This document was too large to scan as a single document. It has been divided into smaller sections.

Section 11 of 14

Document Information			
Document #	0602648		
Title	DRAFT WTP DANGEROUS WASTE PERMIT		
Date	10/04/2006		
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Drawings and Documents

Attachment 51 – Appendix 8.8
Pretreatment Building
Engineering Calculations

The following drawings have been incorporated into Appendix 8.8 and can be viewed at the Ecology Richland Office. **New drawings are in bold lettering.**

Drawing/Document Number	*Description*
24590-PTF-PER-M-02-005, Rev 7	Flooding Volume for PT Facility
24590-PTF-PER-M-03-001 Rev 0	Flooding Volume for 28 Ft Level in PT Facility
24590-PTF-PER-M-04-001, Rev 0	Flooding Volume for 56 Ft Level in PT Facility
24590-PTF-PER-M-04-0003, Rev 0	Flooding Volume for 77 Ft Level in PT Facility
24590-PTF-PER-M-04-0006, Rev 0	Leak Detection for Underground Transfer Lines
24590-PTF-PER-M-04-0008, Rev 1	**Flooding Volume for Room P-0150 in PT Facility**
RESERVED	RESERVED

R10591991

Document title: **Flooding Volume for Room P-0150 in the PT Facility**

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Author(s): Lisa Han Dana F. Miller

Principal author signature:

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Approver's position: Discipline Production Engineering Manager

Approver signature:

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EXPIRES: 07/28/07

This bound document contains a total of 13 sheets

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Notice

Please note that source, special nuclear, and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the US Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

History Sheet

Rev	Date	Reason for revision	Revised by
0	4/15/05	Issued for Permitting Use	G. Chiaramonte
1	11/28/05	Issued for Permitting Use. Major Revision.	Lisa Han

Contents

Appendices

Acronyms and Abbreviations

AEA	Atomic Energy Act of 1954
DOE	US Department of Energy
ETF	effluent treatment facility
FRP	feed receipt process
HLP	HLW lag storage and feed blending process
HLW	high-level waste
LAW	low-activity waste
LERF	liquid effluent retention facility
PT	pretreatment
PWD	plant wash and disposal
RLD	radioactive liquid waste disposal
WAC	Washington Administrative Code

1 Introduction

The Washington Administrative Code, WAC 173-303-640(4)(e), addresses tank systems containing dangerous waste. This code requires that secondary containment systems be designed to contain 100 % of the capacity of the largest tank within its boundary. Because the tank system addressed in this document is in an outdoor uncovered area, also included is the containment of the rainfall.

Flooding scenarios for rooms within the PT facility have been addressed in prior issued documents. This report specifically addresses flooding scenarios for Room P-0150, a tank containment area located outside the PT building, which contains the Radioactive Liquid Waste Disposal (RLD) tanks RLD-TK-00006A and RLD-TK-00006B. The flooding scenario addressed in this document establishes the minimum requirements for secondary containment in Room P-0150.

2 Applicable Documents

WAC 173-303, *Dangerous Waste Regulations*, Washington Administrative Code

3 Description

3.1 Background

The PT facility receives low-activity waste (LAW) feed and high-level waste (HLW) feed from the Double-Shell Tank System. This mixed waste feed is pumped through double-walled underground transfer lines to the PT facility.

The purpose of the PT facility is to pretreat the waste received from the Double-Shell Tank System and to transfer it to the LAW and the HLW vitrification facilities. Within the LAW and HLW vitrification facilities, the waste is formed into glass logs suitable for long-term disposal.

Within the PT facility, the LAW feed is transferred to the waste feed receipt process (FRP) vessels (FRP-VSL-00002A/B/C/D), while the HLW feed is sent to the HLW feed receipt vessel (HLP-VSL-00022). These wastes are temporarily stored in the vessels before being pumped and treated by the PT processing equipment.

These vessels are located in black cells and are not accessible. The black cells are arranged in a "U" shape around a central hot cell in the PT facility, where major processing equipment is located.

The hot cell is remotely maintainable with the use of a crane system. Below the center of the hot cell are two adjacent rooms in the deep pit at the -45 ft elevation. This is the low point for the PT facility. Within these rooms are the plant wash and disposal (PWD) ultimate overflow vessel (PWD-VSL-00033) and the HLW effluent transfer vessel (PWD-VSL-00043).

The FRP vessels are the largest in the PT facility. The flood scenario at 0 ft elevation addressed a postulated failure of one FRP vessel and the movement of its fluid from a black cell to the hot cell, and then to the -45 ft elevation pit in *Flooding Volume for Below Grade and 0 Ft Elevation in PT Facility*

(24590-PTF-PER-M-02-005). The flooding scenario also addressed the fire water pit at the -19 ft elevation.

The RLD tanks RLD-TK-00006A and RLD-TK-00006B, located in Room P-0150 (a concrete containment area) outside of the PT building, receive, sample, and discharge low activity effluent. The majority of the inventory contained in these tanks is process condensate generated in the PT facility evaporators, but these tanks also receive and store alkaline scrubber and other low activity liquids routed from RLD-VSL-00017A/B located in the PT facility. Liquid effluents stored in RLD-TK-00006A/B are pumped to the Liquid Effluent Retention Facility (LERF) and Effluent Treatment Facility (ETF) for further treatment prior to disposal.

3.2 Room P-0150 Flooding Volume

Room P-0150 is a concrete containment area located outside the PT building on the northeast side of the building. It provides secondary containment for tanks RLD-TK-00006A/B, which are the only tanks within this containment area. The room is completely enclosed by the walls and there is no overhead covering or roof.

Each tank sits on a pedestal that is octagonal in shape. Also located in this room are six pumps on individual pedestals, with associated piping. There are 12 concrete posts in the room. The secondary containment includes a low point sump (RLD-SUMP-00003). The floor of the containment area also includes a covered trench between each tank and a sump. The floor and the trench are sloped towards the sump. The room's concrete walls and floor are provided with a special protective coating to contain liquid in case of leakage. For simplicity, these walls and the floor will be referred to as the "secondary containment".

The minimum height for the secondary containment is based on the flooding volume. The basic methodology used to calculate the minimum secondary containment height is to divide resulting volume by the available room area. The available room area is reduced by the area of the tank and pump pedestals. The height of the secondary containment is determined from the top of the floor but for conservatism, no credit is taken for the volume created by the slope of the floor.

3.3 Calculation of the Minimum Height of the Secondary Containment Wall

For calculating the minimum height of the secondary containment walls, the following scenario is considered.

The total volume of the fluid contained in one of the two tanks is discharged by leakage or spillage into the secondary containment. Added to this volume of fluid is the maximum accumulation of rainwater for duration of 24 hours. Refer to Appendix A for basis of rainwater. Therefore, the secondary containment wall is sized to handle the volume of rainwater in addition to the 100 % capacity of the tank.

The secondary containment is calculated in three parts:

Part 1 Determination of Flooding Volume

a) Determine the volume of the tank (V_{tank}) by adding the sum of the volumes of the cylindrical section and the cone roof section. The volume of the entire conical section is included with the cylindrical section volume for conservatism.

b) Determine the volume of the rainwater (V_w) for the area of the room.

c) Determine the total flooding volume (V_{flood}) by adding V_{tank} and V_w.

Part 2 Allowance for Other Components

a) To account for space that is unavailable due to other auxiliary components (piping and structural posts) in the room, a design allowance of 5 % is added to V_{flood}.

b) The volume of sump RLD-SUMP-00003 (78 cu ft) is considered negligible compared to V_{flood} (calculated in Appendix A).

c) The liquid in the failed tank empties or leaks down to the secondary containment height, as the liquid level equalizes. This assumption also applies to a failed nozzle or pipe connected to the bottom of the tank. The flood volume will occupy the area of the failed tank.

Part 3 Determination of Containment Height

The minimum height of the secondary containment wall is calculated incrementally, taking into account the tank pedestals, the pumps, and the results from Parts 1 and 2 above.

Step 1. Calculate the area of available secondary containment up to the thickest part of the tank pedestal, 1 ft 4 in. This step subtracts the tank pedestals and the six pumps from the available area. The tank pedestals are conservatively assumed flat (not sloped) and with an area assumed 25 % larger than the tank footprint. The pumps are conservatively considered rectangular shapes, using the cross-sectional area of the largest concrete pump pedestal. The area determined by this step can be multiplied by 1 ft 4 in to get the volume of liquid contained by the 1 ft 4 in high containment wall section.

Step 2. The available area of the room in this step is the (area of the room) minus (area of remaining intact tank) minus (area of the six pumps).

Calculate the additional height of the secondary containment wall (above the first 1 ft 4 in) required to accommodate the remaining V_{flood} by: subtracting the volume calculated in Step 1, from V_{flood}, and dividing by the available area of the room (in this step above).

Step 3: To determine the minimum secondary containment wall height, add the heights from Step 1 and Step 2 above.

3.4 Results

The minimum secondary containment height required is 7.27 ft above the top of the concrete floor.

Appendix A

Evaluation of Flooding Volume for Room P-0150

Appendix A
Evaluation of Flooding Volume for Room P-0150

Description

Room P-0150 is a concrete containment area located outside the PT building on the northeast side of the building. It provides secondary containment for tanks RLD-TK-00006A/B, which are the only tanks within this containment area. The secondary containment includes low point sump (RLD-SUMP-00003). The floor of the containment area also includes a covered trench between each tank and RLD-SUMP-00003. The floor and interior walls of the containment area including the trench are treated with a special protective coating. The floor and the trench are sloped towards the sump.

This evaluation determines the flooding volume for Room P-0150 and determines the minimum height for the secondary containment structure.

Basis and Assumptions

- The dimensions of Room P-0150 are 113 ft by 77 ft (inside dimensions).
- The dimensions of both RLD-TK-00006A and -00006B are 42 ft inside diameter by 32 ft tall (cylindrical section).
- The thickness of each tank wall is assumed to be 1 inch, therefore the outside diameter will be 42 ft 2 in or 42.17 ft.
- The tanks are flat bottom and each tank contains a cone roof with a center height of 42 inches measured from the top of the cylindrical section.
- The tank pedestals are octagonal and are assumed 25 % larger than the footprint of the tank.
- The volume of RLD-SUMP-00003 is 583 gallons (78 cu ft) and is considered negligible.
- The trenches in the concrete floor are not credited in this flooding volume for conservative purposes.
- The six pump pedestals are conservatively considered rectangular, each with a cross-sectional area equal to that of the largest pump pedestal and the height equal to the containment wall.
- The 24 hour rainfall is 1.27 inches (a 24-hour, 25 year storm, i.e. the storm that occurs once in 25 years.) Rainfall data is derived from Table 7.3 of PNNL 14242, *Hanford Site Climatological Data Summary, 2002 with Historical Data*. The volume of rain for 24 hrs is conservatively estimated.
- To account for room area that is unavailable due to other auxiliary components (piping and structural posts) in the room, a design allowance of 5 % is added to total flood volume.
- The liquid level of the failed tank empties or leaks down to a wall height, where the liquid level equalizes between the outside and inside of the tank. The area of the failed tank is included in the available area of the room. This assumption also applies to a failed nozzle or pipe connected to the bottom of the tank.
- Numbers in excess of 4 significant figures were rounded to the nearest integer.

Determination of Flood Volume

From the dimensions of RLD-TK-00006A/B (both tanks are the same size), the tank volume contribution to flooding volume, V_{tank}, is the sum of the volume of the straight cylindrical section V_{cyl} plus the volume of the cone roof, V_{cone}:

$$V_{tank} = V_{cyl} + V_{cone}$$

$$V_{cyl} = \pi/4 \text{ x } D_{tank}^2 \text{ x } H_{cyl}$$

Where:

D_{tank} = Tank diameter, feet = 42 ft

H_{cyl} = Tank cylindrical height, feet = 32 ft

Then

$$V_{cyl} = \pi/4 \text{ x } (42 \text{ ft})^2 \text{ x } (32 \text{ ft}) = 44{,}334 \text{ cu ft}$$

$$V_{cone} = \pi/12 \text{ x } D_{tank}^2 \text{ x } H_{cone}$$

Where H_{cone} = height of the conical section measured in the tank center from the top of the cylindrical section = 42 inches

Then

$$V_{cone} = \pi/12 \text{ x } (42)^2 \text{ sq ft x } (42 \text{ in}/12 \text{ in/ft})$$

$$V_{cone} = 1616 \text{ cu ft}$$

$$V_{tank} = 44{,}334 \text{ cu ft} + 1616 \text{ cu ft} = 45{,}950 \text{ cu ft}$$

To determine the volume of rainwater, the total room area, A_t, is determined from:

$$A_t = L_r \text{ x } W_r$$

Where:

L_r = room length, ft = 113 ft

W_r = room width, ft = 77 ft

A_t = 113 ft x 77 ft = **8701 sq ft**

Then, the volume of rainwater, V_w, is given by:

$$V_w = (1.27 \text{ inches}/12 \text{ inches/ft}) \text{ x } 8701 \text{ sq ft}$$

$$V_w = 921 \text{ cu ft}$$

The flooding volume, V_{flood}, is the sum of these quantities plus 5 % to allow for auxiliary components (such as piping and posts):

$$V_{flood} = (V_{tank} + V_w) \times 1.05$$

$$V_{flood} = (45{,}950 \text{ cu ft} + 921 \text{ cu ft}) \times 1.05$$

$$V_{flood} = (46{,}871 \text{ cu ft}) \times 1.05 = \mathbf{49{,}215 \text{ cu ft}}$$

Determination of Containment Height

As stated in the method section, for conservatism, the volume created within the sloped area of the floor is neglected.

The pump pedestal dimensions, six each, are as follows: 3.5 ft by 7 ft.

The pumps are conservatively considered to occupy the space above the pump pedestals to the height of the secondary containment wall.

The room dimensions are 113 ft by 77 ft.

Step 1: Secondary Containment Volume (Vc_1) from floor level (0 ft) to top of tank pedestal (1.33 ft).

The secondary containment area has two tank pedestals that are 1.33 ft high. The area of each pedestal is assumed to be 25 % larger than the footprint of the tank.

Cross sectional area of octagonal tank pedestal is conservatively assumed as:

$$A_{ped} = A_{tank,\ out} \times 1.25 \text{ where}$$

$$A_{tank,\ out} = (\pi/4 \times D_{tank,\ out}^2)$$

$$A_{tank,\ out} = \pi/4 \times (42.17 \text{ ft})^2 = 1397 \text{ sq ft}$$

$$A_{ped} = 1397 \text{ sq ft} \times 1.25 = 1746 \text{ sq ft}$$

Total cross sectional area of the room is the length of the room times the width of the room:

$$A_t = L_r \times W_r$$

$$A_t = 113 \text{ ft} \times 77 \text{ ft} = 8701 \text{ sq ft}$$

Cross sectional area of pumps:

$$A_{pump} = 3.5 \text{ ft} \times 7 \text{ ft} = 24.5 \text{ sq ft}$$

Area of the room available for secondary containment up to 1.33 ft height is:

$Ac_1 = [A_t - 2A_{ped} - 6A_{pump}]$

$Ac_1 = [8701 \text{ sq ft} - 2(1746 \text{ sq ft}) - 6(24.5 \text{ sq ft})]$

$Ac_1 = 8701 \text{ sq ft} - 3492 \text{ sq ft} - 147 \text{ sq ft} = 5062 \text{ sq ft}$

Volume of liquid contained by 1.33 ft high secondary containment wall is:

$Vc_1 = Ac_1 \times H_1$

$Vc_1 = 5062 \text{ sq ft} \times 1.33 \text{ ft} = \mathbf{6732 \text{ cu ft}}$

Step 2: The height of the secondary containment wall required to accommodate the remaining total tank volume (above the first 1.33 ft).

This wall height (H_2) is determined by subtracting the volume contained in the first 1.33 ft from the total flooding volume and dividing by the available cross sectional area of this space.

$Vc_2 = V_{flood} - Vc_1$

$Vc_2 = 49{,}215 \text{ cu ft} - 6732 \text{ cu ft} = 42{,}483 \text{ cu ft}$

The available cross sectional area for this space is:

$Ac_2 = A_t - A_{tank,\ out} - 6(A_{pump})$

$Ac_2 = 8701 \text{ sq ft} - 1397 \text{ sq ft} - 6(24.5 \text{ sq ft})$

$Ac_2 = 8701 \text{ sq ft} - 1397 \text{ sq ft} - 147 \text{ sq ft} = 7157 \text{ sq ft}$

Therefore:

$H_2 = Vc_2 / Ac_2$

$H_2 = 42{,}483 \text{ cu ft} / 7157 \text{ sq ft} = 5.94 \text{ ft}$

Step 3: Minimum secondary containment wall height H_{min}.

Secondary containment wall required to accommodate the total flooding volume is 1.33 ft plus the height calculated in step 2.

$H_{min} = 1.33 \text{ ft} + H_2$

$H_{min} = 1.33 \text{ ft} + 5.94 \text{ ft} = \mathbf{7.27 \text{ ft}}$

Attachment 2
05-ED-100

Bechtel National, Inc. and U.S. Department of Energy, Office of River Protection Certification Statements

Bechtel National, Inc. Certification

The following certification statement is provided consistent with Contract No. DE-AC27-01RV14136, Section H.26, Environmental Permits, paragraph (g) for Dangerous Waste Permit package PTF-065, Rev. 0, "Tank Secondary Containment for PTF Facility RLD System."

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

J. P. Henschel
Project Director

11/30/05
Date

U.S. Department of Energy, Richland Operations Office Certification

The following certification statement is provided for the Hanford Tank Waste Treatment and Immobilization Plant for Dangerous Waste Permit package PTF-065, Rev. 0, "Tank Secondary Containment for PTF Facility RLD System."

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

R. J. Schepens, Manager
U.S. Department of Energy,
Office of River Protection

11/30/05
Date

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Drawings and Documents

Attachment 51 – Appendix 8.9
Pretreatment Building
Material Selection Documentation

The following drawings have been incorporated into Appendix 8.9 and can be viewed at the Ecology Richland Office. See Appendix 7.9 for material selection documentation common to the Pretreatment, LAW, HLW, and Laboratory buildings. **New drawings are in bold lettering.**

Drawing/Document Number	*Description*
24590-PTF-N1D-CNP-P0001, Rev 0	Material Selection Data Sheet for CNP-DISTC-00001
~~24590-PTF-N1D-CNP-P0002, Rev 0~~	~~Material Selection Data Sheet for CNP-HX-00002~~
24590-PTF-N1D-CNP-P0002, Rev 1	**Material Selection Data Sheet for CNP-HX-00002**
~~24590-PTF-N1D-CNP-P0003, Rev 0~~	~~Material Selection Data Sheet for CNP-HX-00003~~
24590-PTF-N1D-CNP-P0003, Rev 1	**Material Selection Data Sheet for CNP-HX-00003**
~~24590-PTF-N1D-CNP-P0004, Rev 0~~	~~Material Selection Data Sheet for CNP-HX-00001~~
24590-PTF-N1D-CNP-P0004, Rev 1	**Material Selection Data Sheet for CNP-HX-00001**
~~24590-PTF-N1D-CNP-P0005, Rev 0~~	~~Material Selection Data Sheet for CNP-EVAP-00001~~
24590-PTF-N1D-CNP-P0005, Rev 1	**Material Selection Data Sheet for CNP-EVAP-00001**
~~24590-PTF-N1D-CNP-P0006, Rev 2~~	~~Material Selection Data Sheet for CNP-VSL-00004~~
24590-PTF-N1D-CNP-P0006, Rev 3	**Material Selection Data Sheet for CNP-VSL-00004**
~~24590-PTF-N1D-CNP-P0008, Rev 0~~	~~Material Selection Data Sheet for CNP-BRKPT-00002~~
24590-PTF-N1D-CNP-P0008, Rev 1	**Material Selection Data Sheet for CNP-BRKPT-00002**
~~24590-PTF-N1D-CNP-P0009, Rev 0~~	~~Material Selection Data Sheet for CNP-VSL-00003~~
24590-PTF-N1D-CNP-P0009, Rev 1	**Material Selection Data Sheet for CNP-VSL-00003**
~~24590-PTF-N1D-CNP-P0010, Rev 0~~	~~Material Selection Data Sheet for CNP-BRKPT-00001~~

24590-PTF-N1D-CNP-P0010, Rev 1	**Material Selection Data Sheet for CNP-BRKPT-00001**
~~24590-PTF-N1D-CNP-P0011, Rev 0~~	~~Material Selection Data Sheet for CNP-VSL-00001~~
24590-PTF-N1D-CNP-P0011, Rev 1	**Material Selection Data Sheet for CNP-VSL-00001**
~~24590-PTF-N1D-CNP-P0012, Rev 0~~	~~Material Selection Data Sheet for CNP-HX-00004~~
24590-PTF-N1D-CNP-P0012, Rev 1	**Material Selection Data Sheet for CNP-HX-00004**
~~24590-PTF-N1D-CXP-P0001, Rev 0~~	~~Material Selection Data Sheet for CXP-VSL-00001~~
24590-PTF-N1D-CXP-P0001, Rev 1	**Material Selection Data Sheet for CXP-VSL-00001**
24590-PTF-N1D-CXP-P0003, Rev 1	Material Selection Data Sheet for CXP-VSL-00026A/B/C
~~24590-PTF-N1D-CXP-P0007, Rev 0~~	~~Material Selection Data Sheet for CXP-VSL-00004~~
24590-PTF-N1D-CXP-P0007, Rev 1	**Material Selection Data Sheet for CXP-VSL-00004**
~~24590-PTF-N1D-CXP-P0008, Rev 0~~	~~Material Selection Data Sheet for CXP-VSL-00005~~
24590-PTF-N1D-CXP-P0008, Rev 1	**Material Selection Data Sheet for CXP-VSL-00005**
24590-PTF-N1D-FEP-P0002, Rev 1	Material Selection Data Sheet for FEP-VSL-00017A/B
~~24590-PTF-N1D-FEP-P0003, Rev 0~~	~~Material Selection Data Sheet for FEP-VSL-00005~~
24590-PTF-N1D-FEP-P0003, Rev 1	**Material Selection Data Sheet for FEP-VSL-00005**
24590-PTF-N1D-FEP-P0007, Rev 1	Material Selection Data Sheet for FEP-SEP-00001A/B
24590-PTF-N1D-FEP-P0008, Rev 0	Material Selection Data Sheet for FEP-RBLR-00001A/B
24590-PTF-N1D-FEP-P0009, Rev 0	Material Selection Data Sheet for FEP-COND-00002A/B
24590-PTF-N1D-FEP-P0010, Rev 0	Material Selection Data Sheet for FEP-COND-00003A/B
24590-PTF-N1D-FEP-P0013, Rev 0	Material Selection Data Sheet for FEP-COND-00001A/B
24590-PTF-N1D-FRP-P0001, Rev 2	Material Selection Data Sheet for FRP-VSL-00002A-D
24590-PTF-N1D-HLP-P0001, Rev 0	Material Selection Data Sheet for HLP-BRKPT-00004/6

