 Return Filter

The return filter is mounted directly on the top of the reservoir. The filter indicator is located on the filter housing (See Figure 6). After the oil is warmed to operating temperature, the pressure drop across a filter is a function of flow through the element and element resistance. Element resistance increases with accumulation of residue.

With a new element in place and oil warmed to normal operating temperature (100º-120ºF) very little pressure drop is indicated.

To check element condition:

1. Start each motor/pump assembly per Step 8 of the previous section.

2. Allow oil to warm up to operating temperature.
3. With BV3 in the “LOAD” position, hold the traveling latch open continuously, then extend and retract one of the Chain Jacks with no (chain) load. After extending, shifting the lift cylinder DCV to “CYL RAISE” will send flow through the return filter (Alternatively, shift BV3 to “UNLOAD” and send full pump flow through the applicable filter)

4. Check the return filter indicator. At this point, if the filter indicator is operating in the red, change the element.

**To change return filter element:**

1. Shut off power unit, and locate the return filter. (Refer to DWG-102194 and Figure 6).

2. Loosen the bolts on the filter top. Remove the top and find the filter. Note: The reservoir tank does not need to be drained to replace a return filter.


4. Replace top and hardware then tighten all bolts.
6.5.3 Pressure Filters

The pressure filters, F3 and F4, are connected just downstream of each pump. They are located on the manifold adjacent to the bypass ball valve, BV3. Refer to drawing 102194. The filter indicators operate in much the same way as the return filter indicator.

To change pressure filter element:
1. Shut off the power unit, and close the suction line ball valve for the particular circuit. (Refer to DWG-102194).

2. Loosen the filter cover by unscrewing (note two pins which are used to apply torque to cover). Remove the cover and find the filter. Note: The reservoir tank does not need to be drained to replace these filters as long as the applicable suction line ball valve has been closed per above step.


4. Replace cover and then tighten snugly.

5. Open suction ball valve(s) which was closed in step 1.

6.6 PRESSURE CONTROL AND ADJUSTMENT

Several features are provided in the system for pressure control and for smooth and stable operation.

1. Each identical pump is torque limited and pressure compensated. Pumps are controlled by a compensator setting (RV2, RV3 set @ 4900 psi).

2. A main relief valve, (RV1 set @ 5100 psi) located on the pressure filter manifold near the bypass ball valve (BV3) protects the system. See drawing DWG-102194 for exact location.
6.6.1 To Adjust the HPU Pressure Controls

See DWG-102194 and Figure 7 below:

1. The pump compensator adjustor can be found on the control block located on each pump. It can be adjusted by loosening the lock nut and turning the adjustment screw with an Allen wrench. With the pump motor running and the bypass ball valve, BV3 closed or in the “LOAD” position, decrease the setting by turning it counter clockwise until system pressure begins to fall. Then increase the setting until the correct pressure reads on the pressure gauge. If pressure does not increase, check the setting of the main system relief valve. If it is too low, it will not allow pressure to build.
2. The main system relief valve, RV1 is located on the side of the main manifold behind the bypass ball valve, BV3. It can be set by loosening the lock nut and turning the adjustment screw with an Allen wrench. Turning the screw counterclockwise decreases the setting while turning it clockwise increases the setting. The main system relief valve should be set approximately 200 PSI higher than the pump compensator setting. The pump compensator can be adjusted high enough to achieve this setting temporarily, but it should be turned back down to normal operating pressure after the relief valve has been set.

3. The load holding valve setting is best left to a Bardex factory representative. However, RV2 on the Chain Jack manifold can be adjusted if necessary as follows:

   A. Shift Control Console lever to “CYL RAISE” to retract the cylinders all the way.

   B. With the pump pressure adjusted up to 5200 psi check that RV2 dumps cylinder pressure at 5100 psi with valve held in the “CYL RAISE” position. If not, adjust by loosening the lock nut and turning the adjustment screw with an Allen wrench. Turning the screw counterclockwise decreases the setting while turning it clockwise increases the setting. Once adjustment has been made, tighten the lock nut.
6.7 AIR PURGING PROCEDURE

Refer to Technical Bulletin TB-2015 included in the Appendix for air purging guidelines for typical Bardex equipment. Chain jack operation at low pressure will effectively purge air from the cylinders and hoses. The power unit should be set as low as possible but high enough to open the load holding valve and lift the weight off the traveling crossarm (approximately 1000 psi). At lower pressures the cylinders may not retract.

