**DOCUMENT RELEASE AND CHANGE FORM**

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By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08FR14800

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2. **Title:** Safety-Significant Extended Reach Sluicer System Hydraulic System Pressure Reducing Devices - Functions and Requirements Evaluation Document

3. **Project Number:** T2R29, T2R02

4. **Design Verification Required:** ☒ Yes ☐ No

5. **USQ Number:** TF-16-1014-D R0

6. **PrHA Number**
   - PRHA-02038
   - PRHA-02039
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7. **Approvals**

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8. **Description of Change and Justification**

This DRCF revises RPP-RPT-51989 from Revision 1B to Revision 2.

Problem: The longer boom length of the ERSS designed for AX retrievals has driven the need to qualify the process hoses to a higher tensile load on the 1 ½” EPDM hose internal to the sluicer than previously used. This allows for the operating pressure of the hydraulic system to be increased to improve functionality of the sluicer. The increase in tensile strength allows for the PRVs to be adjusted to higher relief pressures.

Solution: Modify Section 6.1 and Section 8.0 to include ERSSs qualified to a higher tensile strength and corresponding PRV set pressure.

Testing/Analysis: Hose testing is to be performed on a per hose lot basis as usual. ERSSs qualified for 2500 pounds of tensile force have had the corresponding PRV set pressures for the hose reel and boom extension calculated in 58195-000-SUB-008-010 Rev.0 and 58195-000-SUB-011 Rev.0, respectively. Hose qualification and PRV set pressure analyses at 2500 lbs tensile strength have been conducted in the same manner as the previous sluicers qualified to 1847 lbs tensile strength.

9. **TBDs or Holds** ☒ N/A

10. **Related Structures, Systems, and Components**

    a. **Related Building/Facilities** ☐ N/A
    b. **Related Systems** ☐ N/A
    c. **Related Equipment ID Nos. (EIN)** ☐ N/A

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11. **Impacted Documents – Engineering** ☐ N/A

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12. **Impacted Documents (Outside SPF):**
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13. **Related Documents** ☐ N/A

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Safety-Significant Extended Reach Sluicer System
Hydraulic System Pressure Reducing Devices -
Functions and Requirements Evaluation
Document

Prepared by JP Witherspoon
Washington River Protection Solutions
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

Key Words: Functions, requirements, commercial grade dedication, critical characteristics, Extended Reach Sluicer System, ERSS, CGD, TFC-ENG-DESIGN-C-45.

Abstract: This document provides the evaluation and supporting data for the safety-significant extended reach sluicer system hydraulic system pressure reducing devices for their abilities to perform safety functions under those conditions and events for which the safety function is required in accordance with TFC-ENG-DESIGN-C-45, "Control Development Process for Safety Significant Structures, Systems, and Components."

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Approved For Public Release
Safety-Significant Extended Reach Sluicer Hydraulic System Pressure Reducing Devices - Functions and Requirements Evaluation Document

JP Witherspoon
Washington River Protection Solutions, LLC

Date Published
November 2012

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Office of River Protection
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<tr>
<td>C of C</td>
<td>Certificate of Conformance / Certificate of Compliance</td>
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<td>CGD</td>
<td>Commercial Grade Dedication</td>
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<td>DOE</td>
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<tr>
<td>EIN</td>
<td>Equipment Identification Number</td>
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<tr>
<td>EPDM</td>
<td>Ethylene Propylene Diene Monomer</td>
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<td>ERSS</td>
<td>Extended Reach Sluicer System</td>
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<td>safety equipment compliance database</td>
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<td>Stainless Steel</td>
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<td>SSC</td>
<td>System, Structure, and Component</td>
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<td>TFC</td>
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### UNITS

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<td>Degrees Fahrenheit</td>
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<tr>
<td>cSt</td>
<td>CentiStokes</td>
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<tr>
<td>gpm</td>
<td>gallons per minute</td>
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<td>HP</td>
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<tr>
<td>in</td>
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<tr>
<td>lb/in²</td>
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1.0 PURPOSE

The purpose of this document is to describe the evaluation of the extended reach sluicer system (ERSS) hydraulic system pressure reducing devices ability to perform their safety function(s) under those conditions and events for which the safety function is required. This document identifies the related system, structure, and components (SSCs); critical characteristics; functional and performance requirements; failure modes; boundaries; interfaces; required support systems, and the key aspects.

2.0 APPROACH

The safety function of the ERSS hydraulic system pressure reducing devices was developed based on control development for the safety-significant ERSS process hose. Functional/performance requirements were developed by evaluating the required performance needed to accomplish the safety functions (i.e., prevent or mitigate accidents). Additional applicable functional requirements were developed during engineering evaluations of failure modes when the ERSS safety significant hydraulic system pressure reducing devices must perform their safety function.

This evaluation was done in accordance with TOC procedure TFC-ENG-DESIGN-C-45, “Control Development Process for Safety-Significant Structures, Systems, and Components.” The following information is provided in this document:

1. Identification of the safety-significant boundaries for the ERSS safety significant hydraulic system pressure reducing devices.

2. Documentation of support systems required for the ERSS safety significant hydraulic system pressure reducing devices to perform their intended safety functions.