24590-PTF-N1D-HLP-P0003, Rev 1	**Material Selection Data Sheet for HLP-VSL-00022**
24590-PTF-N1D-HLP-P0007, Rev 1	Material Selection Data Sheet for HLP-VSL-00027A/B
24590-PTF-N1D-HLP-P0010, Rev 1	Material Selection Data Sheet for HLP-VSL-00028
24590-PTF-N1D-PJV-P0001, Rev 1	Material Selection Data Sheet for PJV-VSL-00002
~~24590-PTF-N1D-PVP-P0001, Rev 0~~	~~Material Selection Data Sheet for PVP-SCB-00002~~
24590-PTF-N1D-PVP-P0001, Rev 1	**Material Selection Data Sheet for PVP-SCB-00002**
~~24590-PTF-N1D-PVP-P0002, Rev 0~~	~~Material Selection Data Sheet for PVP-VSL-00001~~
24590-PTF-N1D-PVP-P0002, Rev 1	**Material Selection Data Sheet for PVP-VSL-00001**
~~24590-PTF-N1D-PWD-P0001, Rev 0~~	~~Material Selection Data Sheet for PWD-VSL-00044~~
24590-PTF-N1D-PWD-P0001, Rev 1	**Material Selection Data Sheet for PWD-VSL-00044**
24590-PTF-N1D-PWD-P0002, Rev 1	Material Selection Data Sheet for PWD-VSL-00043
~~24590-PTF-N1D-PWD-P0003, Rev 2~~	~~Material Selection Data Sheet for PWD-VSL-00015/16~~
24590-PTF-N1D-PWD-P0003, Rev 3	**Material Selection Data Sheet for PWD-VSL-00015/16**
~~24590-PTF-N1D-PWD-P0005, Rev 1~~	~~Material Selection Data Sheet for PWD-VSL-00033~~
24590-PTF-N1D-PWD-P0005, Rev 2	**Material Selection Data Sheet for PWD-VSL-00033**
~~24590-PTF-N1D-PWD-P0006, Rev 1~~	~~Material Selection Data Sheet for PWD-VSL-00046~~
24590-PTF-N1D-PWD-P0006, Rev 2	**Material Selection Data Sheet for PWD-VSL-00046**
24590-PTF-N1D-PWD-P0007, Rev 0	Plant Item Material Selection Data Sheet for PWD-BRKPT-00007/8/9/10/17/19
~~24590-PTF-N1D-PWD-P0008, Rev 0~~	~~Material Selection Data Sheet for PWD-BRKPT-00015/16~~
24590-PTF-N1D-PWD-P0008, Rev 1	**Material Selection Data Sheet for PWD-BRKPT-00015/16**
~~24590-PTF-N1D-RDP-P0001, Rev 1~~	~~Material Selection Data Sheet (for RDP-VSL-00002A/B/C~~
24590-PTF-N1D-RDP-P0001, Rev 2	**Material Selection Data Sheet (for RDP-VSL-00002A/B/C**

24590-PTF-N1D-RDP-P0002, Rev 0	Material Selection Data Sheet for RDP-VSL-00004
24590-PTF-N1D-RDP-P0002, Rev 0	Material Selection Data Sheet for RDP-VSL-00004
24590-PTF-N1D-RLD-P0002, Rev 1	Material Selection Data Sheet for RLD-VSL-00017A/B
24590-PTF-N1D-RLD-P0002, Rev 2	**Material Selection Data Sheet for RLD-VSL-00017A/B**
24590-PTF-N1D-TCP-P0001, Rev 1	Material Selection Data Sheet for TCP-VSL-00001
24590-PTF-N1D-TCP-P0001, Rev 2	**Material Selection Data Sheet for TCP-VSL-00001**
24590-PTF-N1D-TLP-P0001, Rev 1	Material Selection Data Sheet for TLP-VSL-00009A/B
24590-PTF-N1D-TLP-P0001, Rev 2	**Material Selection Data Sheet for TLP-VSL-00009A/B**
24590-PTF-N1D-TLP-P0002, Rev 0	Material Selection Data Sheet for TLP-COND-00001
24590-PTF-N1D-TLP-P0003, Rev 0	Material Selection Data Sheet for TLP-COND-00002/3
24590-PTF-N1D-TLP-P0005, Rev 1	Material Selection Data Sheet for TLP-SEP-00001
24590-PTF-N1D-TLP-P0005, Rev 3	**Material Selection Data Sheet for TLP-SEP-00001**
24590-PTF-N1D-TLP-P0006, Rev 0	Material Selection Data Sheet for TLP-VSL-00002
24590-PTF-N1D-TLP-P0006, Rev 1	**Material Selection Data Sheet for TLP-VSL-00002**
24590-PTF-N1D-TLP-P0011, Rev 0	Material Selection Data Sheet for TLP-RBLR-00001
24590-PTF-N1D-TLP-P0011, Rev 1	**Material Selection Data Sheet for TLP-RBLR-00001**
24590-PTF-N1D-UFP-P0001, Rev 2	**Material Selection Data Sheet for UFP-BRKPT-00001A/B**
24590-PTF-N1D-UFP-P0002, Rev 0	Material Selection Data Sheet for UFP-PP-00001, 2, 3A/B
24590-PTF-N1D-UFP-P0002, Rev 2	**Material Selection Data Sheet for UFP-PP-00001, 2, 3A/B**
24590-PTF-N1D-UFP-P0003, Rev 0	Material Selection Data Sheet for UFP-VSL-00002A/B
24590-PTF-N1D-UFP-P0004, Rev 1	Material Selection Data Sheet for UFP-FILT-00001, 2, 3A/B
24590-PTF-N1D-UFP-P0004, Rev 3	**Material Selection Data Sheet for UFP-FILT-00001, 2, 3A/B**

~~24590-PTF-N1D-UFP-P0005, Rev 1~~	~~Material Selection Data Sheet for UFP-VSL-00001A/B~~
~~24590-PTF-N1D-UFP-P0005, Rev 1~~	~~Material Selection Data Sheet for UFP-VSL-00001A/B~~
24590-PTF-N1D-UFP-P0005, Rev 2	**Material Selection Data Sheet for UFP-VSL-00001A/B**
24590-PTF-N1D-UFP-P0008, Rev 2	**Material Selection Data Sheet for UFP-VSL-00062A/B/C**
24590-PTF-NID-PWD-P0001, Rev 0	Material Selection Data Sheet for PWD-VSL-00044
24590-PTF-PER-M-02-03, Rev 1	Underground Pipe Protection
RESERVED	RESERVED

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682509

CNP-HX-00002 (PTF)
Cs Evaporator Primary Condenser

- Design Temperature (°F)(max/min): Shell side: 250/40; Tube side: 125/40
- Design Pressure (psig) (max/min): Shell side: 50/FV; Tube side: 100/FV
- Location: outcell

ISSUED BY
RPP-WTP PDC

Design temperature and pressure information is considered bounding and to be confirmed by Vendor.

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operations

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: Shell side and tube side: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

CNP-HX-00002 is a water-cooled, U-tube unit with condensation taking place on the shell side. Product flow includes excess water from the pre-elution and post-elution rinses from the ion exchange columns.

a General Corrosion
In normal operation, the vessel will contain either treated process water (slightly acidic) or DIW. Based on Uhlig (1948), little uniform corrosion is expected at these conditions. The uniform corrosion rate of the 300 series stainless steels in DIW at temperatures up to about boiling are generally considered small, <1 mpy. Hanmer (1981) lists a corrosion rate for 304 (and 304L) in pure water of less than 2 mpy (his smallest unit of measurement).

Conclusion:
304L or 316L are acceptable for this system with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
With the proposed temperatures, 304L is acceptable under the stated no-chloride conditions.

Conclusion:
The data suggest there are no halides to cause pitting, 304L is recommended.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140 °F. Further, the use of "L" grade stainless reduces the opportunity for sensitization.

Conclusion:
The use of 304L is expected to be acceptable for the stated no-chloride conditions.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are potentially suitable for MIC. However, MIC is not normally observed in operating systems.

Conclusion:
MIC will not be a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusion:
Not applicable.

i Vapor Phase Corrosion
Not applicable to this system.

Conclusion:
Vapor phase corrosion is not expected.

j Erosion
There are no solids and the velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
None expected.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
The contents of the condenser are essentially water with no reportable halides. The lowering of the pH by the inadvertent addition of nitric acid would be of no concern.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities,*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158

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1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit,* August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs evaporator primary, inter- and after- condenser (CNP-HX-00002,3,4)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m^3					
Chloride	g/m^3					
Fluoride	g/m^3					
Iron	g/m^3					
Nitrate	g/m^3					
Nitrite	g/m^3					
Phosphate	g/m^3					
Sulfate	g/m^3					
Mercury	g/m^3					
Carbonate	g/m^3					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/m^3					
Other	g/m^3					
pH	N/A					Assumption 1
Temperature	°F					Assumption 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev D
Mass Balance Document: Chemical Max Calculation 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP04
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/m^3 do not need to be reported; list values to two significant digits max.

Assumptions:

1. The overheads from the distillation column are expected to be contain primarily water with pH near or at 7.0.
2. Assume same as T normal operation for the evaporator, 122 °F to 212 °F (pressure of operation for last condenser is atmospheric)

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.1.5 Cs Evaporator Primary Condenser (CNP-HX-00002), Cs Evaporator Inter-Condenser (CNP-HX-00003), and Cs Evaporator After-Condenser (CNP-HX-00004)

Routine Operations

The Cs evaporator primary condenser, CNP-HX-00002, is a water-cooled, U-tube unit with condensation taking place on the shell side. The condenser shell incorporates a condensate sump, which contains a weir arrangement to control the flow split between the reflux and the overhead product flows. The overhead product flow includes excess water from the pre-elution and post-elution rinses sent to the Cs evaporator separator vessel from the cesium ion exchange columns.

To reduce the boiling temperature of the liquids in the Cs evaporator separator vessel, the system is run under vacuum. This is achieved using a two-stage steam ejector system. Exhaust vapors from the ejectors are condensed in Cs evaporator inter-condenser, CNP-HX-00003, and after-condenser, CNP-HX-00004, prior to venting to the ventilation system scrubbing equipment. Process condensate from the Cs evaporator primary condenser and Cs evaporator secondary condenser drains to the acidic/alkaline effluent vessels, PWD-VSL-00015 and PWD-VSL-00016, located in the PWD system.

The condensate from the condensers has a minimal amount of HNO_3, making it slightly acidic but not acidic enough to warrant neutralization; thus, it will be considered and referred to as process condensate.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

24590-PTF-N1D-CNP-P0003
Rev. 1

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682510

ISSUED BY
RPP-WTP PDC

CNP-HX-00003 (PTF)
Cs Evaporator Inter-Condenser

- Design Temperature (°F) (max/min): Shell side: 378/40; Tube side: 125/40
- Design pressure (psig) (max/min): Shell side: 100/FV; Tube side: 100/FV
- Location: outcell

Design temperature and pressure information is considered bounding and to be confirmed by Vendor.

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operation

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: Shell side and tube side: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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Sheet: 1 of 6

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Exhaust vapors from the Cs evaporator separator vessel are condensed in CNP-HX-00003. A minimal amount of HNO_3 is present in the condensate making it slightly acidic.

a General Corrosion
In normal operation, the vessel will contain either treated process water (slightly acidic) or DIW. Based on Uhlig (1948), little uniform corrosion is expected at these conditions. The uniform corrosion rate of the 300 series stainless steels in DIW at temperatures up to about boiling are generally considered small, <1 mpy. Hamner (1981) lists a corrosion rate for 304 (and 304L) in pure water of less than 2 mpy (his smallest unit of measurement).

Conclusion:
304L or 316L are acceptable for this system with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
With the proposed temperatures, 304L is acceptable under the stated no-chloride conditions.

Conclusion:
The data from the flowsheets suggest there are no halides to cause pitting; therefore, 304L is recommended.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization.

Conclusion:
The use of 304L is expected to be acceptable for the stated no-chloride conditions.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are suitable for MIC if infected. However, infection is considered unlikely.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
Not applicable to this system.

Conclusion:
Vapor phase corrosion is not expected.

j Erosion
Velocities within the condenser are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not believed to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
The contents of the condenser are essentially water with no reportable halides. The lowering of the pH by the inadvertent addition of nitric acid would be of no concern.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*,
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158

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1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
3. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs evaporator primary, inter- and after- condenser (CNP-HX-00002,3,4)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m^3					
Chloride	g/m^3					
Fluoride	g/m^3					
Iron	g/m^3					
Nitrate	g/m^3					
Nitrite	g/m^3					
Phosphate	g/m^3					
Sulfate	g/m^3					
Mercury	g/m^3					
Carbonate	g/m^3					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/m^3					
Other	g/m^3					
pH	N/A					Assumption 1
Temperature	°F					Assumption 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document, Chemical Max Calculation 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP04
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/m^3 do not need to be reported; list values to two significant digits max

Assumptions:
1. The overheads from the distilation column are expected to be contain primarily water with pH near or at 7.0.
2. Assume same as T normal operation for the evaporator, 122 °F to 212 °F (pressure of operation for last condenser is atmospheric)

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.1.5 Cs Evaporator Primary Condenser (CNP-HX-00002), Cs Evaporator Inter-Condenser (CNP-HX-00003), and Cs Evaporator After-Condenser (CNP-HX-00004)

Routine Operations

The Cs evaporator primary condenser, CNP-HX-00002, is a water-cooled, U-tube unit with condensation taking place on the shell side. The condenser shell incorporates a condensate sump, which contains a weir arrangement to control the flow split between the reflux and the overhead product flows. The overhead product flow includes excess water from the pre-elution and post-elution rinses sent to the Cs evaporator separator vessel from the cesium ion exchange columns.

To reduce the boiling temperature of the liquids in the Cs evaporator separator vessel, the system is run under vacuum. This is achieved using a two-stage steam ejector system. Exhaust vapors from the ejectors are condensed in Cs evaporator inter-condenser, CNP-HX-00003, and after-condenser, CNP-HX-00004, prior to venting to the ventilation system scrubbing equipment. Process condensate from the Cs evaporator primary condenser and Cs evaporator secondary condenser drains to the acidic/alkaline effluent vessels, PWD-VSL-00015 and PWD-VSL-00016, located in the PWD system.

The condensate from the condensers has a minimal amount of HNO_3, making it slightly acidic but not acidic enough to warrant neutralization; thus, it will be considered and referred to as process condensate.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682511

CNP-HX-00001 (PTF)

Cs Evaporator Concentrate Reboiler

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F) (max/min): Shell side: 325/40; Tube side: 250/40
- Design pressure (psig) (max/min): Shell side: 50/FV; Tube side: 50/FV
- Location: hot cell

Design temperature and pressure information is considered bounding and to be confirmed by Vendor.

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is at the stated pH range at the normal operating temperature.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X (shell-side)	
6% Mo (N08367/N08926)	7.64		X
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material:

Tube-side components: UNS N06022
Shell-side components (steam): 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: **Shell side and tube side; 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)**

Process & Operations Limitations:

- Use DIW as process cooling water.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

a General Corrosion
In the proposed pH operating range, little specific information was found for the general/uniform corrosion of stainless steels or other material in the given waste. This lack of data is not critical because the alloys needed for the system typically fail by pitting, crevice corrosion, or cracking. On this basis, a corrosion allowance has little meaning though a nominal value is given.

Even during high chloride conditions, either 304L or 316L is expected to have a sufficiently low uniform corrosion rate.

Conclusion:
Both 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is notorious for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. At pH < 12, chloride can be a concern. However, Revie (2000) and Uhlig (1948) both note nitrate inhibits chloride corrosion. Therefore, the high nitrate concentrations in the solution are expected to be beneficial.

Because of the high chloride conditions, and the high design temperature, C-22 or better is required for the tube-side components of the reboiler that will be in contact with the waste. For the shell-side, which is in contact with steam only, 304L will be sufficiently resistant. However, taking into consideration the relatively elevated design temperature on the shell side and the increased possibility of crevice corrosion, 316L is recommended.

Conclusion:
The high chloride conditions are such that an alloy such as C-22 or better will be required for only the components in contact with waste. Otherwise, 316L is suitable.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part, this is because the amount varies with temperature, metal sensitization, and the environment. It is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. The use of high nickel alloys for the tube-side components (waste) reduces the susceptibility to cracking.

Conclusion:
With the suggested high chloride conditions, C-22 will be needed for the tube-side components.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are suitable for MIC. However, MIC is not normally observed in operating systems.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not applicable.

i Vapor Phase Corrosion
Not applicable to this system.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not believed to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Addition of Nitric Acid
Reboiler routinely operates at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities,*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
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PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs evaporator separator vessel (CNP-EVAP-00001)
Cs concentrate reboiler (CNP-HX-00001)

Facility PTF

In Black Cell? Yes (CNP-EVAP-00001 only)

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.38E+01	1.29E+01			
Chloride	g/l	5.29E+00	5.89E+00			
Fluoride	g/l	6.28E+00	7.02E+00			
Iron	g/l	1.01E+00	1.05E+00			
Nitrate	g/l	5.78E+02	5.80E+02			
Nitrite	g/l	2.93E+01	3.25E+01			
Phosphate	g/l	2.11E+01	2.30E+01			
Sulfate	g/l	1.12E+01	1.25E+01			
Mercury	g/l	1.72E-02	7.88E-03			
Carbonate	g/l	3.95E+01	4.03E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP02, CNP03,CNP12, CNP10,CNP20
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M6-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. pH approximately 0.3 to 14. Operates primarily at acidic end, NaOH added prior to transfer out. Minimum pH based on 0.5 M nitric acid.
3. Tnormal operation 122 °F to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)

Assumptions:

Breakpot CNP-BRKT-00001 and CNP-VSL-00003 are for non-routine use and are normally empty. These vessels can receive a range of evaporator concentrate.

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.1.4 Cs Evaporator Separator Vessel (CNP-EVAP-00001), Cs Evaporator Concentrate Reboiler (CNP-HX-00001), and Eluate Contingency Storage Vessel (CNP-VSL-00003)

Routine Operations

Eluate from CNP-BRKPT-00002 is gravity-fed through a lute pot, CNP-VSL-00001, into the separator vessel, CNP-EVAP-00001. The Cs evaporator eluate lute pot, CNP-VSL-00001, provides a vacuum seal between CNP-BRKPT-00002 and the Cs evaporator separator vessel, CNP-EVAP-00001. The cesium concentrate is transferred from the Cs evaporator separator vessel using transfer ejectors to send it to vessel HLP-VSL-00028 or HLP-VSL-00027B in the HLP system.

Non-Routine Operations that Could Affect Corrosion/Erosion

If the HLP system cannot accept additional volume at the time of a required transfer, the eluate contingency storage vessel, CNP-VSL-00003, will receive the transfer.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10685019

CNP-EVAP-00001 (PTF)
Cs Evaporator Separator Vessel

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F)(max/min): 250/40
- Design Pressure (psig) (internal/external): 50/15
- Location: incell

Note: Design pressure and temperature information is considered bounding and to be confirmed by Vendor.

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is at the normal operating pH and temperature

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64		X
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N06022

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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0	9/8/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Vessel receives eluate from CNP-BRKPT-00002 and transfers the cesium concentrate to HLP-VSL-00029 or HLP-VSL-00027B via lute pot CNP-VSL-00002. Operating temperature range is 122 °F to 140 °F.

a General Corrosion
Davis (1994) states the corrosion rate for 304L in nitric acid will be less than about 0.1 mpy at the bulk temperatures. Normally, at these conditions, zirconium or titanium would be recommended, and a corrosion allowance of as much as 0.8 inches would be needed for a 40 y design life. However, the presence of fluoride will prevent the use of zirconium or titanium. C-22 has a corrosion rate of about 1 mpy in 5 % HNO_3 at boiling. In these solutions with <5 % HNO_3 and <1 % HCl, the corrosion rate will be smaller. The HF is complexed by the excess Al^{+++} and is expected to have little effect.

Conclusion:
In the presence of expected levels of halides, a high nickel alloy such as C-22 will be required. The standard corrosion allowance of 0.04 inch will be acceptable.

b Pitting Corrosion
With C-22, pitting is not expected to be a problem.

Conclusion:
No significant pitting is expected.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
C-22 is not susceptible to stress corrosion cracking under these conditions.

Conclusion:
Not anticipated.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not a concern in this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive for MIC.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not expected to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
A potential problem with condensing acids. C-22 is expected to be sufficiently resistant as to eliminate this concern.

Conclusion:
Not expected to be a concern.

j Erosion
There are no solids and the velocities are low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Vessel normally operates at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities.*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990
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3. Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 -- HF Mixtures*, ICP-1036, Idaho Chemical Programs -- Operations Office, Idaho Falls, ID
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
6. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
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9. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
10. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
11. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
12. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs evaporator separator vessel (CNP-EVAP-00001)
Cs concentrate reboiler (CNP-HX-00001)

Facility PTF

In Black Cell? Yes (CNP-EVAP-00001 only)

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.38E+01	1.28E+01			
Chloride	g/l	5.29E+00	5.89E+00			
Fluoride	g/l	6.28E+00	7.02E+00			
Iron	g/l	1.01E+00	1.05E+00			
Nitrate	g/l	5.78E+02	5.80E+02			
Nitrite	g/l	2.93E+01	3.25E+01			
Phosphate	g/l	2.11E+01	2.30E+01			
Sulfate	g/l	1.12E+01	1.25E+01			
Mercury	g/l	1.72E-02	7.88E-03			
Carbonate	g/l	3.95E+01	4.03E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3

List of Organic Species:

References
System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP02, CNP03, CNP12, CNP10, CNP20
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^-4 g/l do not need to be reported; list values to two significant digits max.
2. pH approximately 0.3 to 14. Operates primarily at acidic end, NaOH added prior to transfer out. Minimum pH based on 0.5 M nitric acid.
3. Tnormal operation 122 °F to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)

Assumptions:
Breakpot CNP-BRKT-00001 and CNP-VSL-00003 are for non-routine use and are normally empty. These vessels can receive a range of evaporator concentrate.

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.1.4 Cs Evaporator Separator Vessel (CNP-EVAP-00001), Cs Evaporator Concentrate Reboiler (CNP-HX-00001), and Eluate Contingency Storage Vessel (CNP-VSL-00003)

Routine Operations

Eluate from CNP-BRKPT-00002 is gravity-fed through a lute pot, CNP-VSL-00001, into the separator vessel, CNP-EVAP-00001. The Cs evaporator eluate lute pot, CNP-VSL-00001, provides a vacuum seal between CNP-BRKPT-00002 and the Cs evaporator separator vessel, CNP-EVAP-00001. The cesium concentrate is transferred from the Cs evaporator separator vessel using transfer ejectors to send it to vessel HLP-VSL-00028 or HLP-VSL-00027B in the HLP system.

Non-Routine Operations that Could Affect Corrosion/Erosion

If the HLP system cannot accept additional volume at the time of a required transfer, the eluate contingency storage vessel, CNP-VSL-00003, will receive the transfer.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10685020

CNP-VSL-00004 (PTF)

Cs Evaporator Recovered Nitric Acid Vessel

- Design Temperature (°F)(Max/min): 255/40
- Design Pressure (psig) (Max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

ISSUED BY RPP-WTP PDC

Offspring items

CNP-PJM-00019 – CNP-PJM-00022
CNP-VSL-00162, CNP-RFD-00005

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is at the stated pH at the normal operating temperature

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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EXPIRES: 12/07/07

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0	1/13/03	Issues for Permitting Use	DLA	JRD	SWV

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

CNP-VSL-00004 stores recovered nitric acid from CNP-DISTC-00001 at between 115 °F and 140 °F.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in 2 M HNO_3 of less than 2 mpy. Davis (1994) states the corrosion rate for 304L in 12% HNO_3 will be less than about 1 mpy up to about 212°F.

Conclusion:
304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
With the stated conditions, 304L will be adequate.

Conclusion:
The data provided suggest there are insufficient halides to cause pitting and 304L would be adequate.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. At the concentrations of chloride expected, 304L will be satisfactory.

Conclusion:
The use of 304L is expected to be acceptable for chloride free conditions.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are generally not acceptable for MIC.

Conclusion:
Not considered a concern.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
Not expected to be a concern.

Conclusion:
Vapor phase corrosion is not expected.

PLANT ITEM MATERIAL SELECTION DATA SHEET

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.004 inch is adequate for components with solids content less than 2 wt%. Because of the negligible concentration of undissolved solids, no localized protection is necessary for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s for a usage of 100 % operation as documented in 24590-WTP-M0E-50-00003.

The PJM nozzle requires no additional protection as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Vessel routinely operates at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0E-50-00003, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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2. Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 – HF Mixtures*, ICP-1036, Idaho Chemical Programs – Operations Office, Idaho Falls, ID
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
5. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
8. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID,

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Evaporator recovered nitric acid vessel (CNP-VSL-00004)
Cs evaporator nitric acid distillation column (CNP-DISTC-00001)

Facility PTF

In Black Cell? Yes (only CNP-VSL-00004)

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.84E-04	3.86E-04			
Chloride	g/l	4.28E-04	5.12E-04			
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l					Assumption 1
Nitrite	g/l	5.11E-04	6.11E-04			
Phosphate	g/l	8.68E-04	1.04E-03			
Sulfate	g/l	3.36E-04	4.01E-04			
Mercury	g/l					
Carbonate	g/l	1.66E-03	1.82E-03			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References
System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP13, CNP14
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tnormal operation 115 °F to 140 °F (24590-PTF-M6C-CNP-00001, Rev 0)
3. Will be highly acidic, pH approximately 0.3
4. 2M nitric acid is added to the vessel.