At least twenty (20) cycles of each cylinder is sufficient to bleed air out of the system.

6.8 LUBRICATION

The system is mostly self-lubricating during normal operation as most of the moving parts are lubricated by hydraulic oil in the system with the exception of the electric motor, sheave bearings, latch shafts, and the latch cylinder pins.

Whenever any equipment is disassembled for any reason, appropriate parts should be lubricated during re-assembly. Threads of all assembly mounting bolts should be coated with molybdenum disulfide (Moly-Lube 550 or equivalent).

Grease (zerk) fittings on the latch cylinder pins and sheave axles should be pumped full of white lithium marine grade grease.
6.9 ELECTRICAL EQUIPMENT

6.9.1 Load Cell Display Instrumentation

Refer to DWG-102178, Load Cell Instrument Enclosure and Figure 8

The load cell display instrument is a pre-programmed logic device which reads all four load cell inputs (two redundant load cell bridges within each of the two load cells under opposing stoppers). It also displays operational and normal (preset range) status of all four load cell bridge inputs. In addition, it will indicate a fault condition in any of the inputs, trigger an alarm and automatically adjust the averaging function to neglect the faulted signal. Finally, an RS-485 serial communication link is provided for remote monitoring of the display output and load cell (operational/normal) status at a remote computer(s).
The accuracy of the load cell display system is expected to be better than 5% of full scale over the expected chain tension range for which the load cell has been designed (820 kips). Above this limit the display will continue to output a signal with a maximum error of +/-5% of the normal range. However, as the mooring tension approaches the chain yield point of 1230 kips, some type of alarm is warranted. Therefore, at 10% above the chain yield point (1350 kips) an overload alarm is triggered. The affected bridge(s) is disabled at this load for the case of a failed bridge that may be giving an erroneous value. The load cells will not provide an accurate measurement value above the yield point of the chain. In the event of extreme chain tension, a record/alert to this fact will be made available. A disabled input which has occurred in this scenario can be reset as the load cell will typically be undamaged after the high load has been removed. The load cell may need to be re-tared or re-zeroed by factory representatives. An example of disabled bridge(s) status is shown in Figure 8 for LC1A and LC1B.

**NOTE:** IF THE MOORING SYSTEM EXPERIENCES LOADS ABOVE THE NORMALLY EXPECTED LOAD RANGE, A BARDEX FACTORY REPRESENTATIVE SHOULD INSPECT THE EQUIPMENT AND THE LOAD INDICATION SYSTEM.

The load cell display system may require adjustment after chain installation. With no load (no chain) in the chain jack and with the fixed latches closed, the display value should read zero. This can be accomplished by taring the instrument.
When the Chain Jack is in use, the load cell display value in kips (1kip=1000 lbs) should closely match the load shown on the Load Indicating Pressure Gauge. Note that the Load indicating Pressure Gauge will only be accurate when the load is completely on the traveling cross arm (unless the traveling cross arm is fully extended or retracted) and supported by the hydraulics. Be sure to take readings with a still load. If the cylinders are lifting the chain, dynamic friction will add to or subtract from the load depending on cylinder direction. If the cylinders are fully extended the load will be held mechanically and the load indication gauge will not be accurate. If fully retracted, the pressure on the gauge will rise up to full system pressure as adjusted at the pump(s).

The load cell display value will only be accurate when the chain is fully resting on the fixed stoppers. It may be adjusted as described below.

NOTE: THE LOAD CELL DISPLAY INSTRUMENT HAS BEEN FACTORY SET FOR LOAD CELL SIGNALS OVER THE RANGE OF EXPECTED MOORING TENSION. IT CAN AUTOMATICALLY DETECT AN OUT OF RANGE (DEFECTIVE REDUNDANT LOAD CELL BRIDGE WITHIN THE SEALED COMPRESSION LOAD CELL). IF A FAULT IS DETECTED, THE DISPLAY VALUE REMAINS ACCURATE BECAUSE THE FAULTY BRIDGE OR OUT OF RANGE INPUT IS NEGLECTED. THE AVERAGING IS ADJUSTED FOR THE FAULT AND AN ALARM CONDITION IS INDICATED.
Figure 8
Load Cell Display, Main Menu with LC1 Disabled
The compression load cells and signal conditioners within the electrical enclosure are factory set components and do not require adjustment. However, the system may be “zeroed” or “tared” as follows:

1. With no chain resting on the stopper ensure the stopper (latches on the fixed crossarm) is in the closed position (latches resting on the load cells).