3. An evaluation of interfacing systems whose failure could prevent the ERSS safety significant hydraulic system pressure reducing devices from performing their intended safety functions.

4. Documentation of safety SSC functional and performance requirements necessary for the ERSS safety significant hydraulic system pressure reducing devices to perform their safety functions. The safety SSC functional and performance requirements were identified from design requirements, engineering evaluations and calculations, the interactive hazard/accident analysis safety controls development/evaluation process, and process hazard analysis.
5. Critical characteristics necessary for the ERSS safety significant hydraulic system pressure reducing devices to perform their safety functions, and identification of how the critical characteristics can be verified to be met. Critical characteristics may be used in the commercial grade dedication (CGD) process to provide reasonable assurance the safety SSC is acceptable and will perform its safety-related function.

Using information from the evaluation described above, critical characteristics for the ERSS safety significant hydraulic system pressure reducing devices were identified. Subsequent to determining the critical characteristics, key performance requirements were identified. This consisted of identifying any inspections, tests, evaluations or controls needed to verify compliance with critical characteristics.

Compliance with the critical characteristics identified in this Functions and Requirements Evaluation Document shall be verified and documented. Acceptable means of verification can be accomplished by one or more of the following means:

- Procurement from a qualified supplier
- Commercial grade dedication
- Technical evaluation
- Nonconformance report (NCR) disposition (see note below)
- Testing
- Inspection
- Code compliance
- Certificate of Compliance (C of C) or material certification.

NOTE: The NCR process shall be used to upgrade an existing SSC when the SSC was not procured as safety-significant through a qualified supplier or the CGD process. A Technical Evaluation (refer to TFC-ENG-FACSUP-C-02) shall determine how the FRED critical characteristics were verified and shall be listed in the Safety Equipment Compliance Database (SECD).

Documented evidence of compliance is identified in the SECD (refer to TFC-ENG-FACSUP-C-23 and TFC-ENG-FACSUP-CD-23.3).

3.0 SCOPE

The scope of this evaluation includes the ERSS safety significant hydraulic system pressure reducing devices which prevent the sluicer extend/retract cylinders and the hydraulic motor that controls the hose reel from exceeding the test tension loads for the safety-significant process hose.

Note: The process hose, swivel joints and hard piping above the riser are safety-significant and considered primary piping. Evaluation of primary piping components is found in RPP-RPT-42297, Safety-Significant Waste Transfer Primary Piping System – Functions and Requirements
4.0 SAFETY FUNCTION

The safety function of the ERSS hydraulic system pressure reducing devices is to prevent the loss of the safety function of ERSS process hoses. The ERSS hydraulic system pressure reducing devices limit the hydraulic pressure and, therefore, the force that can be applied on the process hoses by the hydraulic cylinders that extend and retract the ERSS sluicer boom and by the hose reel hydraulic motor.

5.0 SYSTEM DESCRIPTIONS

Parts of the ERSS design includes a 1 ½” EPDM hose (process hose) that travels into and out of the ERSS as the boom is extended and retracted. A hose reel with an attached hydraulic motor provides a smooth feed of the hose as it travels through the structure. Multiple hydraulic system pressure control components are installed to protect the EPDM hose from tension force that exceeds the force applied during hose burst testing. These include pressure reducing valves on the individual hydraulic circuits. An in-line filter is installed to protect the pressure reducing valves. The ERSS is located in an enclosure located at an above-ground riser on the Single-Shell Tanks (SST) with the hydraulic manifold assembly that includes the pressure reducing valves and filter on a skid located above ground some distance away. The principal components required to protect the process hose from excess tension forces are pressure reducing valves on both the boom extension circuit and the hose reel circuit and the filter.

5.1 OVERALL DESCRIPTION

The hydraulic system is run by a hydraulic power unit (HPU) that is located above the ground some distance away. The pressure and return line of the HPU feeds to a separate valve manifold that then splits the hydraulic power into different circuits, depending on what function is actuated. Figure 1 outlines this general layout of the ERSS system. Only the boom extend/retract circuit and the hose reel circuits have any potential to put tension on the process hose. Therefore only the pressure reducing valves on these circuits are required to be safety significant to protect the process hose. A P&ID showing the hydraulic system with only these two circuits is attached in Appendix C. The pressure reducing valves on these circuits are general, industry used, hydraulic pressure reducing valves that regulate to a set pressure. At flows higher than the rated capacity, the pressure reducing valves’ efficiency decreases causing a pressure loss through the pressure reducing valve, thus reducing the discharge pressure below the pressure reducing valve set pressure.
The hose reel pressure reducing/relieving valve is used in combination with an electro-proportional valve and coil for smoother operation of the hose reel. The electro-proportional valve and coil allow for variable control of the pressure reducing valve set point. The coil is a separate component from the electro-proportional valve, but they are shown together in figure 2 for simplicity. Varying the input signal controls the setting of the electro-proportional valve. The electro-proportional valve is connected to the main stage pressure reducing/relieving valve.
The electro-proportional valves can come with normal or inverse settings. Valves with inverse settings are set in the closed position with a maximum pressure setting and reduce the pressure as the electrical current increases. This inverse setting is used to control the hose reel pressure. To improve the operability of the hose reel the electric coil is connected with the ERSS control console, so when the control console is de-energized the electro-proportional valve is at its maximum pressure setting. When control console is powered on, the current through the coil decreases the pressure setting of the electro-proportional valve. The coil does not have to be analyzed any further in this document as it cannot increase the circuit pressure. Note that even though figure 2 calls this a ‘relief’ valve, it is more accurately described as a reducing valve as it will reduce the system pressure, not relieve pressure.