Assumptions:

1. Based on the presence of 0.5M HNO_3 the nitrate concentration is expected to be approximately 31 g/l (24590-WTP-M4E-V11T-00001, Rev A)

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.1.3 Cs Evaporator Nitric Acid Distillation Column (CNP-DISTC-00001), Cs Evaporator Recovered Nitric Acid Vessel (CNP-VSL-00004)

Routine Operations

Nitric acid vapor enters the nitric acid distillation column, CNP-DISTC-00001, which separates water from the acid. The recovered nitric acid is stored in the Cs evaporator recovered nitric acid vessel CNP-VSL-00004. During elution, nitric acid is pumped from the storage vessel by the Cs IX feed pump, through the feed cooler, and distributed into the system CXP ion exchange columns.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10666998

CNP-BRKPT-00002 (PTF)
Cs Eluate Breakpot

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F) (max/min): 372/40
- Design Pressure (psig) (internal/external): 15/FV
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:
- The breakpot is normally empty and at ambient temperature.
- Operation at temperatures approaching the maximum design temperature is expected to be of short duration.

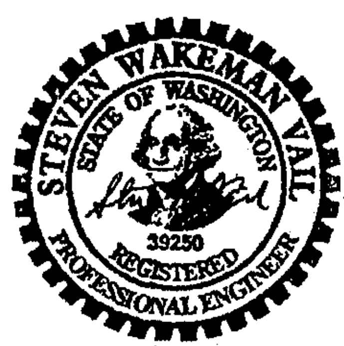
Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:
- Develop procedure to flush thoroughly with water after use with alkaline solution.



3/8/06

EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

During the elution cycle the eluate comes from CXP-IXC-00001/2/3/4 to CNP-BRKPT-00002 and then to CNP-VSL-00001. The elution cycle is 15 hrs and is normally at an ambient temperature of 77 °F. The maximum operating temperature of 140 °F is attributed to circumstances where neutralized Cs concentrate (approx pH 14) could be transferred from CNP-VSL-00003 (the contingency vessel) to CNP-BRKPT-00002. However, this is not a likely route for transfer and for the purposes of this evaluation are considered infrequent. The breakpot could also see steam temperatures during transfer. These high-temperature conditions are assumed to be of short duration. This evaluation is based on a nominal operating temperature of 77 °F.

a General Corrosion
At the expected pH, little specific information was found for the general/uniform corrosion of stainless steels or other material in the given waste. Typically, the austenitic and higher alloy steels are expected to have corrosion rates of less than about 4 mpy in HNO_3 at the maximum temperature. This lack of data is not critical because the alloys needed for the system typically fail by pitting, crevice corrosion, or cracking.

Hamner (1981) lists the corrosion rate for both 304L and 316L as < 2 mpy at temperatures up to 150°F. Based on estimates from Cole (1974), corrosion rates for all of the concentrations <4 M and at temperatures to boiling are expected to be less than 1 mpy.

Conclusion:
Under the stated conditions, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy at up to 150°F.

b Pitting Corrosion
With the stated conditions, 304L will be adequate.

Conclusion:
The data from the flowsheets suggest there are insufficient halides to cause pitting in 304L.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1981), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for cracking.

Conclusion:
The use of 304L is recommended.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not suitable for MIC.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern.

Conclusions
Not believed to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
Vapor phase corrosion is not expected to be a concern. Further, the presence of wash rings indicates deposits can be prevented.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
None anticipated.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Breakpot will see low pH conditions during normal operations.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130176, Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 – HF Mixtures*, ICP-1036, Idaho Chemical Programs – Operations Office, Idaho Falls, ID
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
6. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co. *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
6. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs concentrate breakpot (CNP-BRKPT-00002)
Cs evaporator eluate lute pot (CNP-VSL-00001

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine [3]		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.30E-01	2.31E-01			
Chloride	g/l	8.85E-02	1.06E-01			
Fluoride	g/l	1.05E-01	1.26E-01			
Iron	g/l	1.69E-02	1.69E-02			
Nitrate	g/l	1.54E+01	8.81E+00	4.46E-04	4.46E-04	
Nitrite	g/l	4.88E-01	5.83E-01			
Phosphate	g/l	3.53E-01	4.13E-01			
Sulfate	g/l	1.88E-01	2.24E-01			
Mercury	g/l	5.47E-04	1.42E-04			
Carbonate	g/l	6.59E-01	7.24E-01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Assumption 1
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP11, CXP12, CNP02
Off Normal Input Stream # (e.g., overflow from other vessels): CNP01 acid charge
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Breakpot: Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.
   Vessel: Thermal operating range 77 °F (eluate) to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)
3. Nitric acid charge (CNP01)

Assumptions:

1. Stream CXP12 post elution rinse pH approx 0.5. CXP11 elution stream pH approx. 0.3 or more.

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.1.2 Cs Concentrate Breakpot (CNP-BRKPT-00002), Cs Evaporator Eluate Lute Pot (CNP-VSL-00001)

Routine Operations

Under normal operations, the eluant from the IX columns goes directly to the Cs concentrate breakpot, CNP-BRKPT-00002. Eluate is then gravity-fed through a lute pot, CNP-VSL-00001, into the separator vessel, CNP-EVAP-00001. CNP-BRKPT-00002 is vented to the vessel vent system and contains wash rings and purge air.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10685021

CNP-VSL-00003 (PTF)

Eluate Contingency Storage Vessel

- Design Temperature (°F)(max/min): 255/40
- Design Pressure (psig) (max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

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Off spring items

CNP-PJM-00013, CNP-PJM-00014, CNP-PJM-00015, CNP-PJM-00016, CNP-VSL-00166, CNP-RFD-00003

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is pH 0.3 at the normal operating temperature
- The vessel is pH 14 at the normal operating temperature
- Caustic available to wash rings and for neutralization prior to transfer

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X (jacket only)	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: Vessel: 316 (max 0.030% C; dual certified), or better
Jacket: 304 (max 0.030% C; dual certified), or better

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; additional localized protection required and discussed in section j)

Process & Operations Limitations:

- Develop procedure for thorough flushing/rinsing prior to addition of acid solutions.

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REGISTERED PROFESSIONAL ENGINEER
6/13/06
EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Vessel is available to receive Cs concentrate and Cs eluate from the Cs evaporator breakpot. Also, if the HLP system cannot accept a required transfer, CNP-VSL-00003 is available to receive the transfer.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. Uhlig (1948) shows the rate in water is < 1 mpy.

Hamner (1981) lists a corrosion rate for 304 (and 304L) in 2 M HNO_3 of less than 2 mpy. Davis (1994) states the corrosion rate for 304L in 12% HNO_3 will be less than about 1 mpy up to about 212°F.

Conclusion:
316L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy under all expected conditions.

b Pitting Corrosion
Chloride is notorious for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions chlorides are likely to promote pitting only in tight crevices. At pH < 12, chloride can be a concern. However, Revie (2000) and Uhlig (1948) both note nitrate inhibits chloride corrosion. Therefore the nitrate concentrations in the solution are expected to be beneficial and either 304L or 316L can be used if the chloride conditions stated are met.

Some potential exists for pitting if the vessel contains waste, cooling fails and the solution begins to evaporate. Then chloride could concentrate at the interface making 316L marginal. However, conditions with hot solution are not anticipated.

Conclusion:
Under the stated conditions, 316L is the minimum alloy recommended. Evaporative conditions with salt concentrations at the interface are not anticipated to be a frequent occurrence.

c End Grain Corrosion
Not applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. The use of 316L is preferred over 304L because of greater cracking resistance.

According to Sedriks and Dillon (2000),, caustic cracking tends not to occur below 140°F, though Zapp suggests the temperature may be as high as 212°F. The high nitrate concentrations may inhibit pitting and cracking.

Some potential exists for cracking if the vessel contains waste, cooling fails and the solution begins to evaporate. Then chloride could concentrate at the interface making 316L marginal. However, conditions with hot solution are not anticipated.

Conclusion:
Because of the normal operating environment 316L stainless steel is expected to be acceptable. Evaporative conditions are not anticipated to be a frequent occurrence.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system .

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are suitable for MIC. However, MIC is not normally observed in operating systems except for those exposed to untreated process water.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not applicable.

i Vapor Phase Corrosion
Due to agitation, some splashing is expected. Therefore there will be liquids on the dome of the vessel. This is not expected to be a concern because of the high nitrate content.

Conclusion:
Vapor phase corrosion is not expected.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 2 wt% for a usage of 11 % operation as documented in 24590-WTP-M0E-50-00003. CNP-VSL-00003 requires at least 0.016-inch additional protection. The 2 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of CNP-VSL-00003 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.010-inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 2 wt% for usage of 11 % operation as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Vessel normally operates at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0E-50-00003, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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10. Smith, H. D. and M. R. Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
11. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158

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1. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
3. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
4. Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Eluate contingency vessel (CNP-VSL-00003)
Eluate contingency breakpot (CNP-BRKPT-00001)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine 4		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.17E+01	1.10E+01			
Chloride	g/l	4.51E+00	5.02E+00			
Fluoride	g/l	5.38E+00	5.98E+00			
Iron	g/l	8.60E-01	8.97E-01			
Nitrate	g/l	4.93E+02	4.94E+02			
Nitrite	g/l	2.49E+01	2.77E+01			
Phosphate	g/l	1.80E+01	1.96E+01			
Sulfate	g/l	9.58E+00	1.06E+01			
Mercury	g/l	1.47E-02	6.71E-03			
Carbonate	g/l	3.36E+01	3.43E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP12, CNP14, CXP11, CXP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M6-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.
   CNP-VSL-00003: T normal operation 77 °F (eluate stream) to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)
3. Composition can vary and is received on a contingency basis.
   The vessel revelves Cs Eluate at low pH of approx. 0.3 or more, with low levels of Cl, F, etc, also can receive Cs Evap Concentrate that has been neutralized to pH approx. 14 with high levels of Cl, F, etc. Minumum pH based on 0.5M nitric acid
4. Note CXP11 has the same composition as CXP21 but CXP21 does not appear in the mass balance because it is a contingent stream to the vessel.

Assumptions:

This vessel is a contingency vessel and under normal operations contains a heel only. It is available to receive Cs Concentrate and Cs Eluate.

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.1.4 Cs Evaporator Separator Vessel (CNP-EVAP-00001), Cs Evaporator Concentrate Reboiler (CNP-HX-00001), and Eluate Contingency Storage Vessel (CNP-VSL-00003)

Routine Operations

Eluate from CNP-BRKPT-00002 is gravity-fed through a lute pot, CNP-VSL-00001, into the separator vessel, CNP-EVAP-00001. The Cs evaporator eluate lute pot, CNP-VSL-00001, provides a vacuum seal between CNP-BRKPT-00002 and the Cs evaporator separator vessel, CNP-EVAP-00001. The cesium concentrate is transferred from the Cs evaporator separator vessel using transfer ejectors to send it to vessel HLP-VSL-*00028* or *HLP-VSL-00027B* in the *HLP* system.

Non-Routine Operations that Could Affect Corrosion/Erosion

If the HLP system cannot accept additional volume at the time of a required transfer, the eluate contingency storage vessel, CNP-VSL-00003, will receive the transfer.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667001

CNP-BRKPT-00001, (PTF)
Cs Concentrate Breakpot

- Design Temperature (°F) (max/min): 372/40
- Design Pressure (psig) (internal/external): 15/FV
- Location: incell

ISSUED BY
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is normally empty and at ambient temperature

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified), or better

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop procedure for thorough removal of caustic solution by rinsing/flushing before adding acidic solutions.

STEVEN WAKEMAN VAIL, STATE OF WASHINGTON, 39250, REGISTERED PROFESSIONAL ENGINEER 3/8/06
EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel is normally empty but is available to receive recovered acid flows from the Cs evaporator nitric acid rectifier or from the Cs ion exchange columns or Cs concentrate from the Cs evaporator separator vessel.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

Hamner (1981) lists a corrosion rate for 304 (and 304L) in 2 M HNO_3 of less than 2 mpy. Davis (1994) states the corrosion rate for 304L in 12% HNO_3 will be less than about 1 mpy up to about 212°F.

Conclusion:
316L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy at the stated conditions providing breakpots are flushed before acidic solutions are introduced.

b Pitting Corrosion
Chloride is notorious for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. At pH < 12, chloride can be a concern. However, Revie (2000) and Uhlig (1948) both note nitrate inhibits chloride corrosion. Therefore the nitrate concentration in the solution is expected to be beneficial and 316L can be used if the chloride concentration is not more than stated.

Conclusions
Under the stated conditions, 316L is the minimum alloy recommended.

c End Grain Corrosion
Not applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization to cracking.

Conclusions:
At the normal operating environment 316L stainless steel is expected to be acceptable.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are suitable for MIC. However, MIC is not normally observed in operating systems except for those exposed to untreated process water.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not believed to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
No vapor phase corrosion is expected.

Conclusion:
Not applicable.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
None expected.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
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5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
7. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990
2. CCN 130175, Boschen, Steve, http://www.altixn.com/images/stainlessguide.pdf
3. CCN 130176, Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 – HF Mixtures*, ICP-1036, Idaho Chemical Programs – Operations Office, Idaho Falls, ID
4. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
5. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
6. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
8. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Eluate contingency vessel (CNP-VSL-00003)
Eluate contingency breakpot (CNP-BRKPT-00001

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine 4		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.17E+01	1.10E+01			
Chloride	g/l	4.51E+00	5.02E+00			
Fluoride	g/l	5.36E+00	5.98E+00			
Iron	g/l	8.60E-01	8.97E-01			
Nitrate	g/l	4.93E+02	4.94E+02			
Nitrite	g/l	2.49E+01	2.77E+01			
Phosphate	g/l	1.80E+01	1.96E+01			
Sulfate	g/l	9.58E+00	1.06E+01			
Mercury	g/l	1.47E-02	6.71E-03			
Carbonate	g/l	3.36E+01	3.43E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References

System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP12, CNP14, CXP11, CXP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.
   CNP-VSL-00003: T normal operation 77 °F (eluate stream) to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)
3. Composition can vary and is received on a contingency basis.
   The vessel receives Cs Eluate at low pH of approx. 0.3 or more, with low levels of Cl, F, etc. also can receive Cs Evap Concentrate that has been neutralized to pH approx. 14 with high levels of Cl, F, etc. Minimum pH based on 0.5M nitric acid
4. Note CXP11 has the same composition as CXP21 but CXP21 does not appear in the mass balance because it is a contingent stream to the vessel.

Assumptions:

This vessel is a contingency vessel and under normal operations contains a heel only. It is available to receive Cs Concentrate and Cs Eluate.

4.1.1 Cs Evaporator Breakpot (CNP-BRKPT-00001)

Routine Operations

This vessel is normally empty and is not used on a routine basis but is available to receive Cs concentrate and Cs eluate, which drains to the eluate contingency storage vessel (CNP-VSL-00003).

Non-Routine Operations that Could Affect Corrosion/Erosion

Recovered acid flows by gravity from the bottom of the Cs evaporator nitric acid rectifier (CNP-DISTC-00001) to the Cs evaporator recovered nitric acid vessel (CNP-VSL-00004). CNP-VSL-00004 has enough eluant to complete one elution of a normal bed of SuperLig 644 resin. If the acid needs reprocessing, as evidenced by an activity above allowable levels, it is recycled through the nitric acid recovery process by way of a steam ejector to the Cs concentrate breakpot, CNP-BRKPT-00001, draining to the eluate contingency storage vessel (CNP-VSL-00003). Then it is sent back to the cesium evaporator breakpot (CNP-BRKPT-00002) at the beginning of the system. If the acid is acceptable (low gamma and correct HNO_3 concentration), it is transferred directly into the eluant stream feeding the IX columns.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10685022

ISSUED BY
RPP-WTP PDC

CNP-VSL-00001, (PTF)

Cs Evaporator Eluate Lute Pot

- Design Temperature (°F) (max/min): 237/40
- Design Pressure (psig) (internal/external): 40/Atm
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is the stated pH at the normal operating temperature.
- The condition of high temperature due to self-boiling of Cs concentrate is assumed to be infrequent and of short duration.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop procedure for periodic flushing with water.

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This lute pot receives eluate from the IX columns.

a General Corrosion
In the proposed pH operating range, little specific information was found for the general/uniform corrosion of stainless steels or other material in the given waste. This lack of data is not critical because the alloys needed for the system typically fail by pitting, crevice corrosion, or cracking. On this basis, a corrosion allowance has little meaning though a nominal value is given.

Davis (1994) states the corrosion rate for 304L and 316L will be less than about 0.1 mpy at these temperatures.

Conclusion:
304L and 316L are both expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
With the stated conditions, 304L would be marginal but 316L is recommended. With thorough flushing with water, 304L is acceptable.

Conclusion:
The data from the flowsheets suggest there are sufficient halides to cause pitting in 304L unless thoroughly flushed.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization.

Conclusion:
The use of 316L is recommended for the stated conditions. Though with flushing, 304L is acceptable.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is a not expected to be a concern.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are generally acceptable for MIC. However, MIC is not normally observed in operating systems

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern

Conclusions
Not a concern.

i Vapor Phase Corrosion
Not expected to be a concern.

Conclusion:
Vapor phase corrosion is not expected.

PLANT ITEM MATERIAL SELECTION DATA SHEET

j Erosion
There are no solids and the velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Vessel routinely operates at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
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5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

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1. Cole, HS, 1974, *Corrosion of Austenitic Stainless Steel Alloys Due to HNO_3 – HF Mixtures*, ICP-1036, Idaho Chemical Programs – Operations Office, Idaho Falls, ID
2. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
5. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
6. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
7. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho Chemical Programs, Idaho National Engineering Laboratory, Idaho Falls, ID,

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs concentrate breakpot (CNP-BRKPT-00002)
Cs evaporator eluate lute pot (CNP-VSL-00001)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine[3]		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.30E-01	2.31E-01			
Chloride	g/l	8.85E-02	1.08E-01			
Fluoride	g/l	1.05E-01	1.28E-01			
Iron	g/l	1.69E-02	1.89E-02			
Nitrate	g/l	1.54E+01	8.81E+00	4.46E-04	4.46E-04	
Nitrite	g/l	4.88E-01	5.83E-01			
Phosphate	g/l	3.53E-01	4.13E-01			
Sulfate	g/l	1.88E-01	2.24E-01			
Mercury	g/l	5.47E-04	1.42E-04			
Carbonate	g/l	6.59E-01	7.24E-01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Assumption 1
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP11, CXP12, CNP02
Off Normal Input Stream # (e.g., overflow from other vessels): CNP01 acid charge
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Breakpot: Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.
 Vessel: Tnormal operating range 77 °F (eluate) to 140 °F (24590-PTF-M5C-CNP-00001, Rev 0)
3. Nitric acid charge (CNP01)

Assumptions:
1. Stream CXP12 post elution rinse pH approx 0.5, CXP11 elution stream pH approx. 0.3 or more.

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.1.2 Cs Concentrate Breakpot (CNP-BRKPT-00002), Cs Evaporator Eluate Lute Pot (CNP-VSL-00001)

Routine Operations

Under normal operations, the eluant from the IX columns goes directly to the Cs concentrate breakpot, CNP-BRKPT-00002. Eluate is then gravity-fed through a lute pot, CNP-VSL-00001, into the separator vessel, CNP-EVAP-00001. CNP-BRKPT-00002 is vented to the vessel vent system and contains wash rings and purge air.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

24590-PTF-N1D-CNP-P0012
Rev. 1

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682508

ISSUED BY
RPP-WTP PDC

CNP-HX-00004 (PTF)
Cs Evaporator After-Condenser

- Design Temperature (°F)(max/min): Shell side: 378/40: Tube side: 125/40
- Design Pressure (psig) (max/min): Shell side: 100/FV; Tube side: 100/FV
- Location: outcell

Design temperature and pressure information is considered bounding and to be confirmed by Vendor.

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operation

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: Shell side and tube side: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Exhaust vapors from the Cs evaporator separator vessel are condensed in CNP-HX-00004 prior to venting to the ventilation system scrubbing equipment. The condensate from the condensers has a minimal amount of HNO_3 making it slightly acidic.

a General Corrosion
In normal operation, the vessel will contain either treated process water (slightly acidic) or DIW. Based on Uhlig (1948), little uniform corrosion is expected at these conditions. The uniform corrosion rate of the 300 series stainless steels in DIW at temperatures up to about boiling are generally considered small, <1 mpy. Hamner (1981) lists a corrosion rate for 304 (and 304L) in pure water of less than 2 mpy (his smallest unit of measurement).

Conclusion:
304L or 316L are acceptable for this system with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
With the proposed temperatures, 304L is acceptable under the stated no-chloride conditions.

Conclusion:
The data from the flowsheets suggest there are no halides to cause pitting; 304L is recommended.

c End Grain Corrosion
Not believed to be applicable to this system.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization.

Conclusion:
The use of 304L is expected to be acceptable for the stated no-chloride conditions.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are suitable for MIC if infected. However, infection is considered unlikely.

Conclusion:
MIC is not considered a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not applicable.

i Vapor Phase Corrosion
Not applicable to this system.

Conclusion:
Vapor phase corrosion is not expected.

j Erosion
Velocities within the condenser are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
The contents of the condenser are essentially water with no reportable halides. The lowering of the pH by the inadvertent addition of nitric acid would be of no concern.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities,*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs evaporator primary, inter- and after- condenser (CNP-HX-00002,3,4)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m^3					
Chloride	g/m^3					
Fluoride	g/m^3					
Iron	g/m^3					
Nitrate	g/m^3					
Nitrite	g/m^3					
Phosphate	g/m^3					
Sulfate	g/m^3					
Mercury	g/m^3					
Carbonate	g/m^3					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/m^3					
Other	g/m^3					
pH	N/A					Assumption 1
Temperature	°F					Assumption 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-CNP-00001, Rev 0
Mass Balance Document: Chemical Max Calculation 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CNP04
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0014, Rev 1
Technical Reports: N/A

Notes:
1 Concentrations less than 1x 10^{-4} g/m^3 do not need to be reported; list values to two significant digits max.

Assumptions:
1. The overheads from the distillation column are expected to be contain primarily water with pH near or at 7.0.
2 Assume same as T normal operation for the evaporator, 122 °F to 212 °F (pressure of operation for last condenser is atmospheric)

4.1.5 Cs Evaporator Primary Condenser (CNP-HX-00002), Cs Evaporator Inter-Condenser (CNP-HX-00003), and Cs Evaporator After-Condenser (CNP-HX-00004)

Routine Operations

The Cs evaporator primary condenser, CNP-HX-00002, is a water-cooled, U-tube unit with condensation taking place on the shell side. The condenser shell incorporates a condensate sump, which contains a weir arrangement to control the flow split between the reflux and the overhead product flows. The overhead product flow includes excess water from the pre-elution and post-elution rinses sent to the Cs evaporator separator vessel from the cesium ion exchange columns.

To reduce the boiling temperature of the liquids in the Cs evaporator separator vessel, the system is run under vacuum. This is achieved using a two-stage steam ejector system. Exhaust vapors from the ejectors are condensed in Cs evaporator inter-condenser, CNP-HX-00003, and after-condenser, CNP-HX-00004, prior to venting to the ventilation system scrubbing equipment. Process condensate from the Cs evaporator primary condenser and Cs evaporator secondary condenser drains to the acidic/alkaline effluent vessels, PWD-VSL-00015 and PWD-VSL-00016, located in the PWD system.

The condensate from the condensers has a minimal amount of HNO_3, making it slightly acidic but not acidic enough to warrant neutralization; thus, it will be considered and referred to as process condensate.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10667872

CXP-VSL-00001 (PTF)
Cs Ion Exchange Feed Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (internal/external): 15/10
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Maintenance will not be performed on this vessel for the forty years design life

Operating Modes Considered:

- The vessel is filled with LAW.
- The vessel is filled with demineralized water.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.