2. Ensure the control console lever is in the “CLOSE STOPPER” position (normal released position).

3. With the display enclosure switch in the “ON” position and the security function OFF (see below), depress the keypad button directly below the display window icon “TARE”. This will zero the load measurement readout effectively subtracting the weight of the stopper latches and the force exerted by the latch cylinder.

4. Re-enable the display instrument security function described below.

NOTE: IT IS ADVISABLE TO ENABLE THE DISPLAY INSTRUMENT SECURITY FUNCTION TO KEEP THE SYSTEM CONSISTENT. THE SECURITY FUNCTION WAS NOT ENABLED AS IT LEFT THE BARDEX FACTORY.

To enable the security function:
1. Depress the keypad button directly below the display window icon “MENU”. The screen will change to show four options, depress the keypad button directly below the display window icon “SYSTEM CONFIGURATION”.

2. Using the appropriate icon to move the arrow prompt to row 1 “SECURITY OFF”.

3. Depress the keypad button directly below the display window icon “ENT”. This will highlight the default value (0=OFF, 1=ON), and allow a security code to be entered. This code number can be any value between 2 and 255, which will become the security unlock code. Keep it in a safe place and enter it here__________

4. Once a number is entered, depress the keypad button directly below the display window icon “RUN” to save the change. The security lockout feature is enabled and can only be disabled by entering the same number.

5. Depress the keypad button directly below the display window icon “MAIN” to return to the main (load display) menu.

The display screen has been designed to be viewed in broad daylight. It has a built-in screen saver which causes the display to go blank after 30 minutes if the unit has not detected an operator key press. To re-energize the display, simply depress any keypad button, preferably the MENU or DIAG buttons on the left.
6.9.2 Motor Wiring Megger Reading

Check motors at six-month intervals with a calibrated megohmmeter. Record megger readings, and if a drop in resistance is noted, consult Bardex. All circuits had virtually infinite readings when tested at the Bardex factory. Additionally, both main pump motors have internal heater elements which are intended to drive moisture away from motor windings.

7.0 SPARE PARTS

For a complete spare parts listing, see PDATA-1336 in the Appendix. For items that do not appear in this listing, see Applicable Engineering Drawings in Section 9.0. Contact Support Services at Bardex via contact information given in the front of this manual.

8.0 TROUBLE SHOOTING

CAUTION: TROUBLE SHOOTING PROCEDURES MAY EXPOSE PERSONNEL TO HIGH PRESSURE AND TEMPERATURE HYDRAULIC OIL, AND/OR HIGH VOLTAGES. TROUBLE SHOOTING PROCEDURES SHOULD ONLY BE ATTEMPTED BY EXPERIENCED PERSONNEL UTILIZING PROPER EQUIPMENT. STANDARD SAFETY PRACTICES AND EQUIPMENT MUST BE ADHERED TO AT ALL TIMES.
The purpose of this section is to establish basic trouble shooting procedures and guidelines which can be used to identify sources of malfunctions in the system. The depth of trouble shooting will depend on the training and experience of the technician attempting to isolate or locate system faults. If the following procedures do not result in isolation of fault, contact Bardex for additional guidance or assistance.

8.1 BEFORE ASSUMING SYSTEM FAILURE:

1. Ensure that the system is properly installed and connected per applicable installation procedures and engineering drawings for each piece of equipment.

2. Check hydraulic lines for external leakage or mechanical damage.

3. Ensure that the selector valves are properly positioned and in the full open or closed position, as applicable.

4. Ensure that the electrical system is not causing a system fault. Ensure voltage and frequency regulation is correct.

5. Ensure that the Hydraulic Power Unit reservoir level is correct, oil is clean and filters/strainers are not indicating a fouled or dirty condition.

6. Check all equipment for unusual noises, odors, vibrations or obvious external damage.
8.2 TROUBLE SHOOTING PROCEDURES FOR HYDRAULIC POWER UNIT

1. Hydraulic pump cavitation (loud cackling noise emitted from the pump).
   
   A. Ensure suction valve(s) is fully open (i.e., handle(s) parallel to piping).
   
   B. Check suction indicator. This indicator shows a positive pressure with the motor stopped and the suction line valve open. It should not drop to more than a 0.5 psi vacuum with the motor on and the chain jack cycling.
   
   C. Check oil level.
   
   D. Check oil type and weight. If oil viscosity is too high, pump may cavitate.

2. Motor will not start

   A. Oil level and/or temperature switch may have shut off motor/pump. Check that the motor starters are enabled. Check motor isolator/circuit breaker.
   