The pressure reducing valve on the boom extension circuit is a pilot operated hydraulic cartridge valve. Different than the electro-proportional valve, this pressure reducing valve can only have a single set point that is adjusted by a set screw. Once the valve is set, a tamper resistant cover is installed to prevent valve adjustment.

A safety significant inline filter is placed in the hydraulic line prior to pressure reducing valves. It is used to maintain the cleanliness of the hydraulic oil going through pressure reducing valves, preventing any debris that could cause a failure of the pressure reducing valves. The basic components of the inline filters consist of a replaceable filter element assembled with o-rings inside a metal filter housing. The safety significant filter is located on the hydraulic manifold such that there are no quick disconnects between the filter and the safety significant pressure reducing valves. If any of the quick disconnects, whether upstream or downstream of the pressure reducing valves, were to become disconnected and introduce contaminants into the system once reconnected, that contaminated fluid would be forced through the filter ensuring the pressure reducing valves only see clean hydraulic fluid. Appendix C shows a hydraulic schematic.
5.2 BOUNDARIES

The boundaries of the safety-significant ERSS hydraulic system pressure reducing devices are the pressure reducing valves and the inline filters. These items are located on the WRPS P&IDs. The boom extension pressure reducing valves are labeled as PORxxx-WT-V-101, hose reel electro-proportional valve as PORxxx-WT-V-102 and filter as PORxxx-WT-F-101.

Figure 3 – Example of a P&ID That Includes the Safety Significant Components
5.3 INTERFACES

No interfaces have been identified that would affect these safety significant hydraulic system reducing devices from performing their safety function.

6.0 SYSTEM EVALUATION

6.1 FUNCTIONAL/PERformance REQUIREMENTS

The functional requirement is that the ERSS safety significant hydraulic system pressure reducing valves have set pressures that limit the hydraulic system pressure to the hydraulic cylinders that extend and retract the sluicer boom and to the hydraulic motor that controls the hose reel. Limiting the hydraulic pressure prevents the hydraulic cylinders and hydraulic motors from applying tension loads (forces) that exceed the tension load applied during burst testing of the safety-significant ERSS process hoses. The minimum burst pressure for new hoses is based on RMA/IP-2/2003, *The Hose Handbook*. The hose is tested by applying the maximum tension as limited by the safety-significant hydraulic system pressure control components and then the internal pressure is increased to hose failure to show that the burst pressure is at least four times the ERSS process hose design pressure.

ERSSs Rated to 1847 lbs Tensile Load

With the measured tensile load on the 1 ½ inch hose at 1847 lbs, the burst pressure is at least 1600 psig (four times the process hose design pressure of 400 psig). This test was performed three times on the ERSS process hose lot to determine any variability in the test data due to inconsistencies in the test method or hose composition. The functional requirement of the safety-significant hydraulic system pressure reducing valves is to limit the tension on the process hose to 1847 lbs. Based on the design of the boom extend/retract hydraulic cylinders this equates to limiting the boom extension hydraulic pressure to ≤ 847 psig (VI-50713, Supp. 3 & 4). Based on the design of the hose reel and hydraulic motor, this equates to limiting the hose reel circuit hydraulic pressure to ≤ 2802 psig (VI-50713, Supp. 3 & 4).

ERSSs Rated to 2500 lbs Tensile Load

With the measured tensile load on the 1 ½ inch hose at 2500 lbs, the burst pressure is at least 1600 psig (four times the process hose design pressure of 400 psig). This test was performed three times on the ERSS process hose lot to determine any variability in the test data due to inconsistencies in the test method or hose composition. The functional requirement of the safety-significant hydraulic system pressure reducing valves is to limit the tension on the process hose to 2500 lbs. Based on the design of the boom extend/retract hydraulic cylinders this equates to limiting the boom extension hydraulic pressure to ≤ 1205 psig (58195-000-SUB-008-011 Rev.0). Based on the design of the hose reel and hydraulic motor, this equates to limiting the hose reel circuit hydraulic pressure to ≤ 3297 psig (58195-000-SUB-008-010 Rev.0).
The functional requirement of the safety significant inline filters is to maintain the cleanliness of the hydraulic oil going through the pressure reducing valves, preventing failure of the pressure reducing valves due to plugging/fouling. Vendor fluid filtration recommendations list a fluid cleanliness code of 19/17/14 for cartridge valves (e.g. pressure reducing valves) and 15/13/11 for electro-proportional valves. These codes are taken from and explained in ISO 4406, *Hydraulic Fluid Power – Filter – Method for Coding the Level of Contamination by Solid Particles*. Of these components, the electro-proportional valve is the limiting item that needs protecting. The fluid cleanliness rating that the filters maintain is verified by testing in accordance with ISO 16889-2008, *Hydraulic Fluid Power – Filter – Multi-Pass Method for Evaluating Filtration Performance of a Filter Element*.