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3/8/06
EXPIRES: 12/07/07

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0	5/18/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel normally receives filtered LAW from one of the ultrafilter permeate vessels (UFP-VSL-000062A/B/C), as well as batches of pre-elution displaced LAW from the ion exchange column, and provides feed buffer capacity to allow continuous operation of the IX system.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

In this system, the normal hydroxide concentrations and temperatures are such that either 304L or 316L stainless steel will be acceptable.

Conclusion:
At temperatures less than about 140°F, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L.

Normally the vessel is to operate between 77 and 113 °F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

If the vessel were rinsed with acid or filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the amount of residual chlorides. The more pitting-resistant 316L is recommended.

Conclusion:
Localized corrosion, such as pitting, is not a concern. It is expected that 316L will be a better choice than 304L.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Neither 304L nor 316L are susceptible to caustic cracking at the proposed conditions.

Conclusion:
At the normal operating environment, either 304L or 316L is recommended.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth if microbes were introduced.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Due to the possibility that deposits may remain, 316L is the minimum recommended.

Conclusion:
Not expected to be a concern with 316L.

j Erosion
Erosion of vessel should be minimal with the very low undissolved solids content anticipated. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
There are no moving surfaces within the vessel.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218.
7. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141.
8. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158.
9. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

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3. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158.
4. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084.

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA

Component(s) (Name/ID #) Cs ion exchange feed vessel (CXP-VSL-00001)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.15E+01	3.17E+01			
Chloride	g/l	1.21E+01	1.45E+01			
Fluoride	g/l	1.44E+01	1.73E+01			
Iron	g/l	2.31E+00	2.60E+00			
Nitrate	g/l	2.23E+02	2.59E+02			
Nitrite	g/l	6.69E+01	8.01E+01			
Phosphate	g/l	4.83E+01	5.66E+01			
Sulfate	g/l	2.57E+01	3.08E+01			
Mercury	g/l	7.47E-02	1.94E-02			
Carbonate	g/l	9.03E+01	9.93E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00006, Rev A
Normal Input Stream #: CXP09, UFP33, CXP01
Off Normal Input Stream #: off spec treated LAW high in Cs
P&ID: N/A
PFD: 24590-PTF-M6-V17T-P0012, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T operation 77 °F to 113 °F (24590-PTF-MVC-CXP-00001, Rev 0)
3. pH approximately 12 (based on $Al(OH)_3$ precipitation) to 14, CXP09, UFP33 are highly basic, contain 0.25M NaOH.

Assumptions:

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.3.3 Cs Ion Exchange Feed Vessel (CXP-VSL-00001)

Routine Operations

The Cs ion exchange feed vessel (CXP-VSL-00001) is designed to receive LAW from the ultrafiltration process system (UFP) and provide feed buffer capacity to allow continuous operation of the IX system. The vessel normally receives filtered LAW from one of the three ultrafilter permeate vessels (UFP-VSL-00062-A, -B, or -C), as well as batches of pre-elution displaced LAW from the ion exchange columns. It can receive (intermittently) LAW that bypasses the ultrafilters (from UFP-VSL-00001-A or -B) and off-specification recycle from the Cs treated LAW collection vessel. The total batch volume of the Cs-IX feed vessel is 80,000 gallons.

Non-Routine Operations that Could Affect Corrosion/Erosion

This vessel is also used as a point of recycle for the IX system if the Cs treated LAW is found to be out of specification for ^{137}Cs content. This vessel overflows to PWD-VSL-00033. For corrosion evaluation, the recycle stream is bounded by the feed stream.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667873

ISSUED BY
RPP-WTP PDC

CXP-VSL-00004 (PTF)
Cs IX Caustic Rinse Collection Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (max/min): 15/FV:
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

OFFSPRING ITEMS

CXP-VSL-00006 – CXP-VSL-00009
CXP-PJM-00001, CXP-RFD-00004A/B
CXP-RFD-00005 – CXP-RFD-00006

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is filled with caustic rinse water.
- The vessel is filled with process condensate or demineralized water.
- No acid is present.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel allows recycle and reuse of the originally nominal 0.25 M NaOH solution from the Cs IX column. The solution exits the column with a nominal caustic concentration of about 0.1 M NaOH. This vessel can also receive fresh nominal 0.25 M NaOH solution as well as process condensate from one of the process condensate vessels.

a General Corrosion
The caustic rinse collection vessel collects rinse water from the IX columns during the wash cycle. The rinse solution is made up of diluted caustic solution with process condensate and/or demineralized water

Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

Conclusion:
At the given temperatures, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L. Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 77 to 113 °F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the amount of residual chlorides.

Conclusion:
Localized corrosion, such as pitting, is not expected. At the stated operating conditions304L will be suitable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Neither 304L nor 316L are susceptible to caustic cracking at the proposed conditions.

Conclusion:
At the normal operating environment, the alloy recommended is 304L.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth if microbes were introduced.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Under the stated conditions, with wash ring present in the vessel, this is not expected to be a concern

Conclusion:
Not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.004 inch is adequate for components with solids content less than 2 wt%. No localized protection is necessary for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s for a usage of 100 % operation as documented in 24590-WTP-M0C-50-00004.

The PJM nozzle requires no additional protection as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0C-50-00004, Rev. D, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
3. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs IX caustic rinse collection vessel (CXP-VSL-00004)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l	8.70E-04	1.01E-03			
Nitrite	g/l	1.30E-04	1.55E-04			
Phosphate	g/l	1.35E-04	1.58E-04			
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l	2.53E-04	2.78E-04			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Assumption 1
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP13, CXP22, CXP14
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T P0012, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tnormal operation 77 °F to 113 °F (24590 PTF-MVC-CXP-00004, Rev 0)

Assumptions:
1. Process condensate at pH 7, stream CXP13 has pH 13 (0.1M NaOH)

4.3.4 Cs-IX Caustic Rinse Collection Vessel (CXP-VSL-00004)

Routine Operations

The Cs-IX caustic rinse collection vessel (CXP-VSL-00004) allows recycle and reuse of the originally nominal 0.25 M NaOH solution. The Cs-IX caustic rinse collection vessel is designed to receive spent caustic regeneration solution that has been discharged from a Cs IX column (CXP-IXC-00001, -00002, -00003, or -00004) during the regeneration sequence.

The spent regeneration solution, which originates as a fresh 0.25 M NaOH solution before introduction into the column, exits the column with a nominal caustic concentration of about 0.1 M NaOH. This solution is then collected in the Cs-IX caustic rinse collection vessel for use in the LAW displacement sequence. During the column regeneration, 2500 gallons of fresh 0.25 M NaOH solution are fed to a column. A significant portion of the initial NaOH that is fed to the column reacts with the resin and, as a result, the initial solution exiting the column is depleted in NaOH. Only about half of the volume of the total batch of regeneration solution is captured for use in the LAW displacement sequence; since the later half has a higher strength in NaOH, it is captured. This is accomplished by valving the first portion of the exiting regeneration solution to one of the acidic/alkaline effluent vessels (PWD-VSL-00015 or -00016), and valving the second portion to the Cs-IX caustic rinse collection vessel.

For startup and makeup purposes, the Cs-IX caustic rinse collection vessel can receive fresh nominal 0.25 M NaOH solution from an outcell tank (SHR-TK-00005). It can also receive (as a source of water) process condensate from one of the process condensate tanks (RLD-TK-00006-A or -B) via a header. Some adjustment of the NaOH concentration can be made using these two sources. The solutions made in the Cs-IX caustic rinse collection vessel can also be used to cool Cs IX columns (through the use of flow-through cooling) in abnormal situations. Alternatively, the Cs-IX caustic rinse collection vessel can be used to receive batches of cooling solution that have passed through a column.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667874

ISSUED BY
RPP-WTP PDC

CXP-VSL-00005 - (PTF)
Cs IX Reagent Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (max/min): 15/FV
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is filled with caustic.
- The vessel is filled with demineralized water.
- The vessel is filled with nitric acid (standby condition).

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water (rinse prior to adding acid after receiving solids from CXP-VSL-00004).

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EXPIRES: 12/07/

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This bound document contains a total of 7 sheets.

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1	3/8/06	Issued for Permitting Use	[signature]	HmK	SWVail
0	5/18/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel is expected to receive demineralized water, nominal 0.25 M NaOH solution, nominal 0.1 M NaOH solution, standby nitric acid, and recycled spent regeneration caustic solution from CXP-VSL-00004.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

In this system, the normal hydroxide concentrations and temperatures are such that 304L or a higher alloy stainless steel will be acceptable.

The addition or presence of 0.5 M HNO_3 is not a concern for the given concentrations.

Conclusion:
At temperatures less than about 140°F, 304L or better is expected to be sufficiently resistant to the solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
The nitric acid does not contain chloride or fluoride. The NaOH may contain chloride impurities. The two possible opportunities for pitting are either acidifying high chloride waste or leaving the vessel full of DIW with residual chloride.

Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L. Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate with a fluid temperature 77°F. At this temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

The small quantity of halides will not be harmful even if the solution is neutralized or modified with HNO_3.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the amount of residual chlorides.

Conclusion:
Localized corrosion, such as pitting, is not expected. It is expected that 304L will be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not expected in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Because of the potential for caustic cracking, 304L and 316L are generally not recommended for use above 140°F. However, based on the proposed temperatures, either is acceptable.

Conclusion:
At the normal operating environment, the alloy recommended is 304L stainless.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

PLANT ITEM MATERIAL SELECTION DATA SHEET

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are conducive to microbial growth if microbes were introduced. The use of DIW as process water should minimize the possibility of introduction of microbes.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. Wash rings within vessel should provide sufficient rinsing to minimize presence of deposits.

Conclusion:
Not believed to be of concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not believed to be of concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

p Inadvertent Nitric Acid Addition

Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:

The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
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6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
7. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
8. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
9. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
10. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
11. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
3. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs IX reagent vessel (CXP-VSL-00005)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l	8.83E-04	1.03E-03			
Nitrite	g/l	1.32E-04	1.57E-04			
Phosphate	g/l	1.37E-04	1.61E-04			
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l	2.56E-04	2.62E-04			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A	13.0	13.0			Note 2
Temperature	°F					Assumption 1

List of Organic Species:

References
System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP03
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T P0012, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Normally pH is approximately 13. This vessel also receives 0.1M NaOH, 0.25M NaOH, and 0.5 M nitric acid for chemical adjustment.

Assumptions:
1. Thermal operation is 77 °F, Tmax 113 °F (24590-PTF-MVD-CXP-P0016, Rev 0)

4.3.5 Cs-IX Reagent Vessel (CXP-VSL-00005)

The CS-IX reagent vessel (CXP-VSL-00005) provides reagents for the Cs ion exchange columns.

Routine Operations

The Cs-IX reagent vessel is designed to receive demineralized water, nominal 0.25 M NaOH solution, nominal 0.1 M NaOH solution, and standby nitric acid from outcell sources as fresh reagents. In addition, the Cs-IX reagent vessel receives recycled spent regeneration caustic solution from the Cs-IX caustic rinse collection vessel (CXP-VSL-00004).

The Cs-IX reagent vessel functions like a breakpot, feeding liquids to the suction of the Cs-IX feed pumps and preventing backflow of contaminated fluids to clean systems. Unlike a true breakpot, however, there are valves on the bottom draining discharge line of the Cs-IX reagent vessel because the discharge must serve two pumps on separate occasions. The Cs-IX reagent vessel also serves as a source for ventilation of the Cs IX columns. The Cs-IX reagent vessel has a demister (with pressure-drop-measurement included in the top portion of this vessel) to enable demisting of any potentially entrained liquid with the vented column gasses.

The Cs-IX reagent vessel normally receives the following:

- Demineralized water from outcell tank DIW-TK-00001 during the pre-elution rinse and post-elution rinse sequences
- Nominal 0.25 M NaOH solution from the balance of facilities (BOF) header during the regeneration sequence

Non-Routine Operations that Could Affect Corrosion/Erosion

In abnormal situations, the Cs-IX reagent vessel can receive the following:

- Nominal 0.1 M NaOH solution as recycled spent regeneration solution from the Cs-IX caustic rinse collection vessel (CXP-VSL-00004). This solution is used in the LAW displacement sequence. The vessel can also receive fresh nominal 0.1 M NaOH solution for emergency cooling from outcell tank SHR-TK-00001.
- Standby (0.5 M) nitric acid from outcell tank NAR-TK-00007.

This vessel also overflows to PWD-VSL-00033.

PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10864180

FEP-VSL-00005 (PTF)
Waste Feed Evaporator Condensate Vessel

- Design Temperature (°F)(max/min): 150/49
- Design Pressure (psig) (internal): 15
- Location: out cell

Contents of this document are Dangerous Waste Permit Affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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1	1/12/06	Issued for Permitting Use	[signature]	[signature]	[signature]
0	3/19/04	Issued for Permitting Use	DLA	JRD	SWV

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

The vessel receives condensate from the primary condenser

a General Corrosion
In the proposed pH operating range, no information was found for the general/uniform corrosion of stainless steels or other material. Typically, the austenitic and higher alloy steels are expected to have corrosion rates of less than about 1 mpy. This lack of data is not critical because the alloys needed for the system typically fail by pitting, crevice corrosion, or cracking. On this basis, a corrosion allowance has little meaning though a nominal value is given.

Conclusion:
Both 304L and 316L are expected to have little uniform corrosion under the stated conditions and either would be acceptable. A nominal corrosion allowance is given even though it has minimal significance.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, at pH greater than approximately 12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Further, Revie (2000) and Uhlig (1948) note that nitrate inhibits chloride pitting.

The vessel has about 0.001 M nitrate and approximately 24 ppm chloride. Nominally, the temperature will be between 111 and 122 °F which, with 24 ppm chloride, is acceptable for 316L stainless steel.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum concentrations. Based on the expected operating conditions the vessel should be 316L stainless steel.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F.

Given the environment and the lack of heat transfer into the process stream, caustic cracking is not anticipated to be a problem.

Conclusion:
Based on the normal operating environment, the minimum alloy recommended is a 316L stainless steel.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions on the process side are generally too warm for microbe growth. Further, because the source of the fluid is from the evaporation of a process fluid, no microbes are expected to be present.

Conclusion:
MIC is not considered a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not anticipated to be a problem.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the shell will be continually washed with condensing vapors.

Conclusion:
No vapor phase corrosion is anticipated.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Not applicable.

Conclusion:
Not applicable.

m Galvanic Corrosion
For the environment and the proposed alloys, there is not believed to be a concern.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not expected to be a concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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3. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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9. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
10. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Waste feed evaporator condensate vessel (FEP-VSL-00005)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.94E-02	1.86E-02			
Chloride	g/l	2.17E-02	2.46E-02			
Fluoride	g/l	5.50E-04	6.36E-04			
Iron	g/l	2.16E-03	2.30E-03			
Nitrate	g/l	3.64E-01	4.01E-01			
Nitrite	g/l	2.57E-02	2.93E-02			
Phosphate	g/l	4.48E-02	4.99E-02			
Sulfate	g/l	1.69E-02	1.93E-02			
Mercury	g/l					
Carbonate	g/l	7.89E-02	8.42E-02			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-FEP-00001, Rev 0
Mass Balance Document: 24590-WTP-RPT-PR-04-0001, Rev A
Normal Input Stream #: FEP08, FEP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0004001, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tnormal operation 111 °F to 122 °F (24590-PTF-MEC-FEP-00001, Rev B)
3. pH approx 10 to 11

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.4.3 Waste Feed Evaporator Condensate Vessel (FEP-VSL-00005)

Routine Operations

The condensate draining from the primary condenser is monitored for radioactivity. The area radiation monitor is located close to the condenser outlet to allow a time lag before the condensate can reach the condensate vessel (FEP-VSL-00005). This is to minimize the possibility that contaminated condensate can be transferred to the radioactive liquid waste disposal system (RLD). As the condensate vessel fills, the waste feed evaporator condensate pump (FEP-PMP-00006A/B) recirculates condensate continuously back to the vessel with a portion recycled to the SEP vessel for spraying the demister pads.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

24590-PTF-N1D-HLP-P0003
Rev. 1

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10591354

HLP-VSL-00022 (PTF)
HLW Feed Receipt Vessel

- Design Temperature (°F) (max/min): 215/40
- Design Pressure (psig) (max/min): 15/-4.5
- Location: incell
- PJM Discharge Velocity (fps): 26
- Drive Cycle: 33 % (at 26 fps)

Related Plant Items

HLP-PJM-00056 – HLP-PJM-00057
HLP-PJM-00084 – HLP-PJM-00093

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Operating conditions are as stated on sheets 6 and 7

Operating Modes Considered:

- Normal operating conditions
- The vessel will be cleaned using process condensate, 2M NaOH or 2 M HNO_3 with residual chlorides and fluorides at 113 °F. The condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection is required as discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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REGISTERED PROFESSIONAL ENGINEER
11/15/05
EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel receives Tank Farm waste having a temperature or solids content above acceptable levels for the waste feed receipt vessels (FRP-VSL-00002A/B/C/D). The vessel is equipped with a cooling jacket to keep the temperature at 113°F or below.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He states 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at temperatures up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures of about 122°F. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F. Studies have shown that in simulated waste at 140°F, 304L, with a corrosion rate < 1 mpy, performed slightly better than 316L – possibly due to the presence of nitrate. In this system, the hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable. If the alkaline waste reaches boiling, other work suggests that 304L would be acceptable, probably due to the presence of nitrate. Normally a high nickel alloy such as Inconel 600 would be required for hot caustic.

Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning unless the fluoride is well inhibited. Keeping the vessel as cool as possible, below 100°F, would reduce the extent of attack by chloride (pitting and crevice corrosion) and, and with the addition of Al^{+++}, general corrosion due to fluoride. 304L will be suitable if properly protected by temperature and fluoride complexants such as Al^{+++}. The less control of the acid conditions, the more consideration that will have to be given to more corrosion resistant alloys.

Conclusion:
At temperatures less than about 140°F, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Even considering acid cleaning, 316L will be acceptable if rinsing procedure is developed to reduce the effects of fluoride during acid conditions

b Pitting Corrosion
Chloride is known to cause pitting of stainless steel and related alloys in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (2000) has stated that localized corrosion can occur under the waste deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 113°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions at the upper pH values. The condition of solids and deposits present during possible acid cleaning means that 316L is the lowest alloy to be used. Even then, flushing will be required.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water, which tends to be dirtier, and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain and to concentrate.

Conclusion:
Based on the expected operating conditions, 316L is expected to be satisfactory at the stated operating temperature and if the pH is neutral or higher and if the duration and extent of possible low pH off-normal conditions and acid cleaning are controlled.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment, but also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. With the stated low operating temperature and alkaline conditions, 304L is expected to be satisfactory. However, because of the possibility of acid cleaning, 316 L will be the minimum acceptable alloy.

Conclusion:
The minimum alloy recommended is a 316L stainless steel.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is generally too alkaline. The use of untreated process water may be a concern. The use of DIW is recommended.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Typically not a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether the vessel, and particularly the lid, will be sufficiently washed or whether residual acids or solids will be present. In the former case, 304L would be satisfactory. If solids or acids and solids are present, a 316L or better is preferred.

Conclusion:
316L is recommended.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 8 m/s with solids concentrations of 26.46 wt% for a usage of 100 % operation as documented in 24590-WTP-M0E-50-00003. HLP-VSL-00022 requires at least 0.398-inch additional protection. The 26.46 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of HLP-VSL-00022 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.357–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 26.46 wt% for usage of 100 % operation as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
No moving surfaces within the vessel.
Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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5. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) HLW feed receipt vessel (HLP-VSL-00022)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.97E+01	3.01E+01			
Chloride	g/l	7.84E-01	7.84E-01			
Fluoride	g/l	2.12E-01	2.12E-01			
Iron	g/l	5.72E+01	5.72E+01			
Nitrate	g/l	7.14E+01	7.14E+01			
Nitrite	g/l	8.09E+00	8.09E+00			
Phosphate	g/l	8.51E+00	8.51E+00			
Sulfate	g/l	2.12E+00	2.12E+00			
Mercury	g/l	1.97E-01	1.97E-01			
Carbonate	g/l	9.98E+01	9.98E+01			
Undissolved solids	wt%	26.46%	26.46%			
Other (NaMnO4, Pb,...)	wt%					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-HLP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: FRP14, HLP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID:
PFD: 24590-PTF-M6-V17T-P0007, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T operation mode 1: 113 °F to 190 °F, T operation mode 2: 89 °F to 98 °F (24590-MVC-HLP-00001, Rev 0)
3. pH approximately 13 to 14

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.6.2 HLW Feed Receipt Vessel (HLP-VSL-00022)

Routine Operations

High-level waste feed from the Tank Farms is received into the HLW feed receipt vessel (HLP-VSL-00022). Tank Farm waste that has a temperature or solids content above the criteria for vessels FRP-VSL-00002A/B/C/D, which receive LAW waste from tank farms, can be sent to vessel HLP-VSL-00022. Once receipt is complete, sampling for confirmation of waste acceptance will begin. Sampling for criticality is required for HLW feed receipt. The HLW feed is sampled for waste concentration. The waste concentrations must be below the acceptable criticality limits. The vessels are equipped with cooling jackets to maintain the temperature at or below 113 °F. During this staging period, PJMs will operate to provide sufficient mixing within the vessels, and the recirculation pump will run to maintain a flooded suction line. When required, HLW feed will be transferred for processing. HLW feed may be fed to one of three systems for processing: 1) the waste feed evaporation process system (FEP), 2) the ultrafiltration process system (UFP), or 3) the waste feed receipt process system (FRP), for evaporation, filtration, or blending, respectively. This will be determined by the current plant status and will be evaluated on a case-by-case basis during plant operations.

Non-Routine Operations that Could Affect Corrosion/Erosion

This vessel overflows to PWD-VSL-00033.

There is also the option to return HLW feed from the HLW feed receipt vessel back to the Tank Farms via the waste feed return pump, FRP-PMP-00001, in system FRP. This is the case when the HLW feed does not meet the requirements of the specification for HLW feed. However, this is considered an infrequent event.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10591498

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PVP-SCB-00002 (PTF)
Vessel Vent Caustic Scrubber

- Design Temperature (°F)(max/min): 150/-20
- Design Pressure (psig) (max/min): 15/-5
- Location: incell

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Operating conditions are as stated on sheets 5 and 6

Equipment will not be maintained.

Options Considered:

- Normal operating conditions
- Demineralized water or acid wash

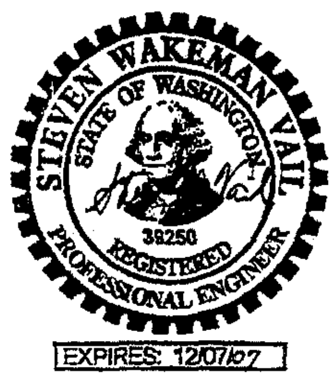
Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X (column)	
6% Mo (N08367)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1	X	

Recommended Material: Column: 316 (max 0.030% C; dual certified)
(0.040 inch corrosion allowance includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)
Column packing: UNS N08367 (0.0 inch corrosion allowance)
Demister packing: UNS N08367 (0.0 inch corrosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water



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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

The scrubber treats the vent off-gas stream collected from the process vessels in the Pretreatment facility. Part of the NO_X/acid gases present in the stream reacts with the caustic in the scrubber to form sodium nitrate. Fresh 5M caustic solution is added to control the pH of the recirculating scrubbing liquid. It is expected that dilute nitric acid will probably be used to dissolve solids build-up in the column.

a General Corrosion
Hammer (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

Dilute acid is not expected to be a concern even in dissolving deposits.

The corrosion rate of the 6% Mo alloys is expected to be the same or less than that of the 300 serious stainless steels.

Conclusion:
At the stated temperatures, 304L, 316L or a 6% Mo are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy and during normal operation < 0.1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Under the stated conditions, 316 stainless steel or better will be required. If the system is always operating, 316L will be satisfactory. However if extended periods of stagnation are likely, a more resistant alloy will be needed. 6% Mo alloys are more resistant to pitting than 316L.

