Safety - Significant AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch-Functions and Requirements Evaluation Document

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1.0 PURPOSE

The purpose of this document is to describe the evaluation of the AN06A-WT-P-022 pump siphon break holes and recirculation branch’s ability to perform its 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 AN06A-WT-P-022 pump siphon break holes and recirculation branch was developed based on hazard and accident analysis. 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 AN06A-WT-P-022 pump siphon break holes and recirculation branch must perform its 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 AN06A-WT-P-022 pump siphon break holes and recirculation branch

2. Documentation of support systems required for the AN06A-WT-P-022 pump siphon break holes and recirculation branch to perform the intended safety function.

3. An evaluation of interfacing systems whose failure could prevent the AN06A-WT-P-022 pump siphon break holes and recirculation branch from performing the intended safety function.

4. Documentation of safety SSC functional and performance requirements necessary for the AN06A-WT-P-022 pump siphon break holes and recirculation branch to perform the safety function. 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 AN06A-WT-P-022 pump siphon break holes and recirculation branch to perform the safety functions, and identification of how the critical characteristics can be verified to be met.
Using information from the evaluation described above, critical characteristics for the AN06A-WT-P-022 pump siphon break holes and recirculation branch 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 the NCR process to upgrade the existing SSC which were not procured as safety-significant. A Technical Evaluation (refer to TFC-ENG-FACSUP-C-02, “Operability/Technical Evaluations”) 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, “Equipment Identification and Data Management,” and TFC-ENG-FACSUP-CD-23.3, “Safety Equipment Compliance Database Update Instructions.”).

3.0 SCOPE

The scope of this evaluation includes the AN06A-WT-P-022 pump siphon break holes and recirculation branch. The recirculation branch is included in Jumper Assembly (EIN: AN06A-WT-J-[A-G-PUMP-POR104]) (Drawing H-14-107489) located in Pump Pit 241-AN-06A. The three way jumper and recirculation branch serves the dual function of transferring waste and recirculating waste back to Tank 241-AN-106. The siphon break holes in the pump column and associated directional piping were part of the as-tested pump assembly. They are included in this evaluation insofar as the configuration (hole diameter) is critical. The siphon break and recirculation branch flow path ensure that sufficient capacity flow paths are available to limit system pressure.

Additionally, the scope of this evaluation is limited to a supernatant transfer from 241-AN-106. This scope does not include transfers to 241-AN-106 from other tanks through the components being evaluated.

4.0 SAFETY FUNCTION

The safety function of the AN06A-WT-P-022 pump siphon break holes and recirculation branch is to prevent the loss of safety function of safety-significant SSCs from overpressure.
5.0 SYSTEM DESCRIPTION

5.1 Overall Description

The AN06A-WT-P-022 pump siphon break holes and recirculation branch system is comprised of the pump; the flexible metal jumper which connects to the discharge of the pump; the three way jumper assembly; and the tank return, Riser 14 (Nozzle G). This is shown in Figure 5-1. The items of particular interest for the pump are the suction screen, siphon break holes and associated directional piping located on the piping that connects directly to the pump.

5.2 Boundaries

Figure 5-2 shows the boundaries of the AN06A-WT-P-022 siphon break holes and recirculation branch: in addition to the siphon breaks, the boundary includes all of the items included in the recirculation branch sizing calculation (RPP-CALC-37755, 241-AN-06A Three-Way Jumper Recirculation Branch Flow Rate Calculation). This includes the following:

- Pump inlet screen,
- Siphon Break Holes;
- Flexible metal jumper from the pump discharge to the 3-way jumper;
- 3-way jumper from the connection to the flexible metal jumper to the connection to the recirculation branch and the flexible metal hose (recirculation branch) to the PUREX nozzle G connection to the tank return; and
- The tank return, Nozzle G (Riser 14).

All the above listed components are listed in Table A-1 of Appendix A of this document.