There are other engineering design features on the ERSS hydraulic system that control the hydraulic circuit pressures. These features are not credited as safety-significant; however they provide important engineered functions so that the ERSS works properly.

### 6.2 FAILURE MODE EVALUATIONS

#### 6.2.1 Loading Conditions

The following are the loading conditions that were evaluated:

- **Dead Load**: There are no dead loads on these safety significant hydraulic system pressure reducing devices. This is accommodated in the design of the hydraulic manifold.

- **Snow Loads**: Snow loads on these safety significant hydraulic system pressure reducing devices are negligible and easily accommodated by the design.

- **Wind Loads**: Wind loads on these safety significant hydraulic system pressure reducing devices have no influence on their operability and is accommodated by the design.

- **Ash Fall Loading**: Ash fall loads on these safety significant hydraulic system pressure reducing devices are negligible and easily accommodated by the design.

- **Earth and Groundwater Pressure**: This loading condition is not applicable as these safety significant hydraulic system pressure reducing devices are located above grade.

- **Vehicle Traffic**: The ERSS is designed so that it will not operate if the hydraulic fluid flow is cut off from either the pressure or return side. If a vehicle runs over a hydraulic line, the system will fail safe.

- **Vehicle Impact**: The safety significant hydraulic system pressure reducing devices are not designed to function during or after a vehicle collision.

- **Blast Effects**: The safety significant hydraulic system pressure reducing devices are not designed to function during or after blast effects/missiles from propane/LPG tank explosions

- **Earthquake Loads**: The safety significant hydraulic system pressure reducing devices are not credited to perform their safety function during or after a seismic event.
Thermal Forces: These safety significant hydraulic system pressure reducing devices are self protective of high system pressures that could result from thermal expansion. These will not see significant stresses or movements that could impact the safety function over the design temperature range.

Creep and Shrinkage Loads: Creep and shrinkage loads are not an applicable failure mode for these safety significant hydraulic system pressure reducing devices.

Hose Whip: All hydraulic hoses are physically connected at both ends; therefore hose whip is not an applicable failure mode.

Load Drops and Undermining from Failed Water Hoses: Undermining from broken water hoses is not an applicable failure mode for these safety significant hydraulic system pressure reducing devices. No conditions other than water runoff have been identified that could potentially cause undermining. C-farm was designed so that water runoff is channeled away from the farm and would not impact equipment; therefore this is not an applicable condition. Additionally, there are no water lines that are continuously pressurized located near these hydraulic components.

Vibrations: The valves and filter can function under moderate vibrations (less earthquakes and blast effects).

6.2.2 Process Conditions

The following are the process conditions that were evaluated:

Process Pressure/Vacuum: Over pressure failure of the pressure reducing valves or filter assembly will not fail the safety function. Over pressure of these components would cause the cause the valve to fail in the closed position; eliminating any flow downstream except for minor weepage past the pilot.

As debris collects on the filter element the pressure differential across the filter will increase. The filter element was selected with a high collapse rating of 3000 psi differential so that a substantial pressure differential across the filter due to plugging does not affect the integrity of the filter.

Process Temperature (Low): Pressure reducing valves are not influenced by changes in fluid viscosity as a result of lower process temperatures. According to the manufactures literature, the pressure reducing valves are designed to operate at temperatures down to -40 °F which is lower than the minimum process (hydraulic fluid) temperature of -25 °F (equal to the minimum outdoor temperature, see environmental conditions below). An e-mail from the manufacturer of the safety significant filter in Appendix B states that the limiting components are seals in the head to bowl and the indicator. When used in a static condition (not flexing or constantly moving), such as this case, these seals can withstand temperatures below -25°F. Low process temperature is not a credible failure mode.

Process Temperature (High): Pressure reducing valves are not influenced by changes in fluid viscosity as a result of higher process temperatures. According to the manufactures literature, the pressure reducing valves are designed to operate at
temperatures up to 200°F. Also according to the manufactures literature, the hydraulic filter assembly is designed to operate at temperatures up to 250°F. These high temperature ratings are due to the seals for both the pressure reducing valves and filter assembly. It is unknown how high the process temperature can reach; however failure due to these seals would result in a fail-safe condition. Engineering controls shutdown the hydraulic power unit if temperatures reach 190+/−5°F preventing any further increase in temperature. It would require multiple failures in order to achieve temperatures above 190+/−5°F. There are no heat sources other than the HPU and environmental temperatures.

**Process Chemistry:** The hydraulic system safety-significant pressure reducing valves consist of carbon steel with Buna-N seals, which are materials that are compatible with hydraulic fluid, including Quaker Quintolubric® 888-46 hydraulic fluid (Quaker Technical Data, *Quintolubric 888-46 – Fire Resistant Hydraulic Fluid* and e-mail from manufacturer as included in Appendix B). The use of Quaker Quintolubric® 888-46 hydraulic oil is protected by configuration management via configuration controlled drawings and the work control process.