Conclusion:
316L is recommended for the main vessel. 6% Mo is also acceptable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. It is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 104°F and 304L is expected to be satisfactory. Because of the possibility of chloride concentration, 316L would be the minimum choice.

Conclusion:
At the normal operating environment, the minimum alloy recommended for normal operation is a 316L stainless although a 6% Mo is acceptable.

e Crevice Corrosion
Crevice corrosion occurs at lower temperatures than does pitting. The presence of packing in contact with itself and the wall of the vessel can lead to crevice attack. The demister pad is at risk where strands contact one another. AL6XN is more resistant than 316L.

Conclusion:
316L is satisfactory for vessel if crevices are minimized. Packing should be AL_2O_3 or 316L or better. Demister pads should be 6% Mo.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system under normal operating conditions.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are generally not ideal for MIC.

Conclusion:
MIC is not considered a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions
Not a expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion will be a function of the degree of agitation, solution chemistry, and temperature. Nonetheless, it is not deemed a problem in this vessel.

Conclusion:
Not likely to be a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Vessel vent caustic scrubber (PVP-SCB-00002)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.23E-02	4.19E-02			
Chloride	g/l	1.73E-02	2.00E-02			
Fluoride	g/l	2.01E-02	2.34E-02			
Iron	g/l	3.17E-03	3.46E-03			
Nitrate	g/l	1.47E-01	1.66E-01			
Nitrite	g/l	4.40E-02	5.08E-02			
Phosphate	g/l	8.63E-02	7.61E-02			
Sulfate	g/l	3.54E-02	4.08E-02			
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-PVP-00001, Rev A
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: PVP04
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0021001, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1 x 10⁻⁴ g/l do not need to be reported; list values to two significant digits max.
2. T operation 24590-PTF-MVC-PVP-00012, Rev A
3. pH approximately 7

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.8.3 Vessel Vent Caustic Scrubber (PVP-SCB-00002)

Routine Operations

The vessel vent caustic scrubber treats the vent offgas stream collected from the process vessels in the PT facility, primarily absorbs the NO_x/acid gases and removes large particulates from the gases. The vessel vent caustic scrubber also removes radioactive aerosols and reduces radioactive particulate loading on the vessel vent HEMEs located downstream of the caustic scrubber. The vent offgases flow upwards in the scrubber through a packed bed filled with Raschig rings or similar packing, and contact with alkaline scrubbing liquid flowing downward in the packed bed. Chilled water is circulated in a cooling jacket that surrounds the lower "sump" portion of the vessel to remove heat generated from the reactions of NO_x and other gases with the caustic present in the scrubbing liquid. The outlet gases from the scrubber flow to the vessel vent HEMEs.

Part of the NO_x/acid gases in the vent gas stream reacts with the caustic in the scrubbing liquid to form sodium nitrate. The scrubbing liquid solution is collected in the sump portion of the vessel below the packed bed section of the scrubber. Recirculating pumps recirculate scrubbing liquid solution to the top of the packed bed section of the scrubber and part of the solution directly to the sump portion to provide adequate mixing. Fresh 5 M caustic solution supplied by the metering pump from the sodium hydroxide reagent system is added to the scrubber sump vessel to control the pH of the recirculating scrubbing liquid.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10684972

PVP-VSL-00001 (PTF)
HEME Drain Collection Vessel

- Design Temperature (°F)(max/min): 200/40
- Design Pressure (psig) (internal/external): 15/FV
- Location: incell

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- Vessel receives wash drains from PVP HEMEs
- Wash is acidic

Materials Considered:

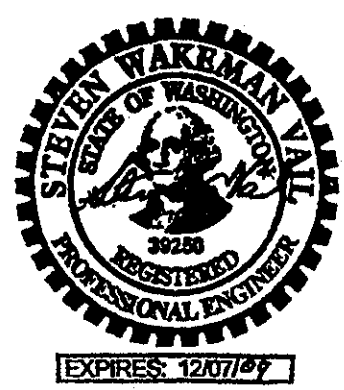
Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water



6/13/06

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel will be used to store HEME drain before transfer to the PWD system.

a General Corrosion
In this system, the normal pH conditions and temperatures are such that 304L stainless steel would be acceptable under the low chloride conditions.

It is anticipated that the contents of this vessel are generally alkaline; however, the possibility of acidic conditions due to acidic wash of the HEME elements exists. Hamner (1981) lists both 304L and 316L corrosion rates as < 2 mpy at temperatures up to 150°F. Based on estimates from Cole (1974), corrosion rates for 304L for all of the concentrations <4 M and at temperatures to boiling are expected to be less that 1 mpy. In about 6 M acid at 145°F, the corrosion rate is approximately 2 mpy.

Conclusion:
304L and 316L are expected to be sufficiently resistant with a probable general corrosion rate of less than 1 mpy under normal operating conditions.

b Pitting Corrosion
Pitting should not be a concern for 304L or 316L at the stated low-chloride conditions and stated temperature.

Conclusion:
Under normal conditions, 304L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Conclusion:
At the normal, stated, operating environment, 304L is recommended.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are acceptable for microbial growth but there appears to be little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem in this vessel.

Conclusions
Not considered to be a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
Not considered to be a concern in this vessel.

Conclusion:
Not a concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
Cavitation is usually encountered in high velocity fluids and not normally expected in vessels.

Conclusion:
Not applicable.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
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7. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
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PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) PVP HEME (PVP-HEME-00001A/B/C); PVP HEME drains (PVP-VSL-00001)

Facility PTF

In Black Cell? yes (PVP-VSL-00001 only)

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	5.04E-03	5.00E-03			
Chloride	g/l	2.06E-03	2.38E-03			
Fluoride	g/l	2.40E-03	2.79E-03			
Iron	g/l	3.79E-04	4.13E-04			
Nitrate	g/l	8.08E-02	9.12E-02			
Nitrite	g/l	2.42E-02	2.79E-02			
Phosphate	g/l	7.91E-03	8.96E-03			
Sulfate	g/l	4.22E-03	4.87E-03			
Mercury	g/l					
Carbonate	g/l	4.7E-02	5.1E-02			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description 24590-PTF-3YD-PVP-00001, Rev A
Mass Balance Document 24590-WTP-M4C-V11T-00006, Rev A
Normal Input Stream # PVP06
Off Normal Input Stream # (e.g., overflow from other vessels) N/A
P&ID N/A
PFD 24590-PTF-M6-V17T-P0021001, Rev 0
Technical Reports N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported, list values to two significant digits max
2. T normal operation 59 °F to 113 °F, nominal 77 °F (24590-PTF-MVC-PVP-00010, Rev 0)
3. pH approximately 10 to 11

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.8.2 Vessel Vent HEME (PVP-HEME-00001A/B/C); HEME Drain Collection Vessel (PVP-VSL-00001)

Routine Operations

The combined vessel vent exhaust stream will flow from the caustic scrubber outlet to the high-efficiency mist eliminators (HEMEs) for removal of mist. There will be three HEMEs. Two of these HEMEs are in service and one is available as an offline standby.

HEMEs are commonly used to remove fine aerosols and can exhibit high efficiencies even for submicron aerosols. They are passive devices with low maintenance requirements and high reliability. The HEMEs will protect the high-efficiency particulate air (HEPA) filters, located downstream of the HEMEs, in the PVV system from excessive loading and activity buildup.

Each HEME is a vertical cylindrical vessel in which the filter cartridge elements are arranged in a set of segmental vertical filter candles, which are supported at the top inside the vessel. There will be four filter cartridge elements installed for each candle. The vent stream will flow from the outside face of the filter cartridge elements to the inside. There will be a continuous atomizing spray of demineralized water at the inlet nozzle for each HEME to ensure the inlet gas stream is saturated. This will also help in draining of the solid particulates from the filter surface. An additional arrangement for intermittent washing of the filter elements will also be provided inside the HEME vessel, which will generally be used during the offline mode.

Various fibers and other construction materials for the HEME element can be selected for their resistance to gas constituents. It is likely that a fiberglass cartridge element will be used for this application. Due to some uncertainties in selection of the best available cartridge material, possible degradation over time, and the long design life for the facility, remote changeout capability for the filter cartridges from the HEMEs is provided.

The drain from each HEME will flow into the HEME drain collection vessel, PVP-VSL-00001, via the dip seal. The drain collection vessel will be used to store HEME drains before their transfer approximately twice a week, or on high level, to the PWD system. The HEME drain transfer pumps, PVP-PMP-00002A/B (one working and one standby), will be utilized for the recirculation and transfer of the HEME drain effluent to PWD vessel, PWD-VSL-00044.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10661286

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PWD-VSL-00044 (PTF)
Plant Wash Vessel

- Design Temperature (°F)(max/min): 237/40
- Design Pressure (psig) (max/min): 15/-8
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items

PWD-VSL-00121 – PWD-VSL-00125
PWD-PJM-00021 – PWD-PJM-00028,
PWD-RFD-00121 – PWD-RFD-00125

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operating conditions

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; additional localized protection required and discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.

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1/5/06

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

PWD-VSL-00044 routinely receives recycle materials from the PVP, PJV, RLD and PWD systems as well as laboratory wastes. During non-routine operation, the vessel can receive plant wash solution through the PWD breakpots. Vessel is equipped with wash rings. 19 M sodium hydroxide reagent header is available to adjust excess acidic effluent to pH > 12.

a General Corrosion
The normal operating temperature is between 59 and 111 °F. Periodically, steam can heat incoming streams to 212 °F (with a design temperature of 237 °F). The high temperature is anticipated to be localized and of short duration.

In this vessel, the temperatures normally will be sufficiently low that uniform corrosion will not be a concern. Hammer (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 266°F, are made of 304L and no failures are known to have occurred. Failures have occurred in the 304L heat transfer surfaces. Gray's review of the Savannah River evaporators (1994), confirms that all failures experienced since the system start-up in 1960 have been from failed tube bundles, not the evaporator vessels. Ohl & Carlos (1994), in their review of the 242-A Evaporator, found in waste similar to that expected in LAW, the corrosion of 304L after about two years of operation at 140°F was less than the accepted variability of the plate. Because of uncertainties in the starting thickness of the metal, a review of the raw data was inconclusive.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.11 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are low due to oxidizing agents. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Conclusion:
At the stated operating conditions and in an alkaline environment, both 304L and 316L have very low corrosion rates and either is acceptable. However, 316L is considered somewhat better suited to the possible cleaning conditions and is recommended.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting. Wilding and Paige (1976) note that nitric acid inhibits chloride attack though their data are at higher temperatures and concentrations.

Conclusion:
Under normal conditions, 316L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. If the concentrations are as stated, stress corrosion cracking will be minimized. Although caustic cracking is possible above 140°F, it is not expected under these conditions due to the presence of oxidizing species such as nitrate.

Conclusion:
Because of the normal operating environment, 316L stainless steel is expected to be acceptable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
The pitting discussion covers this area.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are suitable for microbial growth but, additionally, the location of the system in the process suggests little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
At the operating pH, corrosion fatigue is not expected to be a problem in a proper designed vessel.

Conclusions
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and pitting or crevice corrosion may be a concern. The presence of wash rings within the vessels will allow this area to be rinsed.

Conclusion:
Not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt% at velocities less than 4 m/s. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 13.5 wt% for a usage of 43 % operation as documented in 24590-WTP-M0C-50-00004. PWD-VSL-00044 requires at least 0.067-inch additional protection. The 13.5 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. The fraction of the time that the solids concentration is expected to be at maximum is 10 %. During normal operation, the solids content of PWD-VSL-00044 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.046–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 13.5 wt% for usage of 43 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

l Fretting/Wear
Fretting/wear is not anticipated due to the lack of moving parts.

Conclusion:
Not a concern.

m Galvanic Corrosion
In the proposed environment and with the lack of dissimilar alloys, there are no potential differences. Therefore, no galvanic corrosion is expected.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

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2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Plant wash vessel (PWD-VSL-00044)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.2E-02	5.3E-02	2.30E-01	2.31E-01	
Chloride	g/l	1.2E-01	1.4E-01	8.86E-02	1.06E-01	
Fluoride	g/l	7.2E-02	9.5E-02	1.06E-01	1.28E-01	
Iron	g/l	3.2E-01	2.5E-01	1.69E-02	1.89E-02	
Nitrate	g/l	1.6E+01	1.5E+01	1.54E+01	8.61E+00	
Nitrite	g/l	4.4E-02	5.1E-02	4.98E-01	5.83E-01	
Phosphate	g/l	6.8E-02	7.5E-02	3.53E-01	4.13E-01	
Sulfate	g/l	3.5E-02	4.1E-02	1.86E-01	2.24E-01	
Mercury	g/l	4.0E-01	6.0E-01	5.47E-04	1.42E-04	
Carbonate	g/l	4.7E-02	5.1E-02	6.59E-01	7.24E-01	
Undissolved solids	wt%					Note 4
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-PWD-00001, Rev 1

Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A

Normal Input Stream #: The incoming streams will be diluted to a minimum dilution ratio of 8 to 1 (water to fluid). Data in table represent pre-dilution.

Off Normal Input Stream # (e.g., overflow from other vessels): See section 4.9.13

P&ID: 24590-PTF-M6-PWD-P0002, Rev 2

PFD: 24590-PTF-M5-V17T-P0022002, Rev 2

Technical Reports:

Notes:

1. Concentrations less than 1x 10⁻⁴ g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 59 °F to 111 °F (24590-PTF-MVC-PWD-00028, Rev 0)
3. pH approximately 10 to 11
4. Overflow is diluted to Newtonian fluid with water as soon as normal operation is achieved. Expected minimum dilution ratio 8.

Assumptions:

4.9.13 Plant Wash Vessel (PWD-VSL-00044)

Routine Operations

PWD-VSL-00044 is located on the ground level in a black cell. It has a batch volume of 60,000 gallons. The vessel is sized to receive washes from the largest potential wash and still be able to handle routine transfers from other sources.

An air in-bleed and forced purge air are provided to dilute hydrogen generated in vessel PWD-VSL-00044. Pulse jet mixers are used to provide a uniform mixture during neutralization within vessel PWD-VSL-00044. An RFD supplies a representative sample of the vessel contents, which will be analyzed for pH in the laboratory. Excess acidic effluent is adjusted (to pH>12) with 19 M sodium hydroxide supplied from a reagent header.

An RFD supplies a representative sample of the contents of vessel PWD-VSL-00044 to the lab for analysis. Normally, the contents of vessel PWD-VSL-00044 are blended with those of vessels PWD-VSL-00015 and PWD-VSL-00016 within vessel FEP-VSL-00017A or B to maintain a consistent evaporator feed.

Vessel PWD-VSL-00044 vents to the vessel vent caustic scrubber (PVP-SCB-00002) via the vessel vent header.

During normal operations, vessel PWD-VSL-00044 receives recycle material from the following sources:

- HEME drains via vessel PVP-VSL-00001 and demister drains via PJV-VSL-00002
- Spent scrub solution from PVP-SCB-00002
- Contaminated effluent from RLD-VSL-00003 (LAW vitrification facility)
- Waste from PWD-VSL-00043
- Active material from PWD-VSL-00033
- Laboratory wastes

Overflows from non-Newtonian vessels (marked with *) will be diluted with water as soon as normal operation is achieved/recovered. A minimum dilution ratio (water/fluid) of 8 to 1 is expected.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Vessel PWD-VSL-00044 overflows to PWD-VSL-00033.
- Wash rings are used for vessel and breakpot washing. A vessel-emptying ejector, installed from the UFP system end, is used for non-routine transfers to the acidic/alkaline effluent vessel (PWD-VSL-00016).
- During non-routine operations, vessel PWD-VSL-00044 receives plant wash from the following sources:
  - Plant wash solution from interior surfaces of pretreatment vessels via vessel-emptying ejectors discharging to plant wash/sump breakpots PWD-BRKPT-00007 through 10 and PWD-BRKPT-00017 and 19
  - Plant wash solution from pretreatment cell walls, equipment exterior surfaces, and cell cladding via sump-emptying ejectors discharging to breakpots PWD-BRKPT-00007 through 10 and PWD-BRKPT-00017 and 19
- Condensate drain from pretreatment vessel vent header
- Active condensate from the high- and low-pressure steam condensate headers
- Active material from the closed loop chilled water

24590-PTF-N1D-PWD-P0003
Rev. 3

PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10672004

PWD-VSL-00015 & PWD-VSL-00016 (PTF)
Acidic/Alkaline Effluent Vessel

- Design Temperature (°F)(max/min): 237/0
- Design Pressure (psig) (max/min): 15/-10
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items

PWD-VSL-00015–
PWD-VSL-00101 – PWD-VSL-00105
PWD-PJM-00001 – PWD-PJM-00008
PWD-RFD-00101 – PWD-RFD-00105

PWD-VSL-00016–
PWD-VSL-00111 – PWD-VSL-00115
PWD-PJM-00011 – PWD-PJM-00018,
PWD-RFD-00111 - PWD-RFD-00115

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheets

Options Considered:

- Normal operating conditions.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection will be provided as necessary as discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid operation or ensure a sufficient alkaline heel exists during acid addition.

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 12/07/07

4/18/06

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This bound document contains a total of 8 sheets.

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
3	4/18/06	Issued for Permitting Use	[signature]	[signature]	[signature]
2	12/23/04	Issued for Permitting Use	DLA	APR	SWV
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0	2/26/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

These vessels receive acidic/alkaline cleaning effluent and solutions from equipment in the CNP, CXP and UFP systems, as well as non-routine transfers from other PWD system vessels.

a General Corrosion
The normal operating temperature is 80 to 100 °F. Periodically, steam can heat incoming streams to 212 °F (with a design temperature of 237 °F). The high temperature is anticipated to be localized and of short duration.

In Hamner's data (1981), 304 (and 304L) lists a corrosion rate in NaOH of less than 20 mpy (500 µm/y) at 77 °F and over 20 mpy at 122 °F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122 °F and 50 % NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50 % NaOH at temperatures up to about 122 °F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212 °F though Sedriks (1996) states the data beyond about 122 °F are low because of the presence of oxidizing agents - similar to nitrates and nitrites. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212 °F. Divine's work (1986) with simulated-radwaste evaporators showed that 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy). Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300 °F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years.

The amount of fluoride is expected to be small although ultrafilter washing with nitric acid might result in a high acidic fluoride concentration. Wilding and Paige (1976) have shown that in 5 % nitric acid with 1000 ppm fluoride at 290 °F, the corrosion rate of 304L can be as high as 5 mpy. If it is assumed that the corrosion rate is roughly proportional to the fluoride concentration, even at high temperatures, normal conditions will result in low rates – the unknown is the acid wash conditions. If acid is added from another source, the vessel should either be flushed prior to addition of acid or retain a sufficient alkaline heel.

If the solutions vary between strongly oxidizing (permanganate), alkaline, and acidic, then the conditions are similar to those in nuclear reactor systems during decontamination and enhanced corrosion should be expected.

Conclusion:
304L or 316L will be sufficiently resistant to the waste solution at the expected temperatures with a probable general corrosion rate of less than 1 mpy. Based on the Savannah River experience with Hanford-like waste at higher temperatures, 304L is expected to be satisfactory in hot waste. Rinsing procedure should remove as much waste as possible followed by a water rinse prior to acid cleaning to prevent acid cleaning in the presence of excessive fluoride.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions with 316L more resistant than 304L. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices even with 304L. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Jenkins (2000) has stated that localized corrosion can occur under the deposits on tubes, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting. Wilding and Paige (1976) note that nitric acid inhibits chloride attack though their data are at higher temperatures and concentrations.

The vessels are shown to have substantial concentrations of chlorides and fluorides under normal operation. No indication of how much can be present from ultrafilter washing. At the stated levels of halides and under alkaline conditions, 304L is expected to be satisfactory even at 237 °F. If the pH drops below 12, the halides must be removed. Pulse jet mixers provide sufficient agitation to prevent deposits.

Conclusion:
Under normal conditions with agitation, 304L may be acceptable. However, because of non-routine low pH conditions, the more pitting resistant 316L is recommended for conservatism.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment but also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140 °F. The "L" grades of both 304 and 316 are also more resistant to cracking than the higher carbon versions. Further, the presence of nitrate is expected to inhibit cracking. If the concentrations are as stated, stress corrosion cracking will be minimized. Because of the high chloride concentrations, the likelihood of residual halides is high. Therefore a minimum of 316L is recommended

Conclusion:
With the normal operating environment, 316L stainless steel is expected to be acceptable.

e Crevice Corrosion
The pitting discussion covers this area.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are slightly high for microbial growth but, additionally, the location of the system in the process suggests little chance of the introduction of microbes. Further, the alternation between acidic and alkaline conditions is not conducive to their growth.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
At the operating pH, corrosion fatigue is not expected to be a problem in a proper designed vessel.

Conclusions
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution. The presence of wash rings within the vessels will allow this area to be rinsed.

Conclusion:
Not considered to be a problem.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 2.0 wt% for a usage of 65 % (PWD-VSL-00015) or 54 % (PWD-VSL-00016) operation as documented in 24590-WTP-M0E-50-00003. PWD-VSL-00015 requires at least 0.093-inch additional protection and PWD-VSL-00016 requires at least 0.077 inch additional protection. The 2.0 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of the PWD-VSL-00015/16 vessels is expected to be well below the anticipated maximum.

PLANT ITEM MATERIAL SELECTION DATA SHEET

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.065 inch, for PWD-VSL-00015, and 0.054 inch, for PWD-VSL-00016, of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 2.0 wt% for 65 % (PWD-VSL-00015) or 54 % (PWD-VSL-00016) operation as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Fretting/wear is not anticipated due to the lack of moving parts.

Conclusion:
Not a concern.

m Galvanic Corrosion
In the proposed environment and with the lack of dissimilar alloys, there are no potential differences. Therefore, no galvanic corrosion is expected.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 2 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 2 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

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2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
5. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
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17. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

Bibliography:

1. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Acidic/alkaline effluent vessels (PWD-VSL-00015,16)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	2.02E+01	1.15E+01			
Chloride	g/l	4.28E+00	4.74E+00			
Fluoride	g/l	4.75E+00	5.32E+00			
Iron	g/l	7.14E+00	5.41E+00			
Nitrate	g/l	1.23E+02	1.23E+02			
Nitrite	g/l	2.20E+01	2.45E+01			
Phosphate	g/l	1.82E+01	1.78E+01			
Sulfate	g/l	8.54E+00	9.50E+00			
Mercury	g/l	7.79E-02	7.84E-02			
Carbonate	g/l	5.66E+01	5.46E+01			
Undissolved solids	wt%	1.3%	1.4%			
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References

System Description: 24590-PTF-3YD-PWD-00001, Rev 1
Mass balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: PWD01, UFP27, UFP28, UFP32
Off Normal Input Stream # (e.g., overflow from other vessels): See section 4.9.9, Non-routine Operations
P&ID: 24590-PTF-M6-PWD-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0022001 Rev. 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 60 °F to 100 °F (24590-PTF-MVC-PWD-00031, Rev 0)
3. pH 14 but could receive 2M nitric acid (pH -0.3) from UF cleaning, on non-routine basis.
4. 19M NaOH can be added to these vessels.

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

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WTP Process Corrosion Data

4.9.9 Acidic/Alkaline Effluent Vessel (PWD-VSL-00015)

Routine Operations

The vessel is sized to accommodate one wash/cleaning cycle from ultrafiltration with allowances for the other small streams that are received along with enough space to neutralize material.

