1.0 Scope

This procedure covers the minimum technical requirements for cleaning and flushing of Hydraulic Systems and Piping, and related accessories.

2.0 Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit.

The initial cleanliness level of a hydraulic system can affect its performance and useful life. Unless removed, particulate contamination present after manufacture and assembly of a system can circulate through the system and cause damage to the system components. To reduce the probability of such damage, the fluid and the internal surfaces of the hydraulic fluid power system need to be flushed clean to a specified level.

Flushing of lines in a hydraulic system needs to be viewed as one means of removing in-built and residual contamination.

2.1 Flushing Procedure (see Sub-Section A.1)

2.1.1

2.1.2 Perform oil flushing to reach target cleanliness level.

2.1.3 Inspect and verify that the cleanliness level was achieved.

2.1.4 Follow the proper steps when disassembling the flushing loops to prevent contaminants from entering the cleaned system. Seal off all components with plugs, blind flanges, etc.

2.1.5 Perform routine maintenance to stabilize contaminant levels to within control targets.

2.1A Strategy for Maintaining Cleanliness After Flushing

2.1A.1 Prevent new contaminants from entering.

2.1A.2 Select suitable system filters. New oil should be filled through a system filter or another suitable filter.

2.1A.3 All new components and/or modules to be connected to the system must meet the preceding requirements.
2.1B Flushing Strategy Tips

2.1B.1 Connect circuits in series.

2.1B.2 Components that can be damaged by high fluid velocity, particles should be isolated from the flushing circuit and cleaned individually.

2.1B.3 Components that restrict the flow rate, and thereby increase the pressure drop, should be isolated from the flushing circuit and cleaned individually.

2.1C.3 Manifolds, blocks, pump stations, motors, reservoirs, assemblies and components should be delivered clean according to a specific procedure. If not clean, they must be flushed separately. This also applies where space does not allow flushing of installed piping system.

**EXCEPTION:** Inserta Style Check Valves that are placed inline of the return Piping (These Valves shall remain in place due to the severity of Oil Spillage Versus potential cleanliness issues. The removal of these said Check Valves would pose more of a Oil Spill Probability than an issue with oil contamination or system failure). The Inserta style Check Valves shall be checked for proper operation by the verifying the back pressure in the return lines. (The Check Valve will Store approx 15 psi of back pressure, when the hose end of the line attached to the pipe with the check valve is cracked the pressure will force oil a little bit at a time out of the joint. If the check valve is stuck open with foreign matter then the back pressure will not be present in the return line.)

2.2 General Requirements

2.2.1 All pipe systems shall be flushed to the NFPA accepted standard, ISO 23309 or applicable engineering drawing.

2.2.2 Pipe subassemblies may be tested either separately or assembled.

2.2.3 All fabrication, welding and non-destructive examination shall be completed and accepted before the flushing procedure.

2.2.4 Vents and other connections that can serve as vents shall be open during filling so that all air is vented prior to the application of flushing procedure.

2.2.5 Pressure Tests shall be completed after the flushing procedure is complete.

2.2.6 Dynamic testing of all hydraulic systems shall take place after system flushing to ensure that system is free of leaks.

2.2.7 Adequate Hydraulic filtration and testing equipment shall be installed prior to the beginning of the hydraulic flushing procedure.

2.2.8 Equipment that is not to be included in the procedure shall be isolated or removed from the system.
2.2.9 Flushing Procedure to be maintained until the equipment manufactures recommended cleanliness level is achieved or to ISO 15/13/10 if not specified.

2.2.10 A new filter shall be installed and flushing procedure continued when the cleanliness level no longer drops and has not met the specified cleanliness level. All dirty filters shall be opened and inspected before continuing the flushing procedure.

2.2.11 Approximate volume of Hydraulic Oil to be used and disposed - 10 - 15 Gallons.

2.3 Test Equipment

2.3.1 All gauges and recorders used during flushing procedure shall be tested and certified prior to pressure testing. (Reference 2010 BP Alaska Safety Handbook, pages 80 thru 82 for testing intervals)

2.3.2 The use of a Certified Hydraulic Particle Counter shall be used to record the cleanliness level of the fluid in time increments of 3 min.

2.3.3 A flushing unit equipped with the adequate pump and motor combination to meet or exceed the Reynolds number of turbulent flow of the working fluid shall be used. This flushing unit shall be complete with hydraulic reservoir, adequate filtration, and ancillary equipment to meet or exceed flow requirements.