The hydraulic system safety-significant filter assembly consists of many different metallic and non-metallic components. To ensure material compatibility with Quaker Quintolubric® 888-46 hydraulic oil, the filters will be tested to ISO2943, “Hydraulic Fluid Power – Filter Elements – Verification of Material Compatibility with Fluids” prior to installation.

**Fluid Expansion Effects (e.g., Thermal):** Any effects seen by fluid expansion would be insignificant since both the pressure and return lines would see similar expansion; therefore there would be no fluid movement.

**Erosion:** The ERSS hydraulic system is designed so that any erosion is insignificant.

**Corrosion:** These safety significant hydraulic system pressure reducing devices consist of materials that are designed to be compatible with hydraulic fluid. See Section 6.2.2 “Process Chemistry.”

**Radiation Fields:** The safety significant hydraulic system pressure reducing devices are located above grade (not in pit or tank). Radiation fields are insignificant and do not impact these components from performing their safety function.

**Plugging by Waste:** The process fluid only consists of hydraulic oil; therefore plugging by waste is not applicable.

**Plugged Filters (High Delta Pressure):** When the filters become plugged, the flow is reduced and the system fails safe. See Section 6.2.2 “Process Pressure/Vacuum” for discussion on pressure differential across the filter.

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1 Quintolubric is a registered trademark of Quaker Chemical Corp., Conshohocken, Pennsylvania
Flammable Gas Deflagration/Detonations within Process Equipment: Process conditions only consist of hydraulic oil; therefore flammable gas deflagration/detonations are not applicable conditions to these hydraulic system safety significant components.

Plugging/Fouling (other than filters): Plugging/fouling of the safety significant pressure reducing valves may prevent them from performing their safety function. When connecting the quick disconnects on the system, dirt and debris may be introduced into the hydraulic lines. A safety-significant filter is strategically located on the pressure side of the hydraulic manifold to mitigate the pressure reducing valves from plugging by ensuring all hydraulic fluid passes through the filter prior to the safety-significant pressure reducing valves with no quick disconnects between them. According to manufacturer’s recommendation, maintaining a fluid cleanliness of 15/13/11 or better is necessary to adequately protect the electro-proportional valve.

It is acknowledged that the pressure reducing valve for the hose reel may see reverse flow. There is a bleed line on the hose reel circuit that allows for constant forward flow during idle conditions. This ensures that clean fluid will be circulated through the hose reel hydraulic circuit. Any particulates that may have been in those lines will be flushed back to the HPU, forcing them to be captured by the HPU return line filter, the pressure filter, and/or the safety significant filter before they enter the valve manifold again. No other failure modes have been identified due to plugging/fouling.

6.2.3 Environmental Conditions

The following are the environmental conditions that were evaluated:

Temperature – Low: TFC-ENG-STD-02, “Environmental/Seasonal Requirements for TOC Systems, Structures and Components,” requires in Section 3.1.1, “Temperature,” that Tank Farm SSCs be designed to withstand outside ambient temperatures down to -25°F. An e-mail from the manufacturer of the safety significant filter in Appendix B states that the limiting components are seals in the head to bowl and the indicator. When used in a static condition (not flexing or constantly moving), such as this case, these seals can withstand temperatures below -25°F. The functionality of the components at the low hydraulic (process) temperature is discussed in Section 6.2.2 “Process Temperature (Low).” The safety significant pressure reducing valves are all rated down to -40°F according to the manufacturer’s literature.

Temperature – High: TFC-ENG-STD-02, “Environmental/Seasonal Requirements for TOC Systems, Structures and Components,” requires in Section 3.1.1, “Temperature,” that Tank Farm SSCs be designed to withstand outside ambient temperatures up to 115°F. According to the manufactures literature, the pressure reducing valves are designed to operate at temperatures up to 200°F. Also according to the manufactures literature, the hydraulic filter assembly is designed to operate at temperatures up to 250°F.

Thunderstorms, Dust, and Ice Glaze: The system is designed to work in outdoor environmental conditions. The internal functioning components of the pressure reducing
valves are not subject to dust or ice glaze. They are protected by the safety significant filter.

**Solar Radiation (e.g., Direct Affects/Damage due to Exposure to UV):** The safety significant hydraulic system pressure reducing valves exteriors are metallic and are not subject to failure due to exposure to solar radiation. The safety significant filter assembly is designed of materials that are designed to work in an outdoor environment and are not subject to failure due to exposure to solar radiation.

**Atmospheric Pressure:** No failure modes have been identified related to atmospheric pressure.

**Ash (Exposure to Ash Particles):** The system is designed to work in outdoor environmental conditions. The internal functioning components are not subject to ash. They are protected by the safety significant filter.

**Exposure to Water (e.g., Humidity/Condensation, Precipitation, and Flooding by Service Water):** The system is designed to work in outdoor environmental conditions. No failure modes have been identified due to exposure from water.

**Exposure to Leaked Fluids Other Than Water:** Hydraulic fluid is the only other fluid the system will be exposed to. See section 6.2.2 for further analysis with hydraulic fluid.