During normal operations, vessel PWD-VSL-00015 receives acidic/alkaline effluent from the following sources:

- Alkaline cleaning effluent via breakpot PWD-BRKPT-00015 from ultrafiltration feed vessels (UFP-VSL-00002A/B)
- Caustic rinse from cesium ion exchange columns (CXP-IXC-00001, CXP-IXC-00002, CXP-IXC-00003, and CXP-IXC-00004)
- Process condensate from cesium nitric acid recovery (CNP-HX-00002, 3, and 4)
- Nitric acid, demineralized water, and sodium hydroxide drains from reagent bulge UFP-BULGE-00001

Non-Routine Operations that Could Affect Corrosion/Erosion

During non-routine operations, vessel PWD-VSL-00015 receives acidic/alkaline effluent from the following sources:

- Caustic rinse from cesium ion exchange via caustic rinse collection tank (CXP-VSL-00004)
- Acidic cleaning effluent via breakpot PWD-BRKPT-00015 from ultrafiltration feed vessels (UFP-VSL-00002A/B)
- Caustic rinses from solids washing/leaching (UFP-VSL-00062A/B/C)
- During abnormal operations, vessel PWD-VSL-00015 receives effluent from the following source:
- Overflow from PWD-VSL-00016
- An air in-bleed is provided to dilute hydrogen generated in vessel PWD-VSL-00015. The level and temperature in vessel PWD-VSL-00015, as well as the temperature in the acidic/alkaline effluent breakpot, are monitored in the main control room. Pulse jet mixers are used to provide a uniform mixture during neutralization within vessel PWD-VSL-00015. An RFD supplies a representative sample of the vessel contents, which will be analyzed for pH in the laboratory. Excess acidic effluent is neutralized with 19 M sodium hydroxide supplied from a reagent header. Wash rings are used for vessel and breakpot washing. A vessel-emptying ejector is used for non-routine transfers to the plant wash vessel (PWD-VSL-00044).
- An RFD supplies a representative sample of the contents of vessel PWD-VSL-00015 for analysis. If the pH is confirmed to be 12 or above, RFDs transfer the high- active effluent from vessel PWD-VSL-00015 to the waste feed evaporator feed vessels (FEP-VSL-00017A or B) for recycle.
- Vessel PWD-VSL-00015 vents to the vessel vent caustic scrubber (PVP-SCB-00002) via the vessel vent header, overflows to the acidic/alkaline effluent vessel (PWD-VSL-00016), and ultimately overflows to vessel PWD-VSL-00033. Breakpot PWD-BRKPT-00015 vents to scrubber PVP-SCB-00002 via the vessel vent header and overflows to vessel PWD-VSL-00015.

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WTP Process Corrosion Data

4.9.10 Acidic/Alkaline Effluent Vessel (PWD-VSL-00016)

Routine Operations

The vessel is sized to accommodate one wash/cleaning cycle from ultrafiltration with allowances for the other small streams that are received along with enough space to neutralize material.

During normal operations, vessel PWD-VSL-00016 receives acidic/alkaline effluent from the following sources:

- Alkaline Acidic cleaning effluent via breakpot PWD-BRKPT-00016 from ultrafiltration feed vessels (UFP-VSL-00002A/B)
- Caustic leach solutions (UFP-VSL-00062A/B/C)
- Ultrafiltration solides wash (UFP-VSL-00062A/B/C)
- Nitric acid, demineralized water, and sodium hydroxide drains from reagent bulge UFP-BULGE-00002

Non-Routine Operations that Could Affect Corrosion/Erosion

- During non-routine operations, vessel PWD-VSL-00016 receives acidic/alkaline effluent from the following sources:
  - Caustic rinse from cesium ion exchange via caustic rinse collection tank (CXP-VSL-00004)
  - Caustic rinse from cesium ion exchange columns (CXP-IX-00001/2/3/4).
  - Process condensate from cesium nitric acid recovery (CNP-HX-00002, 3 and 4).
  - Alkline cleaning effluent via breakpot PWD-BRKPT-00016 from Ultrafiltration Feed Vessels (UFP-VSL-00002A/B).
  - Plant wash from PWD-VSL-00044.
  - Overflow from PWD-VSL-00015

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10867002

PWD-VSL-00033, (PTF)

Ultimate Overflow Vessel

- Design Temperature (°F)(max/min): 225/0
- Design Pressure (psig) (max/min): 15/FV
- Location: out cell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

ISSUED BY
RPP-WTP PDC

Offspring items

PWD-VSL-00131, PWD-VSL-00132
PWD-PJM-00031– PWD-PJM-00038,
PWD-RFD-00131, PWD-RFD-00132

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operating conditions which can range from acidic to alkaline
- Alkaline conditions at elevated temperature
- Acid conditions with elevated halides and temperatures, such as would occur if the tank contained a volume of alkaline waste and two or three volumes of 5 N nitric acid were added.

Materials Considered:

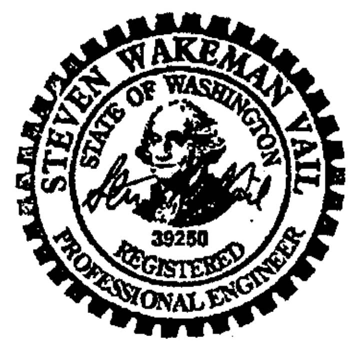
Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance:0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection required as discussed in section j)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.
- Develop a recovery procedure for non-routine vessel overflows.



3/8/06

EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

PWD-VSL-00033 receives material from various sources including drains and flushes from waste feed and transfer lines, drains in the C5/R5 cells and bulges, and plant wash from RLD-VSL-00008. During non-routine operations, this vessel could receive overflow material from most systems within Pretreatment.

a General Corrosion
Under normal operation, the concentrations of most chemicals will be sufficiently low that 304L will be satisfactory. Further, in this vessel, the temperatures normally will be sufficiently low that uniform corrosion will not be a concern, the main exceptions being non-routine operations or from ultrafilter cleaning. The amount of fluoride is expected to be small although ultrafilter washing with nitric acid might result in a high acidic fluoride concentration. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be as high as 5 mpy.

Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years. Ohl & Carlos, in their review of the 242-A Evaporator, found in waste similar to that expected, the corrosion of 304L after about two years of operation at 140°F was less than the accepted variability of the plate.

Davis (1987) states the corrosion rate for 304L in pure NaOH will be less than about 0.11 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are low due to oxidizing agents. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Conclusion:
If the temperature were to remain in the stated operating conditions and the environment were alkaline, 304L would be marginally satisfactory with 316L better.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Jenkins (1998) has stated that localized corrosion can occur under the deposits on tubes, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting. Wilding and Paige (1976) note that nitric acid inhibits chloride attack though the data are at higher temperatures and concentrations.

Conclusion:
Localized corrosion, such as pitting, is common and would be a concern in waste with the expected maximum halide levels. However, the presence of nitrate will mitigate their effects. Under normal conditions with agitation, 316L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. If the concentrations are as stated, stress corrosion cracking will be minimized. Although caustic cracking is possible above 140°F, it is not expected under these conditions, probably due to the presence of oxidizing species such as nitrate.

Conclusion:
Because of the normal operating environment, 316L stainless steel is expected to be acceptable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
For the most part, the pitting discussion covers this area. Should acid cleaning be used, the presence of excessive heat tint (darker than a light or straw yellow) could lead to crevice corrosion.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are suitable for microbial growth, but the location of the system in the process suggests little chance of the introduction of microbes. *Further, the alternation between acidic and alkaline conditions is not* conducive to their growth.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem in this vessel.

Conclusions
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and pitting or crevice corrosion may be a concern.

Conclusion:
Pitting is a possible concern but is covered by the pitting discussion.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 26.7 wt% for a usage of 19 % operation as documented in 24590-WTP-M0C-50-00004. PWD-VSL-00033 requires at least 0.083-inch additional protection. The 26.7 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of PWD-VSL-00033 is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.053-inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 26.7 wt% for usage of 19 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Not expected to be applicable.

Conclusion:
Not a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10661549

PWD-VSL-00046 (PTF)
C3 Floor Drain Collection Vessel

- Design Temperature (°F)(max/min): 225/20
- Design Pressure (psig) (max/min): 68/FV
- Location: outcell

ISSUED BY RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- Normal operating conditions
- Assumption: water provided by BOF will be treated

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1	X	

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

PWD-VSL-00046 normally receives floor drains from all C3 areas in the PT facility generated from normal cleanup activities or small leaks as well as any material in the pit sump. During abnormal operations, the vessel could receive sprinkler water discharge from the C3 area sprinkler system. Additionally, solids could be introduced through the floor drains.

a General Corrosion
In normal operation, the vessel will essentially contain water. Based on Uhlig (1948), little uniform corrosion is expected at these conditions. The stated solutions are compatible with the 300 series stainless steel.

Conclusion:
304L or 316L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Normally the vessel is to operate between 50 and 77°F at neutral pH. At this temperature and with the stated waste, 304L has the potential of pitting, particularly if the liquid is stagnant. Because of the water sources, it is likely that the water will contain dirt and other solids. Additionally, any sand tracked into the building will end up in the drain tank. Consequently, the likelihood of pitting will be higher. The time to initiate would depend on the concentration of the residual chlorides, the cleanliness, and the temperature. Depending on expected conditions, at least 304L and probably more pitting resistant alloys will be needed.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated, if caused by chlorides, by alloys with higher molybdenum contents. Based on the expected operating conditions, and the possibility of the presence of solids, the more pitting-resistant 316L is recommended.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F and 304L is expected to be satisfactory. A better long-term choice would be 316L.

Conclusion:
At the normal operating environment and due to anticipated abnormal conditions, the minimum alloy recommended is a 316L stainless.

e Crevice Corrosion
At the proposed operating temperature, if deposits or other crevices are present, 304L is not acceptable. The applicability of 316L for this waste is accepted if no significant deposits are present. In addition, see Pitting.

Conclusion:
It is assumed that no deposits form and the no other crevices are present. Therefore, 316L is acceptable.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are ideal for microbial growth if the system is infected. However, the most likely source of infection is process water so the use of treated water makes infection unlikely.

Conclusion:
Not expected to be a concern.

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion will be a function the degree of agitation, solution chemistry, and temperature. Nonetheless, it is not deemed a problem in this tank.

Conclusion:
Not likely to be a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of .5 M nitric acid. Nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause high corrosion rates for these alloys.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of .5 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
5. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
6. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
7. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) C3 floor drain collection vessel (PWD-VSL-00046)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l					
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Assumption 1
Temperature	°F					Assumption 2

List of Organic Species:

References
System Description 24590-PTF-3YD-PWD-00001, Rev 1
Mass Balance Document 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: See section 4.9.15, Routine Operations
Off Normal Input Stream # (e.g., overflow from other vessels): See section 4.9.15, Non-routine Operations
P&ID 24590-PTF-M6-PWD-P0043, Rev 2
GA: 24590-PTF-P1-P01T-P0006, Rev 2
Technical Reports:

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max

Assumptions:
1. Assume pH 7.0
2. Assume 50 °F (fire water) to 77 °F (any vessel heel present)

4.9.15 C3 Floor Drain Collection Vessel (PWD-VSL-00046)

Routine Operations

During normal operations, vessel PWD-VSL-00046 receives floor drains from all C3 areas in the PT facility generated from normal cleanup activities or small leaks. PWD-VSL-00046 will also receive any material in the pit sump.

Transfers out of the vessel will normally go to RLD-VSL-00017A/B. If needed, this vessel may be sampled and if the material meets the BOF nonradioactive liquid waste disposal system (NLD) acceptance criteria, it may be transferred to PWD-VSL-00045. Transfers from PWD-VSL-00046 to PWD-VSL-00045 will require installation of a removable spool piece.

Vessel PWD-VSL-00046 vents to the pit via a local HEPA filter and will overflow into the pit.

Non-Routine Operations that Could Affect Corrosion/Erosion

During abnormal operations, vessel PWD-VSL-00046 receives sprinkler water discharge from the C3 area sprinkler system. Miscellaneous solids could be introduced into the vessel through the floor drains. Water in the pit sump PWD-SUMP-00071 is transferred to PWD-VSL-00045 or PWD-VSL-00046.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10672005

ISSUED BY
RPP-WTP PDC

PWD-BRKPT-00015 & PWD-BRKPT-00016 (PTF)
Acidic/Alkaline Effluent Breakpots

- Design Temperature (°F)(max/min): 368/40
- Design Pressure (psig) (internal/external): 15/FV
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- Breakpot will transfer acidic wash.
- Breakpot will transfer alkaline wash.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid or water.

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4/18/06

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

PWD-BRKPT-00015 routinely receives alkaline cleaning effluent from UFP-VSL-00002A/B and non-routinely may receive acidic cleaning effluent from UFP-VSL-00002A/B. PWD-BRKPT-00016 routinely receives acidic cleaning effluent from UFP-VSL-00002A/B and non-routinely may receive alkaline cleaning effluent from UFP-VSL-00002A/B or plant wash from PWD-VSL-00044.

a General Corrosion
Hamner's data (1981), 304 (and 304L) lists a corrosion rate in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy). Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years.

Because the solution is expected to be ≤2M HNO_3, 304L stainless steel is an excellent choice for the material of construction. Corrosion rates of ≤1 mpy are expected.

Conclusion:
At the stated operating conditions, 304L is expected to be sufficiently resistant with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
The vessels are shown to have no chlorides or fluorides under normal operation. Under the stated no-halide conditions, 304L is expected to be satisfactory. It is assumed, however, that the fluids will not be stagnant nor will there be deposits.

Conclusion
At these temperatures and concentrations, pitting is not anticipated and 304L is acceptable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
If the vessel is halide free, 304L will be satisfactory.

Conclusion:
The use of 304L is expected to be acceptable for chloride free conditions.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are generally acceptable for MIC but the location of the system in the process suggests little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
Not considered to be a concern.

Conclusion:
Not a problem.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not considered to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130172, Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
4. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
6. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
7. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Acidic/Alkaline effluent breakpot (PWD-BRKPT-00015)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l					
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-PWD-00001, Rev 1
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP27,28 cleaning effluents (see section 4.9.6, Routing)
Off Normal Input Stream # (e.g., overflow from other vessels): see section 4.9.6, Non-routine
P&ID: 24590-PTF-M6-PWD-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0022001, Rev 0
Technical Reports:

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Acidic/alkaline effluent breakpot (PWD-BRKPT-00016)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l					
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-PWD-00001, Rev 1
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: See section 4.9.5
Off Normal Input Stream # (e.g., overflow from other vessels): PWD02, cleaning effluent (section 4.9.6)
P&ID: 24590-PTF-M6-PWD-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0022001 Rev. 0
Technical Reports:

Notes:

1. Concentrations less then 1x 10^{4} g/l do not need to be reported, list values to two significant digits max.
2. Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.

Assumptions:

4.9.5 Acidic/Alkaline Effluent Breakpot(PWD-BRKPT-00015)

Routine Operations

Receives alkaline cleaning effluent from UFP-VSL-00002A/B. This breakpot serves as a moisture separator for ejected plant wash from PT vessels. The breakpot does not accumulate any fluid.

Non-Routine Operations that Could Affect Corrosion/Erosion

Receives acidic cleaning effluent from UFP-VSL-00002A/B.

4.9.6 Acidic /Alkaline Effluent Breakpot (PWD-BRKPT-00016)

Routine Operations

Receives acidic cleaning effluent from UFP-VSL-00002A/B.
This breakpot serves as a moisture separator for ejected plant wash from PT vessels. The breakpot does not accumulate any fluid.

Non-Routine Operations that Could Affect Corrosion/Erosion

Receives alkaline cleaning effluent from UFP-VSL-00002A/B. Receives plant wash from PWD-VSL-00044.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10663180

ISSUED BY
RPP-WTP PDC

RDP-VSL-00002A/B/C (PTF)
Spent Resin Slurry Vessels

- Design Temperature (°F)(max/min): 138/30
- Design Pressure (psig) (max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Associated Items

RDP-PJM-00001 – RDP-PJM-00012

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheets

Options Considered:

- Normal operations include receipt, storage and transfer of spent IX media
- Slurry received contains approximately 20 volume% solids (not considered normal operating condition)
- Off-normal conditions include the receipt of fresh resin overflow from system CRP and the receipt of un-eluted or off-spec Cs resin to be returned for further elution

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1	X	

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection will be provided as necessary as discussed in section j)

Process & Operations Limitations:

- Develop flushing/rinsing procedure

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REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
2	1/19/06	Issued for Permitting Use			
1	1/24/05	Issued for Permitting Use	DLA	APR	SWV
0	4/26/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

RDP-VSL-00002A/B/C collect and transfer spent resin. These vessels receive both transport liquid and spent resin slurry streams. Normally the vessels operate at 100°F with a maximum fluid temperature of 113°F.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in 2 M HNO_3 of less than 2 mpy. Davis (1994) states the corrosion rate for 304L in 12% HNO_3 will be less than about 1 mpy up to about 212°F.

In this system, the conditions are such that 304L stainless steel will be acceptable.

Conclusion:
Under normal conditions either 304L or 316L will be satisfactory.

b Pitting Corrosion
While chloride is known to cause pitting in acid and neutral solutions, with no chloride present in reportable concentrations, both 304L and 316L stainless steel are acceptable.

Conclusion:
The use of 304L or 316L is acceptable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not expected in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L is expected to be satisfactory.

Conclusion:
At the normal operating environment, either 304L or 316L is acceptable.

e Crevice Corrosion
Comments under Pitting are generally applicable here. However, the one additional factor is the presence of resin beads. These will form crevices at the wall could initiate crevice corrosion.

Conclusion:
The presence of resin increases the probability of initiating crevice corrosion. The more pitting resistant 316L is recommended

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
MIC is not considered a problem in this system.

Conclusion:
Not a concern.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern. The pressures encountered are so low and the strength of the material is so comparatively high that corrosion fatigue is not a problem.

Conclusions
Not a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
Not expected in this system.

Conclusion:
Not considered to be a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with normal maximum solids concentrations of 7.0 wt% and maximum solids concentrations of 53 wt% with a usage of 19 % operation as documented in 24590-WTP-M0C-50-00004. Vessels RDP-VSL-00002A/B/C require at least 0.060-inch additional protection. The 53 wt% is considered to be conservative. The fraction of time the solids concentration is expected to be at maximum is 10 %. During normal operation, 90 % of the time, the solids content of RDP-VSL-00002A/B/C is expected to be 7.0 wt%.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.038–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with normal solids concentrations of 7.0 wt% and a maximum solids concentrations of 53 wt% with a usage of 19 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Vessels normally operate at low pH.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0C-50-00004, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. CCN 130177, Zapp, PE, 2000, *Material Corrosion and Plate-Out Test of Types 304L and 316L Stainless Steel*, WSRC-TR-2000-00434, Savannah River Site, Aiken, SC
5. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
6. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
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9. Smith, H. D. and M. R. Elmore, 1992, Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW), PNL-7816, Pacific Northwest Laboratory, Richland, Washington.

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. CCN 130172, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Spent resin slurry vessel (RDP-VSL-00002 A/B/C)
Spent resin dewatering moisture separation vessel (RDP-VSL-00004)

Facility PTF

In Black Cell? Yes (RDP-VSL-00002A/B/C only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine (note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l			4.65E-04	4.65E-04	
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-RDP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP19, CXP18, RDP09
Off Normal Input Stream # (e.g., overflow from other vessels): Overflow from CRP-VSL-00002
P&ID: 24590-PTF-M6-RDP-P0001, Rev 0
PFD: 24590-PTF-M5-V17T-P0020, Rev 1
Technical Reports:

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. 100 °F to 113 °F (24590-PTF-MVC-RDP-00001, Rev 0)
3. pH approximately 1

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.10.1 Spent Resin Slurry Vessel (RDP-VSL-00002A/B/C)

Routine Operations

The spent resin slurry vessels (RDP-VSL-00002-A/B/C) are designed to collect and transfer a batch of spent resin every week. The system is capable of processing alternate batch types. After commissioning, the time between spent resin batch transfers and the type of transfer will be determined by operational experience. The spent resin slurry vessels (RDP-VSL-00002-A/B/C) are 12.0 ft in diameter and 19.8 ft in total height with a working volume of 7500 gal.

The spent resin slurry vessels (RDP-VSL-00002-A/B/C) receive both liquid and slurry streams.

These vessels, with associated piping and controls, serve as both the source of transport liquid and the receipt vessels for spent resin slurry. Each vessel is designed to contain one full batch of ion exchange resin plus the transport liquid associated with transferring the resin bed out of an IX column. The total working volume required for removing the spent resin from an IX column is 7500 gallons per vessel (6900 gallons of transport fluid and 600 gallons of resin). During normal operation, the vessels will contain approximately 8 % vol/vol solids. The solids content is greater during the first few minutes of displacement when the incoming slurry line could be very high in solids, but the high solids content is gradually diluted to 8 % vol/vol solids as the clear column sequence is completed and the full batch of transport fluid is transferred. Nozzles will be included as required for process feed streams, overflow lines, reagent addition, ventilation, and recycle return lines.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667003

ISSUED BY
RPP-WTP PDC

RLD-VSL-00017-A/B (PTF)
Alkaline Effluent Vessels

- Design Temperature (°F)(max/min): 180/40
- Design Pressure (psig) (max/min): 15/FV
- Location: out cell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operating conditions

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.08 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid or water.

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0	2/17/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

These vessels will normally receive caustic effluent from LVP-VSL-00001, spent reagents from CRP-VSL-00001 and potentially active material from PWD-VSL-00046.

a General Corrosion
Hamner's data (1981) shows a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are incorrect. Danielson and Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Ohl and Carlos (1994), in their review of the 242-A Evaporator, found in waste similar to that expected in LAW, the corrosion of 304L after about two years of operation at 140°F was less than the accepted variability of the plate. Because of uncertainties in the starting thickness of the metal, a review of the raw data was inconclusive.

Uhlig (1948) has shown that pure nickel is resistant to corrosion by NaOH. However, as Divine (1986) pointed out, the presence of complexing agents may reverse the trend. Agarwal (2000) states that the higher nickel alloys, such as C-22, are highly corrosion resistant though specific mention of alkaline media is not made. The general literature mainly discusses cracking problems (see below) rather than uniform corrosion.

In these vessels, the hydroxide concentration will be significantly lower as is the temperature; thus, the corrosion rates will be smaller.

Conclusion:
At temperatures less than about 140°F, 304L or 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Based on the Savannah River experience with Hanford-like waste at higher temperatures, 304L is expected to be satisfactory to 180°F. Rinsing procedure should be developed to minimize effects of acid in the presence of fluoride. A 0.08 inch corrosion allowance is recommended to compensate for the possibility of high fluoride concentrations in acid conditions.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Jenkins (1998) has stated that localized corrosion can occur under the deposits on tubes, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting. Wilding and Paige (1976) note that nitric acid inhibits chloride attack though their data are at higher temperatures and concentrations.

Conclusion:
Localized corrosion, such as pitting, is not expected to be a concern at the normal operating conditions. 304L is satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion: Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. The "L" grades are also more resistant to cracking than the higher carbon versions. If the concentrations are as stated, stress corrosion cracking will be minimized.

Conclusion:
Because of the normal operating environment 304L stainless steel is expected to be acceptable even to 180 °F.

e Crevice Corrosion
For the most part, the pitting discussion covers this area.

Conclusion:
See Pitting

PLANT ITEM MATERIAL SELECTION DATA SHEET

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are slightly high for microbial growth. Additionally, the location of the system in the process suggests little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem in this vessel.

Conclusions
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and pitting or crevice corrosion may be a concern. A rinsing procedure should be developed to minimize the formation of deposits.

Conclusion:
Provided deposits are not allowed to remain, vapor phase corrosion is not a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Not expected to be applicable.