5.3 Interfaces

The only interface is the heat trace installed around the jumpers.
Flexible Metal Hose from Pump Discharge to 3-Way Jumper
EIN: AN06A-WT-FMJ[PUMP-9N]

Recirculation Branch Flexible Metal Hose
To POR-104

Siphon Break ¼ inch Holes & Directional Piping

3-Way Jumper
EIN: AN06A-WT-J-[A-G-PUMP-POR104]

Pump Assembly
EIN: AN06A-WT-P-022

Inlet Suction Screen

Nozzle #G

Riser #14 Tank Return
EIN: AN06A-WT-RISER-14 (G)

Figure 5-1 AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch
Flexible Metal Hose from Pump Discharge to 3-Way Jumper

Siphon Break 3/8 inch Holes & Directional Piping

Pump Assembly

Inlet Suction Screen

Boundaries

Nozzle #G

3-Way Jumper

Riser #14 Tank Return

Figure 5-2 Boundaries, AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch
6.0 SYSTEM EVALUATION

6.1 Functional/Performance Requirements

The functional and performance requirement for the AN06A-WT-P-022 pump siphon break holes and recirculation branch is:

- Holes (siphon break holes) on the waste transfer pump AN06A-WT-P-022 discharge pipe (that discharges to the tank headspace) and a recirculation branch on the 241-AN-06A pump pit three-way jumper (that recirculates waste back to 241-AN-106), ensure sufficient flow capacity paths are available to limit the waste transfer system pressure. In the event that the downstream waste transfer path is plugged or isolated, the pressure will be limited to \( \leq 275 \) psig (see RPP-CALC-37755). These features protect the Primary Piping System, whose design pressure is 275 psig, when valves on the three-way jumper are aligned to physically connect waste transfer pump AN06A-WT-P-022 to the primary piping system through Nozzle “A”.

6.2 Failure Mode Evaluations

6.2.1 Loading Conditions

Loading conditions for Tank Farm facilities have been incorporated into the Jumper Assembly, EIN: AN06A-WT-J-[A-G-PUMP-POR104], design according to Tank Farms Engineering Standard TFC-ENG-STD-06, “Design Loads for Tank Farms Facilities.” The following are the loading conditions that were evaluated:

**Dead Load:** Dead loads consist of the weight of Jumper Assemblies. (EIN: AN06A-WT-J-[A-G-PUMP-POR104]). Rigid section of piping and flex hose are schedule 40 and are more than adequate to support its self-weight and prevent flexible metal hose from kinking or crimping.

**Snow/Wind/Ash Fall/Earth and Groundwater pressure/Vehicle Traffic/Vehicle Impact/ Blast Effects:** Snow/Wind/Ash Fall/Earth and Groundwater pressure/Vehicle Traffic/Vehicle Impact/ Blast Effects and damage from excavation activities are not applicable because equipment is located in a covered pit.

**Earthquake Loads:** Jumper Assemblies and the evaluated pump are not credited to perform its safety function during or after a seismic event (RPP-13033, *Tank Farms Documented Safety Analysis*, Section 3.3.2.4.7.3, “Natural Events”).
Thermal Forces: All evaluated jumpers are either flexible metal hose or connected by flexible metal hose and will accommodate any thermal expansion, thus eliminating any thermal force related failure modes. The pump is not fixed on one end and thus protected from thermal forces.

Creep and Shrinkage Loads: Concrete movements of the pit due to creep or shrinkage were determined to be insignificant as the pits have been in place for years and no movement of the concrete is anticipated.

Hose Whip: The flexible metal hoses used are attached at both ends. Thus stresses from hose whip are not possible. There are other hoses installed in the 241-AN-AN06A pit which could become disconnected at one end with resultant hose whip. These are qualified safety-significant waste transfer hoses that have been evaluated and shown to be installed such that failure is not anticipated.

Load Drop: The siphon break holes and recirculation branch are not designed to perform its function during or following loadings due to load drops.

Failed Water Hoses: Loading due to failed water hoses is not applicable. There are no water hoses or other piping installed in the pit.

6.2.2 Process Conditions

Process Pressure/Vacuum (Normal, Off-Normal): All components of the system being evaluated are designed for 400 psig @ 180°F. This is greater than the maximum pressure that the Pump is capable of. Vacuum that could cause damage to the piping components being evaluated is not considered a credible failure mode.

Process Temperature (Low): There are no credible failure modes associated with low process temperature.

Process Temperature (High): The design temperature for the evaluated system is 180°F. The design temperature exceeds the maximum high process temperature which is the tank waste which is less than 120°F.

The waste transfer lines in a pit are heat traced and insulated. The heat trace temperature is self limited to a maximum of 150°F per the manufacturer’s information.