**Exposure To/Submergence in Leaked Waste:** Exposure to leaked waste is not an applicable condition to these safety significant hydraulic system pressure reducing devices.

**Fires (Range Fires, Vehicle Fires, Refueling Activity Fires, Other Fires):** These safety significant hydraulic system pressure reducing devices are not designed to function during or after exposure to fires (i.e., range fires, vehicle fires, etc.).

**High Radiation Fields:** High radiation field are not an applicable condition to these safety significant hydraulic system pressure reducing devices.

**Flammable Gas Deflagrations in Enclosures:** These safety significant hydraulic system pressure reducing devices are located above grade outside of any waste enclosures (e.g., waste transfer associated structures). Therefore, flammable gas deflagrations in enclosures are not an applicable condition.

**Mechanical Abrasions:** There was no mechanism identified that would result in mechanical abrasion.

### 6.2.4 Other Failure Modes

**Quick Disconnect Not Connected:** If the quick disconnects on either the pressure or return side of these circuits were to not be engaged, or become disconnected due to improper installation, they would not see any hydraulic flow. Without hydraulic flow, that circuit, or possibly the whole system depending on which hose(s) are not connected, will not be able to function, failing in a safe condition.
6.2.5 Aging

The pressure reducing valves are not exposed to uncontrolled environmental conditions in that the internal components are in contact only with hydraulic oil maintained in the recommended ranges of temperature, flow, and pressure during ERSS hydraulic system operation. No failures due to aging of the pressure reducing valves have been identified.

In an e-mail from the filter manufacturer in Appendix B, there is no set shelf life, provided the filters are stored in a dry, indoor environment. There is no set service life. The service life is determined by the pressure drop across the filter (i.e. plugging). This is determined in Section 6.2.2 to not fail the safety function. A shelf/service life of 5 years from the date of manufacture (month/year indicated on the filter) is conservatively established based on other industry recommendations (see Appendix B).

6.3 SUPPORTING SYSTEMS

An evaluation of supporting SSCs for the ERSS safety significant hydraulic system components was performed in accordance with TFC-ENG-DESIGN-C-45, Attachment A, Section 3.0. The purpose of this evaluation was to determine if these components relied on any support SSC’s to perform their intended safety function.

**Electrical Power:** These safety significant hydraulic system components do not need electrical power to perform their safety function.

**Compressed Air:** These safety significant hydraulic system components do not need compressed air to perform its safety function.

**Pressure Relief:** These safety significant hydraulic system components do not need pressure relief to perform their safety function.

**Temperature Control (HVAC):** No HVAC systems are required for these safety significant hydraulic system components to perform their safety function.

**Freeze Protection:** No freeze protection is required for these safety significant hydraulic system components to perform their safety function.

**Cooling:** No cooling systems are required for these safety significant hydraulic system components to perform their safety function.

**Lubrication:** These safety significant hydraulic system components have passive components that have no need for lubrication.

**Filtration:** See Section 6.2.2 “Plugging/Fouling.”

**Water:** Use of water as a support system is not required for these safety significant hydraulic system components to perform their required safety function.

**Other:** No other supporting systems have been identified.
7.0 CONTROLS

7.1 SHELF LIFE AND SERVICE LIFE
A shelf/service life of 5 years for the safety significant filter assembly is conservatively established (see Section 6.2.5). No other shelf life or service life controls are needed for the hydraulic system devices to meet the safety function.

7.2 OTHER CONTROLS

7.2.1 Quality Control
Quality control is also used when performing maintenance specifically on the valve manifold skid and will be maintained through WRPS’s work control processes. When replacing any valves or the filter on this valve manifold skid quality assurance needs to verify that the cleanliness was maintained on the system. This ensures that no particulates or debris will enter the hydraulic system between the safety significant filter and the safety significant pressure reducing valves that could possibly damage the valves. This is required to replace the safety function of the safety significant filters during periods of maintenance. No other controls have been identified.

8.0 SSC CRITICAL CHARACTERISTICS
The critical characteristics of the ERSS safety significant hydraulic system components safety are:

- Pressure Reducing Valve;
  - Set pressure must be as follows on ERSSs rated to 1847 lbs tensile load
    - Hose Reel Circuit: $\leq 2802 \text{ lb/in}^2 \text{ gauge}$.
    - Extend/Retract Cylinder Circuit: $\leq 847 \text{ lb/in}^2 \text{ gauge}$.
  - Set pressure must be as follows on ERSSs rated to 2500 lbs tensile load
    - Hose Reel Circuit: $\leq 3297 \text{ lb/in}^2 \text{ gauge}$.
    - Extend/Retract Cylinder Circuit: $\leq 1205 \text{ lb/in}^2 \text{ gauge}$.
- Filter
  - Filter provides a fluid cleanliness code rating of $\leq 15/13/11$ per ISO 4406 as tested by ISO 16889
  - Material Compatible with hydraulic fluid per ISO 2943
9.0 REFERENCES


APPENDIX A

NOT USED
APPENDIX B

E-MAILS BETWEEN WRPS AND VENDOR CORRESPONDENTS
-----Original Message-----

From: David Caron [David.Caron@hyprofiltration.com]
Sent: Tuesday, November 27, 2012 01:19 PM Pacific Standard Time
To: Bullock, Marshall C
Subject: RE: HY PRO filters

Marshall

Sorry for the delayed response

There is no true recommended service on these type of elements from a time frame point of view. The best decision would always be to monitor fluid cleanliness remotely with a “laser particle counter” or via differential pressure indication on the vessels.