Conclusion:
Not a concern.

m Galvanic Corrosion
For the environment and the proposed alloys, there is not believed to be a concern.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

p Inadvertent Nitric Acid Addition

Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:

The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels i FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Alkaline effluent vessel (RLD-VSL-00017A/B)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l	8.16E-01	1.79E+00			
Fluoride	g/l	2.08E+00	4.55E+00			
Iron	g/l					
Nitrate	g/l	3.62E+00	7.88E+00			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-RDP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LVP21, RLD09
Off Normal Input Stream # (e.g., overflow from other vessels): See section 4.11.2, Non-routine Operations
P&ID: 24590-PTF-M6-RLD-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0022004, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 59 °F to 125 °F, nominal 111 °F (24590-PTF-MVC-RLD-00004, Rev 0); could receive caustic scrubber purge non routinely at 125 °F
3. pH approximately 13 to 15

Assumptions:

4.11.2 Alkaline Effluent Vessel (RLD-VSL-00017 A/B)

Routine Operations

During normal operations, RLD-VSL-00017A will receive the following feeds:

- Caustic effluent from caustic collection vessel LVP-VSL-00001
- Caustic effluent from a future caustic collection vessel
- Spent reagents from CRP-VSL-00001
- Potentially active material from the C3 drain vessel PWD-VSL-00046

Non-Routine Operations that Could Affect Corrosion/Erosion

During non-routine operations, RLD-VSL-00017A/B will receive the following feeds:

- Process condensate area sump RLD-SUMP-00003
- PWD-VSL-00045 contents that do not meet BOF transfer criteria
- Overflow from reagent vessels (from floor berms of SHR-TK-00009, DIW-TK-00001/SHR-TK-00001, and NAR-TK-00007)
- Potentially active material from non-radioactive liquid effluent tank in BOF (NLD-TK-00001)

24590-PTF-N1D-TCP-P0001
Rev. 2

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10664390

TCP-VSL-00001 (PTF)
Treated LAW Concentrate Storage Vessel

- Design Temperature (°F)(max/min): 237/40
- Design Pressure (psig) (max/min): 15/-8
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items--
TCP-PJM-00001 – TCP-PJM-00008

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RPP-WTP PDC

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Operating conditions are as stated on sheets 6 and 7

Operating Modes Considered:
- Normal operating conditions

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified),

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; additional localized protection is required as discussed in section j)

Process & Operations Limitations:
- Develop flushing/rinsing procedure for acid and water

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EXPIRES: 12/07/07
1/30/06

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REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
2	1/30/06	Issued for Permitting Use			
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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

This vessel receives a continuous feed from the treated LAW evaporator separator vessel. LAW concentrate is normally received at 122°F. Vessel is equipped with a steam injection system to maintain fluid temperature above the freezing point (77 to 100°F). TCP-VSL-00001 may also receive treated LAW from CXP-VSL-00026A/B/C or treated solids from UFP-VSL-00002A/B. This is expected to be an infrequent occurrence.

a General Corrosion

Based on Hamner's data (1981), 304 (and 304L) has a corrosion rate of less than 20 mpy (500 μm/y) in NaOH at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F. Davis (1994) is more precise and states the corrosion rate for 304L in NaOH will be less than about 0.1 mpy; Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated LAW. These two references therefore corroborate Dillon and Sedriks. In addition, Divine (1992) showed that 304L corroded less than 316L in simulated complexant waste with fluorides and chlorides at 140°F. The corrosion rate of 304L after six months of testing was less than 0.2 mpy.

Ohl & Carlos (1994), in their review of the 242-A Evaporator, found that in waste similar to that expected in WTP, including the presence of radiation, the corrosion, of 304L after about 2 years of operation was less than the accepted variability of the plate. The NDE data are sufficiently uncertain to prevent definite conclusions from being drawn. However, a review by Zapp (1998) of the Savannah River evaporators showed the 304L shell had not been replaced after over 30 years of operation despite failure of the 304L evaporator tubes (which operate at higher temperature than the shell).

Conclusion:
At stated temperatures, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion

Chloride is well known for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. It is his opinion that 304L would probably be acceptable, but the use of 316L and especially a 6% Mo alloy would provide a benefit because of their better resistance to pitting by chlorides. Davis (1994) recommends the use of 316L over 304L. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. In addition, Divine's work (1992) showed no hint of pitting after six months at 140°F under boiling heat transfer conditions. Revie (2000) notes that nitrate inhibits chloride corrosion. Therefore, the high nitrate concentrations in the waste are expected to be beneficial.

The apparent lack of pitting in the 242-A Evaporator suggests 304L is acceptable for the vessel. Based on Divine's work (1992), which was conducted in boiling waste at a bulk temperature of 140°F, 304L should be acceptable.

The vessel is equipped with wash rings capable of supplying water or acid. There is a possibility of neutral to acid conditions with halides present. Therefore, 316L is better than 304L.

Conclusion:
316L is recommended.

c End Grain Corrosion

End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions. This system is alkaline except possibly during cleaning. The temperature during cleaning must not be above 122°F.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking

Several sources of cracking are present in this system: chloride and sodium hydroxide, both of which cause stress corrosion cracking of stainless steel.

The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment and also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as

PLANT ITEM MATERIAL SELECTION DATA SHEET

10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. From the above references, it also observed that alkaline conditions reduce the probability of the initiation of stress corrosion cracking to essentially zero. However, should a pit or crevice, including a deposit, be present under which the environment can become acid, then the alkaline environment will no longer have an effect.

Caustic cracking, according to Jones (1992), is not expected to occur below about 140°F for stainless steel. Zapp (1998) suggests cracking in waste is not a concern below about 280°F.

Conclusion:
316L is recommended to offer greater protection against pitting and therefore reduce the likelihood of cracking.

e Crevice Corrosion
Essentially the same comments and conclusions obtained for pitting are valid here.

Conclusion:
Same as for pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Corrosion at welds in the vessel is not a concern.

g Microbiologically Induced Corrosion (MIC)
MIC typically is not prevalent in high pH solutions. Borenstein (1988) states most microbes prefer a pH below 7 though some have been grown at above 9.5. Further, microbial growth is normally not a concern in tanks.

Conclusion:
MIC is not expected to be a concern in the vessels.

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions:
Not a concern.

i Vapor Phase Corrosion
Because of the highly alkaline conditions, no free HF or HCl is expected to be present in the vapor phase and no uniform/general corrosion is expected. A rinsing procedure should be developed to prevent formation of deposits. The nitrate and hydroxide in the waste are also present in any deposits and should minimize pitting.

Conclusion:
General corrosion will not be a concern. Use of 316 is recommended as more pitting-resistant.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with normal maximum solids concentrations of 3.4 wt% and maximum solids concentrations of 20 wt% with a usage of 77 % operation as documented in 24590-WTP-M0C-50-00004. TCP-VSL-00001 requires at least 0.164-inch additional protection. The 20 wt% is considered to be conservative. The fraction of time the solids concentration is expected to be at maximum is 10 %. During normal operation, 90 % of the time, the solids content of TCP-VSL-00001 is expected to be 3.4 wt%.

PLANT ITEM MATERIAL SELECTION DATA SHEET

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.113-inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with normal solids concentrations of 3.4 wt% and a maximum solids concentration of 20 wt% with a usage of 77 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
There are no moving surfaces within the vessels.

Conclusion:
Galling is of no concern in these vessels.

l Fretting/Wear
There are no contacting surfaces that are part of the vessel.

Conclusion:
Fretting and wear are not of concern.

m Galvanic Corrosion
The vessel contains no dissimilar metals.

Conclusion:
Galvanic corrosion is not a concern.

n Cavitation
None expected.

Conclusion:
Cavitation is not a concern.

o Creep
Creep is a high temperature phenomenon, occurring at greater than about 932°F.

Conclusion:
Creep is of negligible concern.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Kirch, N. W., 1984, Technical Basis for Waste Tank Corrosion Specifications, SD-WM-TI-150, Rockwell Hanford Operations, Richland, Washington.

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Treated LAW concentrate storage vessel (TCP-VSL-00001)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.9E+01	3.5E+01			
Chloride	g/l	1.8E+01	2.0E+01			
Fluoride	g/l	1.8E+01	2.0E+01			
Iron	g/l	2.8E+00	2.9E+00			
Nitrate	g/l	2.7E+02	2.9E+02			
Nitrite	g/l	8.2E+01	8.9E+01			
Phosphate	g/l	5.9E+01	6.3E+01			
Sulfate	g/l	3.1E+01	3.4E+01			
Mercury	g/l	9.0E-01	3.1E-02			
Carbonate	g/l	1.3E+02	1.1E+02			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-TCP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00006, Rev A
Normal Input Stream #: TLP02, TCP03
Off Normal Input Stream # (e.g., overflow from other vessels): FRP03, UFP08
P&ID: 24590-PTF-M6-TCP-P0001, Rev 0
PFD: 24590-PTF-M5-V17T-P0008, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 122 °F to 150 °F (24590-PTF-MVC-TCP-00001, Rev 0)
3. pH approximately 12to 14

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.12.1 Treated LAW Concentrate Storage Vessel (TCP-VSL-00001)

Routine Operations

The treated LAW concentrate storage vessel (TCP-VSL-00001) is designed to receive a continuous feed from the treated LAW evaporator separator vessel (TLP-SEP-00001). The treated LAW concentrate is then transferred in batches to the LAW vitrification facility, as required for continuous glass production. A batch transfer (~9300 gal) will be required each time one of the concentrate receipt vessels (LCP-VSL-00001/2) in the LAW vitrification facility is empty. Capability is also maintained to transfer to a future LAW vitrification facility, per WTP contract requirements (DOE 2000). The batch transfer frequency may fluctuate, as it is based on a design feed rate of LAW fluid to the glass melters. The treated LAW concentrate storage vessel (TCP-VSL-00001) is designed to provide 7 days of lag storage in the event that the PT facility is not able to provide concentrate feed. The lag storage batch volume is based on the average treated LAW rate needed to support ILAW glass production of 80 t/day.

The normal influent temperature of the LAW concentrate is 122 °F. TCP-VSL-00001 is equipped with a high-pressure steam injection system (109 psig and 343 °F from the Basis of Design, 24590-WTP-DB-ENG-01-001) to maintain fluid temperature above the freezing point (77 to 100 °F), depending on envelope being processed. This is approximately the point at which crystallization or precipitation of solids occurs. Should solids form, or be transferred to TCP-VSL-00001, PJMs are available to aid in the suspension of particles and homogenize the LAW concentrate for transfer. Wash rings and a high-pressure steam ejector system are installed for cleaning or decontamination of the vessel and internals. TCP-VSL-00001 vents to a scrubber, PVP-SCB-00002, via a collection header.

The PJMs in TCP-VSL-00001 will be operated to suspend solids and maintain a homogeneous mixture. They can be active as long as the liquid level in the vessel is above the PJM low-level setpoint.

Non-Routine Operations that Could Affect Corrosion/Erosion

TCP-VSL-00001 may also receive treated LAW from the IX treated LAW collection vessels (CXP-VSL-00026-A/B/C), bypassing the treated LAW evaporator system. Under infrequent operating conditions, treated solids from the ultrafiltration feed vessels (UFP-VSL-00002A/B) may also be blended with the treated LAW concentrate in TCP-VSL-00001 if the solids meet the specifications for LAW vitrification.

This is not expected to occur very often and requires a jumper, not normally installed, on the provided transfer line.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

R10684974

TLP-VSL-00009A&B, (PTF)
LAW SBS Condensate Receipt Vessels

- Design Temperature (°F)(max/min): 192/40
- Design Pressure (psig) (max/min): 15/-8
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 25 % (at 40 fps)

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Offspring items

TLP-PJM-00001 – TLP-PJM-00016

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operating conditions at the stated temperature

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N08367 or N08926

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection is required as discussed in section j)

Process & Operations Limitations:

- None

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REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
2	6/13/06	Issued for Permitting Use	[signature]	[signature]	[signature]
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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

These vessels receive LAW SBS vitrification effluent and effluents recycles from pretreatment including streams from RLD-VSL-00005, RLD-TK-00006A/B, RLD-VSL-00017A/B, and TCP-VSL-00001. 5 M NaOH is used to adjust the pH as needed. Vessels could also receive non-routinely pretreatment off-specification effluents. Wash rings are available. Emptying ejectors, located external to the vessel, are available for emptying vessel heel.

a General Corrosion
The solution is neutral to slightly alkaline pH. According to Hamner (1981) and others, the uniform corrosion rate of 304L and higher alloys at the stated operating temperatures is small, <1 mpy.

Conclusion:
If the temperature remains in the stated operating conditions and the environment remains alkaline, 304L would be satisfactory.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect.

Based on the data of Phull (2000) and others, 10,000 ppm chloride at 190°F and at neutral pH requires at least a 6% Mo alloy.

Conclusion:
Localized corrosion, such as pitting, is common and would be a concern for the 300 series stainless steels with the expected halide levels. Under these conditions, 6% Mo alloy or better is required.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. At the stated halide concentration and normal temperatures, a 6% Mo alloy is required.

Conclusion:
Because of the normal operating environment 316L stainless steel is not expected to be acceptable. A 6% Mo is recommended.

e Crevice Corrosion
The pitting discussion covers this area.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are suitable for microbial growth but, additionally, the location of the system in the process suggests little chance of the introduction of microbes unless introduced by the plant wash system.

Conclusion:
MIC is not expected to be a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem in this vessel.

Conclusions
Not considered to be a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and may not be thoroughly rinsed and pitting or crevice corrosion may be a concern. A more resistant 6% Mo alloy is recommended.

Conclusion:
See Pitting.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 6% Mo alloy should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with solids concentrations of 3.4 wt% for a usage of 30 % operation as documented in 24590-WTP-M0E-50-00003. The vessels require at least 0.056-inch additional protection. The 3.4 wt% is considered to be conservative and is based on the WTP Prime Contract maximum. During normal operation, the solids content of the vessels is expected to be well below the anticipated maximum.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.036 inch of additional 6% Mo alloy should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 3.4 wt% for a usage of 30 % operation as documented in 24590-WTP-M0E-50-00003.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Not expected to be applicable.

Conclusion:
Not a concern.

m Galvanic Corrosion
For the environment and the proposed alloys, this is not believed to be a concern.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0E-50-00003, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
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6. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
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1. Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
2. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0)), Pacific Northwest Laboratory, Richland WA.
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
5. Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
6. Jenkins, CF, 1998, *Performance of Evaporators in High Level Radioactive Chemical Waste Service*, Presented at Corrosion 98, NACE International, Houston TX 77084
7. Jenkins, CF. SRTC, teleconference with JR Divine, RPP-WTP, 16 February, 2000.
8. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
9. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
10. Ohl, PC & WC Carlos, 1994, *Hanford High-Level Evaporator/Crystallizer Corrosion Evaluation*, Presented at Corrosion 94, NACE International, Houston TX 77218.
11. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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13. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
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15. Wilding, MW & BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID.
16. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) LAW SBS condensate receipt vessel (TLP-VSL-00009A/B)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4 08E-02	4 10E-02			
Chloride	g/l	9 69E+00	1 06E+01			
Fluoride	g/l	2 12E+00	2 33E+00			
Iron	g/l	2 08E-02	2 01E-02			
Nitrate	g/l	4 08E-01	3 45E-01			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l	7 92E-01	2 69E-02			
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description 24590-PTF-3YD-TLP-00001, Rev 0
Mass Balance Document 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream # TLP12, RLD21
Off Normal Input Stream # (e g , overflow from other vessels) N/A
P&ID 24590-PTF-M6-TLP-P0001, Rev 0
PFD 24590-PTF-M5-V17T-P0005, Rev 0
Technical Reports

Notes:
1 Concentrations less than 1x 10^{-4} g/l do not need to be reported, list values to two significant digits max
2 T normal operation 113 °F (24590-PTF-MVC-TLP-00001, Rev 0)
3 pH approximately 6 8 to 9
4 5M NaOH can be added to these vessels

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.13.5 LAW SBS Condensate Receipt Vessel (TLP-VSL-00009 A/B)

Routine Operations

The two LAW SBS condensate receipt vessels (TLP-VSL-00009A/B), each with a batch volume of 80,000 gallons, receive LAW SBS vitrification effluent and effluents recycled from pretreatment. These streams include the following:

- LAW SBS condensate from the vitrification SBS condensate vessel (RLD-VSL-00005)
- Off-specification effluent from the process condensate tanks (RLD-TK-00006A/B)
- Off-specification effluent from the alkaline effluent vessels (RLD-VSL-00017A/B)
- Treated LAW concentrate recycle from the treated LAW concentrate storage vessel (TCP-VSL-00001)

LAW SBS condensate is transferred from the LAW vitrification facility to the PT facility through a pipeline installed within an underground trench.

The receipt vessels will alternate duty. One vessel receives LAW SBS condensate, any recycles, and adds 5 M caustic (NaOH) to adjust the pH as needed. A remote sampling point on the LAW SBS evaporator feed line is used to sample for pH and determine necessary adjustments. The second vessel will feed the evaporator system using the variable-speed LAW SBS condensate feed pumps (TLP-PMP-00005A/B), which are controlled by level indication in the separator vessel. The vessels will switch duties as needed/available to keep a continuous feed flow to the evaporator.

Each vessel is equipped with PJMs that blend and maintain solids suspension in the waste.

Non-Routine Operations that Could Affect Corrosion/Erosion

Under infrequent conditions receives pretreatment off-specification effluents. The two receipt vessels (TLP-VSL-00009A/B) will overflow to the ultimate overflow vessel (PWD-VSL-00033). For purposes of decontamination, each vessel is equipped with wash rings.

PLANT ITEM MATERIAL SELECTION DATA SHEET

TLP-SEP-00001 (PTF)
Treated LAW Evaporator Separator Vessel

R10686593

- Design Temperature (°F)(max/min): 175/49
- Design Pressure (psig) (internal/external): 50/14.7
- Location: incell

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- Normal operating conditions
- The vessel will be cleaned using 2 N HNO_3 with residual chlorides and fluorides at reduced temperatures

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch general erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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6/24/06
EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

a General Corrosion
The vessel has a normal operating temperature of 122°F. According to Hamner (1981), 304 (and 304L) has a corrosion rate of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy in NaOH at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. These data are qualified by Dillon (2000) and Sedriks (1996) who both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F. Davis (1994) states the corrosion rate for 304L will be less than about 0.1 mpy at these temperatures. Based on short term studies, Danielson & Pitman (2000), suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at 122°F. Zapp's report (1998) notes the successful use of 304L as the shell of the Savannah River evaporators.

Uhlig (1948) has shown that pure nickel is more resistant to corrosion by NaOH than stainless steel. However, as Divine pointed out (1986), the presence of complexing agents [part of the total organic carbon (TOC) measured] may reverse the trend. Agarwal (2000) states that the higher nickel alloys are highly corrosion resistant though specific mention of alkaline media is not made. Their high nickel content is a positive feature. The general literature mainly discusses cracking problems (see below) rather than uniform corrosion.

Ohl & Carlos (1994), in their review of the 242-A Evaporator, found that after about 2 years of operation in waste similar to LAW, the corrosion of 304L was less than the accepted variability of the plate. Thus, the NDE data are sufficiently uncertain to prevent definite conclusions from being drawn.

Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning unless the fluoride is well inhibited. The use of acid cleaning while operating at higher temperatures would require the use of a 6% Mo alloy. Keeping the vessel as cool as possible would reduce the extent of attack by chloride (pitting and crevice corrosion) and, with the addition of Al^{+++}, general corrosion due to fluoride. 304L will be suitable if properly protected by temperature and fluoride complexants such as Al^{+++}.

Conclusion:
At temperatures less than 140°F, 304L or 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. The Savannah River work suggests they will be acceptable to higher temperatures in waste.

b Pitting Corrosion
Chloride is notorious for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) is of the opinion that fluoride will have little effect.

Revie (2000) and Uhlig (1948) both note nitrate inhibits chloride corrosion. Therefore the high nitrate concentrations in the LAW are expected to be beneficial. The 18,000 – 20,000 ppm chloride concentration will mean residual chloride is present during acid cleaning.

The apparent lack of pitting in the 242-A Evaporator suggests 304L is acceptable at the design conditions - ≤ 140°F. Zapp (1998) confirms the good behavior of 304L in the shell. The 304L shell of the evaporator at Savannah River has performed successfully for approximately 30 years.

Conclusion:
Localized corrosion, such as pitting, is common but probably can be mitigated by alloys with higher nickel and molybdenum contents even under heat transfer conditions or where deposits can form. Based on Savannah River data, the vessel is expected to be free of significant corrosion and can be constructed of 304L. Rinsing/flushing procedure will be developed to eliminate concern during acid cleaning.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment and because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. From the above references, it is observed that alkaline conditions reduce the probability of the initiation of stress corrosion cracking to essentially zero. However, should a pit or crevice, including a deposit, be present where the environment can become acid, then the alkaline environment will no longer have an effect and stress corrosion can occur.

Caustic cracking tends not to occur below 140°F (Sedriks 1996; Dillon 2000)) or below 212°F (Zapp 1998). Because the maximum operating temperature is 122°F, all sources suggest caustic cracking should be minimal. Zapp's data from the Savannah River Site evaporators is auspicious for the use of 304L for the vessel.

Conclusion:
The use of 304L is expected to be acceptable for the vessel during operation. During rinsing and flushing, the temperature should be kept as low as possible. A rinsing/flushing procedure is needed to define temperature/time limits.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are too extreme for MIC with high temperatures and pH. Additionally, MIC is not normally observed in operating systems except for those exposed to process water.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a concern.

Conclusions
Not applicable.

i Vapor Phase Corrosion
Due to flashing liquid, the surface is expected to be continually sprayed with liquid and be kept relatively clean.

Conclusion:
No vapor phase corrosion is expected.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

p Inadvertent Nitric Acid Addition

Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:

The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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4. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000
5. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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14. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
15. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID
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Bibliography:

1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Waste feed evaporator separator (TLP-SEP-00001)
Treated LAW evaporator reboiler (TLP-RBLR-00001)

Facility PTF

In Black Cell? Yes (TLP-SEP-00001 only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.85E+01	3.52E+01			
Chloride	g/l	1.83E+01	2.00E+01			
Fluoride	g/l	1.84E+01	2.01E+01			
Iron	g/l	2.83E+00	2.89E+00			
Nitrate	g/l	2.72E+02	2.88E+02			
Nitrite	g/l	8.19E+01	8.89E+01			
Phosphate	g/l	5.91E+01	6.28E+01			
Sulfate	g/l	3.15E+01	3.42E+01			
Mercury	g/l	8.96E-01	3.14E-02			
Carbonate	g/l	1.27E+02	1.10E+02			
Undissolved solids	wt%					
Other	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-TLP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: TLP13, TLP02, CXP23
Off Normal Input Stream # (e.g., overflow from other vessels): FRP03, UFP08
P&ID: 24590-PTF-M6-TLP-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0005, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10⁻⁴ g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 122 °F (24590-PTF-MVC-TLP-00002, Rev B)
3. pH approximately 12 to 14

Assumptions:

4.13.3 Treated LAW Evaporator Separator Vessel (TLP-SEP-00001)

Routine Operations

When the recirculating liquor reaches the separator vessel, flash evaporation occurs due to reduced pressure in the vessel. The liquid continues to flash, separating the vapor and liquid streams. The liquid stream recirculates in this closed loop while the vapor stream enters the evaporator overheads. The maximum designed boil-off rate for the TLP evaporator system will be 30 gpm of vapor condensate.

The pressure in the separator vessel is maintained at about 1 psia by a controlled in-bleed of air to the suction side of the primary vacuum ejector. This reduced pressure lowers the boiling point of the liquor to about 122 °F. If the pressure in the separator vessel rises, the air in-bleed is reduced to allow a higher rate of vapor to be withdrawn from the separator vessel, thereby reducing the pressure.

The overhead vapor produced in the separator vessel is superheated by about 24 °F due to the boiling point elevation of the concentrate. The overhead vapor is passed through a set of demister pads for de-entrainment purposes. The demister pads are sprayed with recycled condensate from the treated LAW evaporator condensate vessel, or in the event that evaporator condensate is unavailable, the process condensate tanks (RLD-TK-00006A/B). This spray ensures that the demister pads are always wetted completely to mitigate solids formation and plugging. This also diminishes solids formation on the walls of the separator above the liquid level in the vessel.

The nature of the evaporator feed, coupled with the boiling action, creates the potential for foaming in the separator vessel (TLP-SEP-00001). The separator vessel design includes an antifoam agent feed line from the antifoam vessel. The need for, and magnitude of, the antifoam addition will be determined by development and commissioning work. This addition is expected to be part of normal operations.

The treated LAW evaporator will concentrate the waste to between 8 and 10 M sodium or a maximum specific gravity of approximately 1.44. Concentrate is removed continuously from the treated LAW evaporator at the lowest point on the suction side of the recirculation pump using the variable-speed evaporator concentrate pumps (TLP-PMP-00011A/B).

While in operation, the evaporator train provides sufficient vapor space dilution to prevent the build-up of hydrogen.