Process Chemistry (Chemical Attack by Waste, Headspace Vapors, Etc.): All components in the system being evaluated are compatible with the waste and flush water being transferred. Components in the system being evaluated are various stainless steel alloys, Teflon seals, and ultra-
high molecular weight polyethylene seals which are shown to be compatible per RPP-45262, AN101 Pump Pit Material Evaluation, and RPP-46296, 241-C Farm Waste Retrieval Pressure Boundary Material Evaluation. Steel components are compatible per RPP-RPT-42297, Safety-Significant Waste Transfer Primary Piping Systems-Functions and Requirements Evaluation Document.

**Fluid Expansion Effects (e.g., Thermal):** Fluid expansion does not affect the AN06A-WT-P-022 pump siphon break holes and recirculation branch since any fluid expansion would immediately be relieved via the siphon break holes on the waste transfer pump AN06A-WT-P-022 discharge pipe (that discharges to the tank headspace) and a recirculation branch on the 241-AN-06A pump pit three-way jumper (that recirculates waste back to 241-AN-106).

**Erosion:** Erosion is a concern in extended use situations involving high flow rates and/or abrasive fluids. Should any erosion occur the effect of increased wear would enlarge the siphon break holes or recirculation branch ensuring sufficient flow capacity paths would be available to limit the waste transfer system pressure.

**Corrosion:** See the previous discussion for Process Chemistry (Chemical Attack by Waste, Headspace Vapors, Etc.).

**Radiation Fields:** All components in the system being evaluated are compatible with the radiation fields. Components in the system being evaluated are various stainless steel alloys, Teflon seals, and ultra-high molecular weight polyethylene seals which are shown to be compatible per RPP-45262 and RPP-46296, 241-C. Steel components are compatible per RPP-RPT-42297.

**Plugging/Fouling:** The siphon break holes and recirculation branch could fail to perform its safety function if either siphon break or the recirculation branch becomes plugged. The siphon breaks are ¼ inch diameter holes and the connection from the 2 inch pipe to the recirculation hose is a ½ inch diameter. The pump inlet screen has 0.188 inch maximum diameter openings. Therefore, the particles that would be large enough to plug the ¼ inch siphon break holes or ½ inch dia. hole that feeds the recirculation branch, will be stopped by the 0.188 inch openings through the screen on the pump. The system being evaluated has not been used for a waste transfer into DST 241-AN-106.

During operation, the recirculation branch is continuously flushed by the waste, thus preventing the buildup of waste solids that could cause fouling. The recirculation line is self draining which would prevent buildup of solids in the line.
Plugged Filters (High Delta Pressure): There are no filters in the system. This condition is not applicable.

Flammable Gas Deflagration/Detonations within Process Equipment: The AN06A-WT-P-022 pump siphon break holes and recirculation branch is not designed to operate after a flammable gas deflagration.

6.2.3 Environmental Conditions

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. With heat trace installed the AN06A-WT-P-022 pump siphon break holes and recirculation branch is maintained, but is not designed to withstand stresses due to freezing fluids. This is covered in section 6.3 Freeze Protection.

Temperature – High: The design temperature for the evaluated system is 180°F. The design temperature exceeds the maximum high environmental temperature based on engineering judgment. Note: There are no heaters in the pit.

Thunderstorms, Dust, and Ice Glaze: Wind is expected to carry some dust and dirt into the pit, but external dust and dirt do not affect the internal workings of the AN06A-WT-P-022 pump siphon break holes and recirculation branch. Since the siphon break holes and recirculation branch is installed inside the pit, it is not directly subject to thunderstorms or ice glaze.

Solar Radiation (E.G., Direct Affects/Damage due to Exposure to Ultra-Violet Radiation [UV]): AN06A-WT-P-022 pump siphon break holes and recirculation branch assembly is located in a below grade covered pit or other structure and thus not directly exposed to solar radiation.

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

Ash (Exposure to Ash Particles): In the event of a nearby volcanic eruption, wind is expected to carry some volcanic ash into the pit or structure, but external ash does not affect the internal workings of the AN06A-WT-P-022 pump siphon break holes and recirculation branch.
Exposure to Water (E.G., Humidity/Condensation, Precipitation, Flooding by Service Water): Exposure to water will not affect the internal workings of the AN06A-WT-P-022 pump siphon break holes and recirculation branch.