   B. Check the motor starting wires and connections to ensure that they are connected properly. Remove any corrosion and moisture from terminals and contacts.
C. Check the continuity of the starting wires and terminals.

D. Verify proper motor voltage and frequency.

3. Pump Motors Over-Heat

A. Check for proper motor voltage and frequency

B. Check for over heating of motor bearings

C. Check for motor to pump misalignment and proper ventilation.

4. Oil Overheating

A. Ensure bypass valve BV3 position “UNLOAD” is selected when chain jack is not cycling for long periods.

B. Ensure that heat exchanger is not clogged and fan is running when oil warms up to operating temperature (warning indicator will illuminate at the same time that the fan starts).

C. Ensure that the reservoir is within limits on sight gauge.

NOTE: WHEN RUNNING THE HPU FOR LONG PERIODS WITHOUT USING THE CHAIN JACK, TURN THE BYPASS VALVE, BV3 TO THE “UNLOAD” POSITION TO CIRCULATE OIL THROUGH THE HEAT EXCHANGER.
5. Low Pressure

A. Check all piping for external leakage.

B. Check suction strainer indicators (gauges) and pressure gauges on HPU control panel.

C. Check pump compensator settings and system relief valve settings.

D. Ensure BV3 is switched to “LOAD” to build pressure.

E. If all external lines are in good condition, all selector valves are positioned correctly, the pumps may require servicing. Contact factory representative for assistance.
8.3 TROUBLESHOOTING PROCEDURES FOR CHAIN JACKS

1. Cylinders will not extend, load does not lower.

WARNING:
THE PILOT LINE MAY BE UNDER PRESSURE. SHUT THE POWER
UNIT OFF. CYCLE THE MAIN LIFT/LOWER CONTROL VALVE
SEVERAL TIMES WITH THE POWER UNIT OFF TO RELIEVE
PRESSURE PRIOR TO OPENING THE SYSTEM.

A. Check pressure in extend side of control valve in the console
   by plumbing in a test gauge. It should be as indicated on the
   hydraulic schematic.

B. Check load holding valve in-line filter inside load holding
   valve manifold pilot port. If the filter is clogged, pilot pressure
   may not reach the valve and shift it to allow flow out of the
   cylinder.

2. Cylinders fail to retract, load is not raised.

A. Check that BV3 is in the "LOAD" position.
B. Verify pressure registers on the gauge at the control console. If pressure is low and the load does not move the power unit may be malfunctioning. Refer to 6.6. Nominal pressure is 4900 psi. This pressure will be indicated when the cylinders are fully retracted with the valve held in the “CYLINDER RAISE” position. Pressure is also seen at HPU pressure gauges when BV3 is in the “LOAD” position.

C. Load is greater than the chain jack stall capacity of 550 kips.

3. Cylinders creep, extend slowly, with valve in neutral position.

A. Chain Jack relief valve set too low. Check for flow over the valve. Listen for a hissing sound. Flow may also be checked by holding onto the tubing immediately next to the relief valve. If it is hot and vibrating, flow is present. See section 6.6 for relief valve setting check.

B. Cylinder piston seals leaking. Refer to 6.3.

C. Load is greater than the chain jack stall capacity of 550 kips.

8.4 TROUBLE SHOOTING PROCEDURES FOR CONTROL CONSOLE

1. Low Pressure

A. Check all tubing for external leaks.

B. Ensure selector valves on Control Console and HPU are correctly positioned and full over against mechanical stops.
C. See Section 6.6 on pressure setting.

D. If all external lines are in good condition, all selector valves are positioned correctly, and relief valve adjustment does not correct for loss of pressure, the hydraulic power supply may need attention.

2. Low Flow

A. Ensure that selector valves are properly positioned and full over against mechanical stops.

B. Check for external leaks.

8.5 LOAD MONITORING SYSTEM

1. Load Indication Gauge reads different load (when chain is on hydraulics) than load cell instruments indicate (when chain is on stopper).

A. Check Load Indication (pressure) Gauge calibration. Recalibrate if necessary.

B. Open Load Cell Instrument Enclosure and inspect wiring and that all signal conditioners lights are illuminated. (Green Power ON normal; over range Red light may indicate a problem)

C. Re-tare the display with no chain load on the stopper.
# 9.0 ENGINEERING DRAWINGS

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<th>TITLE</th>
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<td>DWG-102140</td>
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APPENDIX