As for the shelf life of the product, the seals have no expiration, and as long as the element is kept in a dry environment for storage there wont be any issues with expiration. The biggest concern is typically that of moisture causing degradation in the plated steel surfaces. The media is a combination of synthetics and micro-glass fiber and does not have a shelf-life.

Regards

David Caron CLS
Operations Development
Hy-Pro Filtration
317-849-3535 office
317-440-0848 cell
317-849-9201 fax

From: Bullock, Marshall C [mailto:Marshall_C_Bullock@rl.gov]
Sent: Monday, November 26, 2012 3:32 PM
To: David Caron
Cc: Fink, Peter K
Subject: FW: HY PRO filters

HI David, I have been working with Charlie on getting some information about these Hy-Pro Filters. WRPS was wondering if there was a recommended service and/or shelf life on these filters we ordered.

Marshall C. Bullock
In House Design Engineering
Procurement Engineering Specialist
Phone: 509-372-1237
Email: Marshall_C_Bullock@rl.gov

Contractor to DOE Hanford Tank Farms
-----Original Message-----
From: David Caron [mailto:David.Caron@hyprofiltration.com]
Sent: Wednesday, November 21, 2012 11:32 AM
To: Fink, Peter K
Cc: Bullock, Marshall C; Bauer, Roger E
Subject: Re: Hy-Pro Filter

Peter,

The operating parameters set forth by the Oring manufacturers are intended for standard production use. I spoke with our provider today in reference to this topic.

The seals have a safety factor built into the design of the compound as well. Knowing the application is industrial static, the seals should still perform at -25 F.

Regards

David Y. Caron C.L.S
Operations Development
317-849-3535 ph
317-849-9201 fax
317-440-0848 cell

On Nov 20, 2012, at 7:25 PM, "Fink, Peter K" <Peter_K_Fink@rl.gov> wrote:

David Caron,

I am a mechanical engineer with WRPS in Washington State. We appreciate your timely response in producing the batch of filters for us. I had a few follow-up questions with these filters that I was hoping you might be able to answer.

Are the fluorocarbon seals the limiting component for the temperature ratings of these filter elements since the temperature rating is in parenthesis next to them on the drawing specification attached? They have a temperature rating down to -20°F; however our design criteria for low temperatures is -25°F. Would these O-rings be able to be used in temperatures down to -25°F, knowing that they will only be used in the designed static condition? Previous O-ring manufacturer’s that we had spoken with gave lower temperature ratings for O-rings that were used in static conditions.

If you could let me know by or before Monday, November 26th, I would appreciate it.

Thank You,

Peter Fink
Retrieval & Closure Engineer
509-373-4470
Peter_K_Fink@rl.gov

Contractor to the United States Department of Energy
Hello Peter,

I found a letter from our division stating the element life shortly after we talked this afternoon. Please note that in the attached letter from our division (hydraulic filter division), we make a general statement that the element orings have a minimum shelf life of 5 years. This is a general statement that only pertains to the elements manufactured here at our division. The Oring division literature in the Oring handbook (http://www.parker.com/literature/ORD%205700%20Parker_O-Ring_Handbook.pdf), section 2 gives a 15yr life depending on storage conditions. I wish I had a more definitive answer for you. You can either error on the side of safety and say 5 years or assume the product will be stored in an environment that is not harmful to the orings (per the oring handbook) and say 15 years. I made a couple of terminology change suggestions to the paragraph you sent. They are only suggestions.

Keith,

I am following up with our conversation earlier to make sure I understood you correctly. Like I had said previously, we purchased filter model number WPF302QHVM2KS162. The limiting component on this filter assembly for shelf life would be the FKM seals. The Parker O-Ring Handbook, Section 2.9 “Age Control” specifies that the storage time for these orings are 15 years. Operating service life of these filters is based on the filter element plugging up causing a greater delta pressure. There is no concern with the filters degrading over time and becoming less efficient (i.e. letting greater sized particles through) with the Microglass III elements that we have selected.

Best Regards

Keith Lemle
Design Engineer
Hydraulic Filter Division
Parker Hannifin HFD
16810 Fulton County Rd #2
Metamora, Ohio 43540
Direct Line 419-644-0287
klemle@parker.com
www.parker.com/hydraulicfilter
From: "Fink, Peter K" <Peter_K_Fink@rl.gov>
To: "klemle@parker.com" <klemle@parker.com>
Date: 07/12/2012 03:23 PM
Subject: WPF Series Filter Aging

Keith,

I am following up with our conversation earlier to make sure I understood you correctly. Like I had said previously, we purchased filter number WPF302QHM2KS162. The limiting component on this filter assembly for shelf life limitations would be the FKM seals. According to the Parker O-Ring Handbook, Section 2.9 “Age Control” specifies that the storage time for these filters are 15 years. During our operation with these filters, the service life of these filters is based on the filter core plugging up causing a greater delta pressure. There is no concern with the filters degrading over time and becoming less efficient (i.e. letting greater sized particles through) with the Microglass III core that we have selected.