Exposure to Leaked Fluids Other Than Water (E.G., Hydraulic Fluid): There are no other fluids that could be leaked into the pit.

Exposure To/Submergence in Leaked Waste: No failure modes due to submergence in leaked waste have been identified that could cause the siphon break holes and recirculation branch to fail to perform its safety function.

Fires (Range Fires, Vehicle Fires, Refueling Activity Fires, Other Fires): Exposure to fires (i.e., range fires, vehicle fires) is not within the design requirements.

High Radiation Fields: The siphon break holes and recirculation branch is installed in a pit and would only receive radiation exposure from the tank waste. This is described in Section 6.2.2 radiation fields.

Flammable Gas Deflagrations in Enclosures: A flammable gas deflagration is not within the design requirements.

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

6.2.4 Other Failure Modes

Fixatives: During pit work a common activity is to apply a layer of fixative in the pit before gaining access to the pit. The fixative holds the contamination in place so that it is less hazardous to personnel. The fixative is generally applied with a sprayer or a whirly. Application of fixatives will not affect the internal workings of the AN06A-WT-P-022 pump siphon break holes and recirculation branch.

Flow Pressure Transients (Water Hammer): There were no failure modes identified due to flow pressure transients that would cause a reduction in the system’s ability to protect safety significant SSCs from overpressure.
6.2.5 Aging

Metallic components of the system are not subject to aging requirements. Aging of seals and non-metallic components could cause leaks but would not impact the ability of the system to perform its safety function.

6.3 Supporting Systems

- **Electrical power:** The AN06A-WT-P-022 siphon break holes and recirculation branch does not need electrical power to perform its safety function.

- **Compressed air:** The AN06A-WT-P-022 siphon break holes and recirculation branch does not need compressed air to perform its safety function.

- **Pressure relief:** The AN06A-WT-P-022 siphon break holes and recirculation branch provides overpressure relief and does not need any additional pressure relief mechanism in order to perform its safety function.

- **Temperature control (HVAC):** No heating, ventilation and air conditioning (HVAC) systems are required for the Siphon Break Holes and Recirculation Branch to perform their safety function.

- **Freeze protection:** Ambient temperatures outside the pit can be as low as -25°F as specified in TFC-ENG-STD-02 design parameters. Freezing temperatures can be reached in this pit. This would prevent the siphon break holes and recirculation branch from performing its safety function. However, the equipment is located in the 241-AN-06A pump pit and the installed heat trace can be used to implement TOC freeze protection requirements.

- **Cooling:** No cooling systems are required for the AN06A-WT-P-022 siphon break holes and recirculation branch to perform their safety function.

- **Lubrication:** No lubrication is required for the AN06A-WT-P-022 siphon break holes and recirculation branch to perform the safety function.

- **Filtration:** No lubrication is required for the siphon break holes and recirculation branch to perform the safety function.
• **Water:** Use of water as a support system is not required for the AN06A-WT-P-022 siphon break holes and recirculation branch to perform the required safety function.

• **Other:** No other supporting systems have been identified that are required for the AN06A-WT-P-022 siphon break holes and recirculation branch to perform the safety function.

7.0 **CONTROLS**

7.1 **Shelf Life and Service Life:** No shelf life or service life requirements have been identified, thus there are no controls required.

7.2 **Other Controls:** No other controls have been identified.

8.0 **CRITICAL CHARACTERISTICS**

The following are the critical characteristics for the four major components of the AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch:

• Critical characteristics for pump AN06A-WT-P-022 include:
  
  o Dimensions of the perforations through the screen are \( \leq 0.188 \) inches.
  o Dimensions of the siphon break holes are ¼ inch diameter.
  o Configuration of the piping that directs the flow from the siphon breaks has been fabricated as required by the construction drawings.

• Critical characteristics for the flexible metal hose jumper (EIN: AN06A-WT-FMJ[PUMP-SN]) include:
  
  o Dimensions, material, and configuration of the flexible metal jumper (overall length, piping components, nominal hose diameter) meet the requirements of the construction drawing.
  o Materials of the flexible metal jumper are compatible with tank waste.