2.4 Test Duration

The flushing procedure duration shall be in accordance with the applicable engineering drawing. If the test duration is not specified on the engineering drawing, or other separate document, the duration shall be maintained until a minimum Sawyer Systems Standard Cleanliness level or below has been reached. Once samples from the system indicate the specified cleanliness level has been reached for three consecutive test intervals; continue flushing for at least 30 more minutes at turbulent flow.

2.5 Test Fluid

2.5.1 The test fluid shall be Hydraulic Fluid that is specified by the equipment manufacturer, to be tested and shall not contain suspended solids that may plug small lines. The temperature of the fluid during testing shall not be less than 100 degree F.

2.5.2 Sufficient precautions shall be taken to avoid excessive pressure
2.6 Completion of Flushing Procedure

2.6.1 Debris shall be cleaned from all lines after testing.
2.6.2 Filters will be checked for cleanliness and inspected for component failure or damage.
2.6.3 Strainers shall be emptied and cleaned.

2.7 Sawyer/Contractor Requirements

2.7.1 Contractor or approved subcontractor shall carry out the required inspection and testing.
2.7.2 Contractor shall ensure that tests do not result in damage to equipment.
2.7.3 Contractor shall ensure that all applicable portions of the system are tested.
2.7.4 Contractor shall notify Customer of all repairs.
2.7.5 Contractor shall advise Customer in advance of pressure testing.

2.8 Testing Documentation Requirements

2.8.1 Test reports and test results shall be submitted to Customer after completion of pressure tests and prior to shipment or acceptance of the equipment.
2.8.2 Charts shall be signed by the Contractor representative and Customer after completion of the test.
2.8.3 Contractor shall maintain records of all cleanliness records for the duration of the tests.
2.8.4 As a minimum, the test records shall contain the following:
   - Date of test
   - Equipment and line number
   - Design pressure
   - Cleanliness Level Records for duration of testing
   - Test medium
   - Remarks that describe extent and location of observed defects
   - Certification of results by examiner
   - Certification files for all pressure relief valves, test gauges, and particle counter.
**SUBSECTION A.1 (continued)
Hydraulic Flushing Lines Flushing Procedure**

Sign off on each section only after it is completed. Include notation of any punch list items.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>INITIALS</th>
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<tbody>
<tr>
<td></td>
<td><strong>PRELIMINARY CHECKLIST –</strong></td>
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<tr>
<td>A.1</td>
<td>Flushing HPU connected and filled with proper fluid.</td>
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<tr>
<td>A.2</td>
<td>New / clean filter elements installed in flushing HPU.</td>
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<tr>
<td>A.3</td>
<td>Flushing hoses connected</td>
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<tr>
<td></td>
<td><strong>FLUSHING PROCEDURE</strong></td>
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<tr>
<td>B.1</td>
<td>Check connections with clean, dry air. Fix any leaks</td>
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<td>B.2</td>
<td>Pressure outlet from flushing unit connected to circuit. inlet to flushing</td>
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<tr>
<td>B.3</td>
<td>Return to flushing unit connected to flushing unit return header.</td>
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<tr>
<td>B.4</td>
<td>Connect particle counter to flushing return header and function check.</td>
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<td>B.5</td>
<td>Job Safety Meeting held</td>
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<tr>
<td>B.5.1</td>
<td>Recheck that all hoses connections are tight.</td>
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<td>B.5.2</td>
<td>Check that all ball valves are in proper position.</td>
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<td>B.6</td>
<td>Radio check that spotters are in position.</td>
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<td>B.7</td>
<td>Start flushing unit and begin supplying oil while checking for leaks.</td>
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<td>B.8</td>
<td>Continue purging and filling hydraulic lines for 15 minutes.</td>
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<td>B.9</td>
<td>Start particle count and note initial cleanliness reading: ISO</td>
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<tr>
<td>B.10</td>
<td>Continue flushing until cleanliness code is reached.</td>
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<td>B.11</td>
<td>Cleanliness code ISO __________ attained.</td>
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<td>B.12</td>
<td>Attach particle counter print tape of cleanliness summary</td>
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<tr>
<td>ITEM</td>
<td>DESCRIPTION</td>
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<td>B.13</td>
<td>Reduce flow to zero</td>
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<td>B.14</td>
<td>Flushing completed, proceed to Dynamic pressure test</td>
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<td>B.15</td>
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