If there is anything else you think I should know with regards to filters, please let me know. I would appreciate your confirmation that the paragraph above is correct for me to setup shelf and service life limits.

Thank You,

**Peter Fink**
Retrieval & Closure Engineer
509-373-4470
Peter_K_Fink@rl.gov

Contractor to the United States Department of Energy

"PLEASE NOTE: The preceding information may be confidential or privileged. It only should be used or disseminated for the purpose of conducting business with Parker. If you are not an intended recipient, please notify the sender by replying to this message and then delete the information from your system. Thank you for your cooperation."
November 5, 2007

Subject: Shelf Life of Parker Hydraulic Filter Division Elements

To Whom It May Concern:

There is no official certification or statement delineating the expected shelf life of elements produced by the Parker Hydraulic Filter Division. The Filter Division does publish a Return Goods Policy for its Distribution, which does limit the return of elements and cartridges based on manufacturing date.

As a general rule, microglass fiber elements are made of inert materials that are immune to degradation over time. Cellulose media (paper) elements can show signs of deterioration over long periods of time, but if properly stored and protected from the affect of moisture, can have very long shelf life as well. The epoxy adhesives used to assemble elements are likewise slow to deteriorate.

Parker cannot make a blanket statement concerning all elements due to different construction materials. End caps can be of stamped or machined steel that is plated, aluminum or a composite nylon material. Once again, properly protected from outside environmental agents, these components can experience long life with little or no degradation in performance or properties.

The items that have been historically of concern are the elastomer sealing devices (i.e. gaskets, o-rings, grommets, etc.). Environmental agents and storage conditions are the variables that most affect the longevity of these materials. A five year minimum shelf life would typically be expected to cover potential degradation of the elastomers in all elements as long as proper storage precautions are observed.

We hope this answers your concerns and those of your customer.
Fink, Peter K

From: Ervin Scott [ErvinS@sunhydraulics.com]
Sent: Tuesday, July 31, 2012 9:36 AM
To: Fink, Peter K
Cc: Bert Martinez
Subject: RE: Use of Quaker Quintolubric Oil with RBAN Valve

Peter,

Since we spoke on the phone I have done a bit more research within the Engineering group here. Based on the information from the Quaker hydraulic fluid cut sheet we believe it will function properly with the RBAN-XBN but we cannot say for certain since we do not have much experience with it.

Some concerns we have would be the reduced life of the fluid at high temperatures. At temperatures about 100°C the fluid lifespan is reduced by about 1000 hours. This is about the operating temperature of the RBAN when left fully energized for extended periods of time. This could cause for additional maintenance. As far as the seal compatibility that we spoke about on the phone, page 2 of the cut sheet does show it as compatible with Buna-N seals.

Regards,

Ervin Scott

Sun Hydraulics Corporation
941-362-1314
Ervins@sunhydraulics.com

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From: Fink, Peter K [mailto:Peter_K_Fink@rl.gov]
Sent: Tuesday, July 31, 2012 11:12 AM
To: Ervin Scott
Subject: Use of Quaker Quintolubric Oil with RBAN Valve

Hi Ervin,

I am e-mailing you to follow up with our conversation earlier. From Sun Hydraulics' technical tips there is a note that says "All Electro-proportional solenoid valves are designed for use with mineral based hydraulic fluid." I want to make sure that the valve we have chosen, RBAN-XBN, will function correctly using Quaker Quintolubric 888-46 hydraulic fluid. Per our conversation, the valve is compatible and will function properly with this hydraulic fluid. If you could confirm that this is correct, it would be appreciated.

Thank You,

Peter Fink
Retrieval & Closure Engineer
509-373-4470
Peter_K_Fink@rl.gov

Contractor to the United States Department of Energy
Fink, Peter K

From: Peter Skoog [skoogp@quakerchem.com]
Sent: Tuesday, August 14, 2012 7:12 AM
To: Fink, Peter K
Cc: John Accurso; Cindy Basile
Subject: Quintolubric 888-48 Cleanliness in Drums

Dear Mr. Fink,

Quaker's cleanliness specifications for Quintolubric call for a bulk ISO cleanliness of 16/14/11. Product put into drums will typically gain 1-2 ISO classes due to handling and particulate present in the drum. One can expect an ISO cleanliness of 18/16/14 from product received in drums and intermediate bulk containers (IBCs or totes). Please note that the 18/16/14 ISO cleanliness for Quintolubric 888 Series fluids is a typical number and not a product specification.

If you need further information, please feel free to contact me directly.

Sincerely,

Peter N. Skoog
Quaker Chemical Corporation
Global Product Manager - Fluid Power Products
ph: 610-832-4216
cell: 610-322-8338

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APPENDIX C

P&ID SHOWING SAFETY HYDRAULIC CIRCUITS