• Critical characteristics for the three way jumper (EIN: AN06A-WT-J-[(A-G-PUMP-POR104)]) include:
  
  o Rigid piping components (pipe, elbows, PUREX connectors, weldolet, reducers) meet the size and configuration requirement of the construction drawings.
  o The drilled hole that allows waste to recirculate through the flexible metal hose is ¾ inch diameter.
  o Dimensions, material, and configuration of the recirculation branch flexible metal hose (overall length, piping components, nominal hose diameter) meet the requirements of the construction drawing.
Materials of the 3-way jumper are compatible with tank waste.

Critical characteristics for the tank return (Riser 14) include:

- It was determined that there were no critical characteristics associated with the tank return.

A listing providing additional details of the critical characteristics is provided in Table A-1 of Appendix A of this evaluation.

### 9.0 REFERENCES


Appendix A - AN06A-WT-P-022 Pump Siphon Break Holes and Recirculation Branch
Critical Characteristics
Table A-1. AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch Critical Characteristics. (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>No.</th>
<th>Drawing Number</th>
<th>Description</th>
<th>Safety Function from PP-13033</th>
<th>Critical Characteristics</th>
<th>Acceptance Criteria</th>
<th>Acceptable Methods of Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drawing: DWG WRS0026002 (VI-50306) Sheet Number: N/A Part/Item Number: N/A</td>
<td>EIN Number: AN06A-WT-P-022 Nomenclature: Pump Material: N/A</td>
<td>Prevent the loss of the safety function of safety-significant SSCs from overpressure.</td>
<td>Dimensions</td>
<td>Perforations through the inlet screen are ≤ 0.188 inches.</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dimensions</td>
<td>Siphon break holes are ¼ inch diameter</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>General Configuration</td>
<td>Piping that directs the flow from the siphon break has been configured as required by the fabrication drawings</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Material of Construction</td>
<td>The pump components shall match the material specifications as required by the fabrication drawings</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dimensions</td>
<td>Nominal Hose Diameter meets the fabrication drawing requirements</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>General Configuration</td>
<td>Terminations on the hose ends have been configured as required by the fabrication drawings.</td>
<td>Nonconformance Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Material of Construction</td>
<td>The flexible metal hose jumper components shall match the material specifications as required by the fabrication drawings.</td>
<td>Nonconformance Report</td>
</tr>
</tbody>
</table>
Table A-1. AN06A-WT-P-022 Siphon Break Holes and Recirculation Branch Critical Characteristics. (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>No.</th>
<th>Drawing Number</th>
<th>Description</th>
<th>Safety Function from PP-13033</th>
<th>Critical Characteristics</th>
<th>Acceptance Criteria</th>
<th>Acceptable Methods of Verification</th>
</tr>
</thead>
</table>
| 3   | Drawing: H-14-107489  
   Sheet Number: 1  
   Part/Item Number: N/A | EIN Number: AN06A-WT-J-AN06A-WT-J-[A-G-PUMP-PO104]  
   Nomenclature: Jumper  
   Material: N/A | Prevent the loss of the safety function of safety-significant SSCs from overpressure. | General Configuration  
   Components (pipe, elbows, PUREX connectors, weldolet, reducers) meet the size and configuration requirement of the fabrication drawings | Nonconformance Report | Nonconformance Report |
|     |                |             |                               | Dimensions  
   The drilled hole that allows waste to recirculate through the flexible metal recirculation hose is 5/8 inch diameter | Nonconformance Report |
|     |                |             |                               | Dimensions  
   The flexible metal recirculation hose overall length meets the fabrication drawing requirements. | Nonconformance Report |
|     |                |             |                               | Dimensions  
   Nominal Hose Diameter meets the fabrication drawing requirements. | Nonconformance Report |
|     |                |             |                               | Material of Construction  
   Components of the jumper are compatible with tank waste. | Nonconformance Report |
|     |                |             |                               | Material of Construction  
   The jumper components shall match the material specifications as required by the fabrication drawings. | Nonconformance Report |
| 4   | Drawing: H-2-72010  
   Sheet Number: 1  
   Part/Item Number: N/A | EIN Number: AN06A-WT-RISER-14 (G)  
   Nomenclature: Riser  
   Material: N/A | Prevent the loss of the safety function of safety-significant SSCs from overpressure. | No critical characteristics were identified. | N/A | N/A |