For purposes of decontamination, the separator vessel is equipped with wash rings.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10684975

TLP-VSL-00002 (PTF)
Treated LAW Evaporator Condensate Vessel

- Design Temperature (°F)(max/min): 150/49
- Design Pressure (psig): 15
- Location: outcell

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Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- Normal operating conditions
- Acid cleaning at normal temperature

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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6/13/06
EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Vessel receives condensate from the condensers and demister vessel.

a General Corrosion
At the stated pH, temperature and halide concentrations, the corrosion rates will be small. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 1 mpy up to the proposed operating temperatures.

Conclusion:
At the normal operating temperature, either 304L or 316L will be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Based on the Savannah River experience with Hanford-like waste at higher temperatures, 304L is expected to be satisfactory to 300 °F.

b Pitting Corrosion
Pitting should not be a concern for 304L or 316L at the stated low-chloride conditions and stated temperature.

Conclusion:
Under normal conditions, 304L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140 °F. However, Zapp's work (1998) indicates that with the high pH, cracking would be expected to occur only at temperatures well above the design temperature.

Conclusion:
With the stated normal operating conditions, 300 series stainless steels are expected to be acceptable.

e Crevice Corrosion
For the most part, the pitting discussion covers this area. It is assumed that the fluids will not be stagnant and no deposits are anticipated.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating temperatures are acceptable for microbial growth but the location of the vessel in the process suggests little chance of the introduction of microbes.

Conclusion:
MIC is not expected to be a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a problem in this vessel.

Conclusions:
Not considered to be a problem.

i Vapor Phase Corrosion
The vapor phase portion of the vessel will be spattered with solution and pitting or crevice corrosion may be a concern but wash rings are available for rinsing.

Conclusion:
Not considered to be a problem.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
Not expected to be applicable.

Conclusion:
Not a concern.

m Galvanic Corrosion
For the environment and the proposed alloys, there is not believed to be a concern.

Conclusion:
Not a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

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2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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4. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
6. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA
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10. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Treated LAW evaporator condensate vessel (TLP-VSL-00002)

Facility PTF

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.1E-02	3.3E-02			
Chloride	g/l	4.2E-02	5.4E-02			
Fluoride	g/l	9.2E-04	1.2E-03			
Iron	g/l	3.4E-03	4.1E-03			
Nitrate	g/l	5.7E-01	7.1E-01			
Nitrite	g/l	4.1E-02	5.2E-02			
Phosphate	g/l	7.1E-02	8.9E-02			
Sulfate	g/l	2.7E-02	3.4E-02			
Mercury	g/l	4.5E-04				
Carbonate	g/l	1.3E-01	1.6E-01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-TLP-00001, Rev 0
Mass Balance Document: 24590-WTP-MAC-V11T-00005, Rev A
Normal Input Stream #: TLP03
Off Normal Input Stream # (e.g., overflow from other vessels): FRP03, UFP06
P&ID: 24590-PTF-M6-TLP-P0002, Rev 0
PFD: 24590-PTF-M5-V17T-P0005, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 68 °F to 167 °F (24590-PTF-MVC-TLP-00002, Rev B)
3. pH approximately 11 to 12

Assumptions:

Note: Vendor submittal (24590-QL-POA-MEVV-00001-14-00002, Rev. 00C) updates operating temperature. Normal operating temperature is 104 °F.

4.13.4 Treated LAW Evaporator Condensate Vessel (TLP-VSL-00002)

Routine Operations

Condensate from the condensers and demister vessel all drain to a common condensate vessel, TLP-VSL-00002. As the condensate vessel fills, the treated LAW evaporator condensate pump recirculates condensate continuously back to the vessel with a portion recycled to the separator vessel for spraying the de-entrainment pads. When the condensate vessel is filled to its high level setpoint, the condensate is directed to the clean condensate tank RLD-TK-00006A/B.

The condensate draining from the primary condenser is monitored for radioactivity. The radiation monitor is located close to the condenser condensate outlet to allow a time lag before any contaminated condensate can reach the condensate vessel. This minimizes the possibility that contaminated condensate can be transferred to system RLD. In the event that the radiation monitor detects high activity, the evaporator is placed into reflux state and the condensate vessel is isolated so that a sample may be retrieved. A manual sampling point is located on the discharge side of the condensate pump. If the condensate is contaminated, it is redirected to the LAW SBS condensate receipt vessels (TLP-VSL-00009A/B) via valving and an evaporator shutdown can be initiated if necessary.

The vessel vent system draws air into the vapor space of the condensate vessel while removing gases. Vacuum control air is withdrawn from the system PVP vessel vent header. The condensate vessel overflows to PWD-VSL-00033.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10684976

TLP-RBLR-00001 (PTF)
Treated LAW Evaporator Reboiler

- Design Temperature (°F) (max/min): Shell side: 275/49; Tube side: 175/49
- Design Pressure (psig) (max/min): Shell side: 50/FV; Tube side: 50/FV
- Location: incell

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Options Considered:

- pH between 12 and 14; halide concentrations similar to TLP-SEP-00001; operating temperature 122 °F

Materials Considered:

Material (UNS No.)	Acceptable Material	Unacceptable Material
Carbon Steel		X
304L (S30403)	X	
316L (S31603)	X	
6% Mo (N08367/N08926)	X	
Alloy G-30 (N06030	X (heat exchange surfaces)	
Alloy 22 (N06022)	X	
Ti-2 (R50400)		X

Recommended Material: Shell: 304 (max 0.030% C; dual certified)
Tubes and related heated surfaces: N06030 (G-30 or equivalent)

Recommended Corrosion Allowance: Tube side: 0.04 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)
Shell side: 0.0 inch

Process & Operations Limitations:

- Develop flushing/rinsing procedure for acid or water

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

a General Corrosion
Hammer's data (1981), 304 (and 304L) lists a corrosion rate in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data above 122°F are incorrect. Danielson & Pitman (2000), based on short-term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling.

Ohl & Carlos (1994) found, in their review of the 242-A Evaporator with waste similar to that expected in LAW, the corrosion of 304L was less than the accepted variability of the plate thickness after two years of operation at 140°F. Because of uncertainties of the starting wall thickness, a review of the raw data was inconclusive. 304L appears have corroded at an average rate of about 10 mpy though it may have been higher or lower.

Uhlig (1948) has shown that pure nickel is more resistant to corrosion by NaOH than stainless steel. However, as Divine (1986) pointed out, the presence of complexing agents may reverse the trend. Agarwal (2000) states that the higher nickel alloys, such as C-22 and G-30, are highly corrosion resistant though specific mention of alkaline media is not made. The general literature mainly discusses cracking problems (see below) rather than uniform corrosion.

Zapp (1998) notes that the evaporator vessels at Savannah River Site are made of 304L and have suffered no failures in over 30 years of operation. Savannah River uses G-3 and G-30 alloys for the evaporator tubes.

The shell side, however, will see only steam and 304L is satisfactory.

Conclusion:
For the shell, it appears that 304L is acceptable.

b Pitting Corrosion
Chloride is notorious for causing pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are of the opinion that fluoride will have little effect. Jenkins (1998) has stated that localized corrosion can occur under the deposits on tubes, probably due to the chlorides.

Revie (2000) and Uhlig (1948) note that nitrate inhibits chloride corrosion. Therefore, the high nitrate concentrations in the LAW are expected to be beneficial.

The apparent lack of pitting in the 242-A Evaporator suggests 304L is acceptable at the design conditions. Zapp (1998) confirms the behavior of 304L in the shell. Use of austenitic alloys is not recommended for the tubes.

Based on tests performed by Divine (1986), 304L would be satisfactory for the tubes. However, if it is assumed the temperature can approach low pressure steam temperatures, then, based on Savannah River data, a higher alloy is recommended for the tubes. Some of the data described above suggest that a high chromium and perhaps molybdenum content will be needed. G-30 alloy, based on the current Savannah River experience, can be selected.

The higher nickel and molybdenum alloys are expected to be more pitting resistant than the austenitic alloys. Because high purity nickel, Ni 200, did not fare well in Divine's tests (1986) in the presence of complexants, but the chromium content of the alloys may mitigate that effect. Jenkins (1998) reports that G3 and G30 evaporator tubes have been used successfully at Savannah River Site for over 10 years and they expect at least 20 years service while 304L had failed after about 10 years. The shell of the evaporator has performed successfully for approximately 30 years.

Conclusion:
Localized corrosion, such as pitting, is common but probably can be mitigated by alloys with higher nickel and molybdenum contents even under heat transfer conditions or where deposits can form. Based on Savannah River data, the shell is expected to be free of significant corrosion and can be 304L.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part, this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. From the above references, it also observed that alkaline conditions reduce the probability of the initiation of stress corrosion cracking to essentially zero. However, should a pit or crevice, including a deposit, be present where the environment can become acid, then the alkaline environment will no longer have an effect and stress corrosion can occur.

Caustic cracking tends to occur below 140°F (Sedriks 1996; Dillon, 2000) or below 212°F (Zapp 1998). Because the normal operating temperature is below 140°F, all sources suggest caustic cracking should be minimal. Zapp's data from the Savannah River Site evaporators is auspicious for the use of 304L for the shell. If the 140°F temperature is exceeded, such as on the evaporator tubes, higher alloys are needed.

Conclusion:
The use of 304L is expected to be acceptable for the shell at the stated operating temperature. The tubes should be a higher alloy, such as G-30.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Weld corrosion is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
MIC is normally observed at lower pH conditions and temperatures. Although microbes can live at very low pH, and probably high pH, as well as at 572°F and in radiation fields, no reports of MIC in the proposed conditions have been reported.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not considered a problem.

Conclusions:
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the tank will be continually washed with condensing vapors and periodically sprayed with wash water via the vessel wash rings while also being spattered with caustic.

Conclusion:
Based on Zapp's work (1998), no vapor phase corrosion is anticipated.

j Erosion
Velocities within the reboiler are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

l Fretting/Wear
Not anticipated to be a problem.

Conclusion:
Not expected to be a concern.

m Galvanic Corrosion
For the environment and the proposed alloys, none expected.

Conclusion:
Not a concern.

n Cavitation
Not applicable.

Conclusion:
Not applicable.

o Creep
Not a concern at the given temperatures and at the given pressures.

Conclusion:
Not applicable.

p Inadvertent Addition of Nitric Acid
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
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PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Waste feed evaporator separator (TLP-SEP-00001)
Treated LAW evaporator reboiler (TLP-RBLR-00001)

Facility PTF

In Black Cell? Yes (TLP-SEP-00001 only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.85E+01	3.52E+01			
Chloride	g/l	1.83E+01	2.00E+01			
Fluoride	g/l	1.84E+01	2.01E+01			
Iron	g/l	2.83E+00	2.89E+00			
Nitrate	g/l	2.72E+02	2.88E+02			
Nitrite	g/l	8.19E+01	8.89E+01			
Phosphate	g/l	5.91E+01	6.28E+01			
Sulfate	g/l	3.15E+01	3.42E+01			
Mercury	g/l	8.96E-01	3.14E-02			
Carbonate	g/l	1.27E+02	1.10E+02			
Undissolved solids	wt%					
Other	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-TLP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: TLP13, TLP02, CXP23
Off Normal Input Stream # (e.g., overflow from other vessels): FRP03, UFP08
P&ID: 24590-PTF-M6-TLP-P0003, Rev 0
PFD: 24590-PTF-M5-V17T-P0005, Rev 0
Technical Reports:

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 122 °F (24590-PTF-MVC-TLP-00002, Rev B)
3. pH approximately 12 to 14

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.13.2 Treated LAW Evaporator Reboiler (TLP-RBLR-00001)

Routine Operations

Two streams are fed into the treated LAW evaporator at the suction side of the recirculation pump (TLP-PMP-00001). First, the treated LAW is transferred from one of the three treated LAW collection vessels at a fixed flow rate. Second, the LAW SBS condensate/recycle stream is transferred from one of the LAW SBS vessels (TLP-VSL-00009A or B) using the variable-speed LAW SBS condensate feed pumps (TLP-PMP-00005A/B).

The recirculation pump moves the liquor through the evaporator recirculation loop maintaining a high flow rate through the evaporation system. First, the liquor is pumped through the treated LAW evaporator reboiler (TLP-RBLR-00001), which raises the temperature of the liquor. Recirculating liquor is prevented from boiling in the reboiler tubes by maintaining sufficient hydrostatic head to increase the boiling point above the temperature of the liquor in the reboiler. Low-pressure steam, modulated via a flow controller, will be used to heat the feed liquor to the selected system boil-off rate. Low-pressure steam is available at 40 psig and 286 °F, from the *Basis of Design* (24590-WTP-DB-ENG-01-001).

Non-Routine Operations that Could Affect Corrosion/Erosion

High solids in evaporator.

PLANT ITEM MATERIAL SELECTION DATA SHEET

UFP-BRKPT-00001A/B (PTF)
Ultrafiltration Recycle Breakpot

- Design Temperature (°F)(max/min): 368/40
- Design Pressure (psig): 15
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

Operating Modes Considered:

- The breakpot is normally empty and at ambient temperature. Steam temperatures during transfers will be of short duration.
- Vessel may see acid during vessel washing or during inadvertent transfers.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for water and acid.

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Breakpot will routinely transfer the ultrafiltration feed vessel heel prior to ultrafilter cleaning.

a General Corrosion
Hammer (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Conclusion:
At temperatures less than about 140°F, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Based on the Savannah River experience with Hanford-like waste at higher temperatures, 304L is expected to be satisfactory to 300°F.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (1998) has stated that localized corrosion can occur under the deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting. Normally the vessel is to operate at 77°F. At the normal temperature, based on the work of Zapp (1989) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. If acid washes are anticipated, care should be taken to minimize the presence of deposits. 316L will provide greater protection against pitting.

Conclusion:
Based on the expected operating conditions, 304L is expected to be satisfactory. However, due to the possible presence of acid and high halide concentrations, 316L is recommended.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to stress corrosion crack stainless steel is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. Further, the use of "L" grade stainless reduces the opportunity for sensitization. Further, the presence of nitrate is expected to increase the limits slightly.

Conclusion:
For the normal operating conditions, the minimum alloy recommended is a 304L stainless steel.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Not expected to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH under normal operating conditions is too alkaline. Further, the system is sufficiently far downstream of the main entry points of microbes that infection is unlikely.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. A rinsing/flushing procedure will need to be developed to minimize the formation of deposits.

Conclusion:
Vapor phase corrosion is not a concern.

j Erosion
Velocities within the vessel are expected to be small. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with solids content less than 27.3 wt%.

Conclusion:
Not a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No opportunity for fretting exists.

Conclusion:
Not considered a problem.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130172, Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
4. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
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9. Jenkins, CF, 1998, *Performance of Evaporators in High Level Radioactive Chemical Waste Service*, Presented at Corrosion 98, NACE International, Houston TX 77084
10. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
11. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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3. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
6. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
7. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafiltration recycle breakpot (UFP-BRKPT-00001A/B)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine (Note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.61E+01	4.79E+01	3.61E+01	4.79E+01	
Chloride	g/l	1.20E+01	1.44E+01	1.20E+01	1.44E+01	
Fluoride	g/l	1.43E+01	1.72E+01	1.43E+01	1.72E+01	
Iron	g/l	1.69E+02	1.15E+02	1.69E+02	1.15E+02	
Nitrate	g/l	2.29E+02	2.63E+02	2.29E+02	2.63E+02	
Nitrite	g/l	6.66E+01	7.87E+01	6.66E+01	7.87E+01	
Phosphate	g/l	4.81E+01	5.83E+01	4.81E+01	5.83E+01	
Sulfate	g/l	2.56E+01	3.06E+01	2.56E+01	3.06E+01	
Mercury	g/l	1.18E+00	1.57E+00	1.18E+00	1.57E+00	
Carbonate	g/l	1.05E+02	1.06E+02	1.05E+02	1.06E+02	
Undissolved solids	wt%	25.00%	25.00%	25.00%	25.00%	
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 2
						Note 4

List of Organic Species:

References

System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP38
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0001, Rev 1
PFD: 24590-PTF-M5-V17T-P0009, Rev 0
Technical Reports:

Notes:

1. Concentrations less than 1×10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Steam is used for transfer. The breakpot is normally empty and at ambient temperature most of the time.
3. Same concentration during ultrafilter plugging as during normal cleaning operation.
4. Breakpot is used as radiation barrier and normally does not contain process fluid.

6

Assumptions:

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.14.1 Ultrafiltration Recycle Breakpot (UFP-BRKPT-00001 A/B)

Routine Operations

Emptying the ultrafiltration feed vessel heel prior to ultrafilter cleaning.

Non-Routine Operations that Could Affect Corrosion/Erosion

Emptying the ultrafiltration feed vessel due to plugging of ultrafilters.

24590-PTF-N1D-UFP-P0002
Rev. 2

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682506

UFP-PP-00001A/B, 2A/B, 3A/B (PTF)
Ultrafilter Pulsepots

- Design Temperature (°F): 200
- Design Pressure (psig) (max/min): 200/-15
- Location: out cell

ISSUED BY
RPP-WTP PDC

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessels are always alkaline, pH > 12, at the normal operating temperature.
- Pulsepots will backpulse during cleaning operations with 2M nitric acid and 2M caustic.
- Process condensate will be supplied to flush reagents between uses.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 12/07/07

5/24/06

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 6 sheets.

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
2	5/24/06	Issued for Permitting Use			
1	3/10/05	Issued for Permitting Use	DLA	JRD	APR
0	10/9/03	Issued for Permitting Use	DLA	JRD	SWV

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Pulse-pots are used to perform back-pulsing on the ultrafilter tube units. Back-pulsing may involve adding cleaning chemicals such as 2 M HNO_3, 2 M NaOH or process condensate.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks (1996) states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

In this system, the hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable. It must be noted the amount of fluoride is expected to be relatively small except for the contract maximum. The amount of dilution of fluoride when acid is added is unknown but is generally assumed to be normally well diluted. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning. Keeping the vessel as cool as possible when acid is present would reduce the extent of attack by chloride (pitting and crevice corrosion) and, with the presence of Al^{+++}, general corrosion due to fluoride. Properly protected by temperature and fluoride complexants such as Al^{+++}, 304L will be suitable.

Conclusion:
304L is expected to be sufficiently resistant with a probable general corrosion rate of less than 1 mpy. A procedure will be necessary to minimize the presence of fluorides during acid cleaning.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (1998) has stated that localized corrosion can occur under the deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate between 77 and 194°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. Under acidic conditions, 304L is still expected to be acceptable.

Conclusion:
Based on the expected operating conditions, 304L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. With the stated temperature and alkaline conditions, 304L is expected to be satisfactory. However, if acid cleaning is to be used and the halide concentration cannot be controlled, 316 L will be the minimum acceptable alloy and it may be necessary to use a more resistant alloy.

Conclusion:
Because of the normal operating environment that will include periodic acid cleaning, the minimum alloy recommended is a 304L stainless steel.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

PLANT ITEM MATERIAL SELECTION DATA SHEET

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is either too alkaline or too acid. Further, the system is sufficiently far downstream of the main entry points of microbes that infection is unlikely.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Not a concern.

i Vapor Phase Corrosion
Not expected to be a concern.

Conclusion:
Not a concern.

j Erosion
Velocities within the vessel are expected to be small. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with solids content less than 27.3 wt% at velocities less than 4 mps.

Conclusion:
Not believed to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
None expected.

Conclusion:
Not considered a problem.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 2 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 2 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
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4. CCN 110849, Memo from B Yorgesen to S Vail, 12 January 2005, "Revised Process Corrosion Data Sheet for UFP-VSL-00002A/B"
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PLANT ITEM MATERIAL SELECTION DATA SHEET

CCN 110849
Revised Process Corrosion Data Sheet

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafiltration feed vessels (UFP-VSL-00002 A/B)
Ultrafilter (UFP-FILT-00001,2,3 A/B), Ultrafiltration pulse pot (UFP-PP-00001,2,3 A/B
Ultrafilter Heat Exchangers (UFP-HX-00001A/B)

Facility PTF

In Black Cell? Yes (UFP-VSL-00002A/B only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.61E+01	4.79E+01			
Chloride	g/l	1.20E+01	1.44E+01			
Fluoride	g/l	1.43E+01	1.72E+01			
Iron	g/l	1.89E+02	1.15E+02			
Nitrate	g/l	2.29E+02	2.63E+02			
Nitrite	g/l	6.66E+01	7.97E+01			
Phosphate	g/l	4.81E+01	5.63E+01			
Sulfate	g/l	2.56E+01	3.06E+01			
Mercury	g/l	1.18E+00	1.67E+00			
Carbonate	g/l	1.05E+02	1.06E+02			
Undissolved solids	wt%	25%	25%			
Other (NaMnO4, Pb,...)	g/l	1.00E-02				Note 4
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP04, UFP17, UFP39, UFP07
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0002,3, Rev 1
PFD: 24590-PTF-M5-V17T-P0010, Rev 1
Technical Reports: N/A

Notes:
1 Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max
2 T normal operation 77 °F to 194 °F (24590-PTF-MVC-UFP-00002, Rev 0)
3 Alkaline streams with pH range from approximately 12 to 14
4 NaMnO4 is added for oxidative leaching. The other chemicals should not be effected by oxidative leaching.
Concentrations may be lowered, but for conservatism did not change in this datasheet

Assumptions:
Assume the NaMnO4 addition was 1.1 Mole per mole of Cr

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.14.3 Ultrafiltration Feed Vessels (UFP-VSL-00002A/B), Ultra Filters (UFP-FILT-00001,2,3 A/B), Ultrafiltration Pulse Pots (UFP-PP-00001A/B, 2A/B, 3A/B)

Routine Operations

These two vessels receive the feed from the ultrafiltration feed preparation vessels (UFP-VSL-00001A/B). The feed is then concentrated to 20 % solids by being pumped and recirculated through an ultrafiltration loop. The liquid fraction of the filtered feed is sent to the LAW vitrification facility. The feed containing the 20 % solids is sampled to determine the appropriate treatment steps. Treatment of the solids may include solids washing to remove excess sodium through dilution and ultrafiltration, and/or caustic leaching by adding 19 M NaOH until the solution reaches 3 M, allowing a period of 8 hours for digestion, during which the solution is heated to between 176 °F to 194 °F, and then cooled back to ambient temperature (77 °F). After cooling, the contents are reconcentrated to 20 % solids by ultrafiltration. Ultrafiltration pulse-pots (UFP-PP-00001A/B, UFP-PP-00002A/B, and UFP-PP-00003A/B) are used to perform back-pulsing on the ultrafilter tube units. Back-pulsing may involve adding cleaning chemicals (2 M HNO_3, 2 M NaOH, and process condensate).

Non-Routine Operations that Could Affect Corrosion/Erosion

There is the option to transfer the Sr/TRU solids directly to the HLW blending vessel (HLP-VSL-00028), if necessary.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682507

ISSUED BY
RPP-WTP PDC

UFP-FILT-00001A/B, 2A/B, 3A/B (PTF)
Ultrafilter

- Design Temperature (°F)(max/min): 200/59
- Design Pressure (psig) (max/min): 200/0
- Location: outcell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is always alkaline, within the stated limits, at the normal operating temperature.
- The vessel will be cleaned using 2 M HNO_3, 2M caustic or process condensate at normal operating temperatures; the condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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EXPIRES: 12/07/07

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

a General Corrosion
Hammer (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F. In addition, Zapp (1998) reports that the Savannah River Site evaporator shells have successfully operated for 30 years at temperatures of about 300°F; 304L heat transfer tubes have survived only about 10 years.

In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

The proposed acid cleaning requires an examination of the conditions in the system during that period. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning especially in the pores of the filters unless the free fluoride concentration is kept low – even small amounts of corrosion can change the filter characteristics. Keeping the vessel as cool as possible, below 100°F if possible would reduce the extent of attack by chloride (pitting and crevice corrosion) and, and with the addition of Al^{+++}, general corrosion due to fluoride. At the stated temperature and fluoride complexants, such as Al^{+++}, 304L would be suitable, provided there is strict control of the acid cleaning conditions. 316L would provide a greater margin of safety.

Conclusion:
At the expected temperatures, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. During acid cleaning, in the presence of fluoride, 316L is required as a minimum.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (1998) has stated that localized corrosion can occur under the deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting.

Normally the vessel is to operate between 77 and 86°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. There is uncertainty about the behavior of the sintered junctions in the filters in strong caustic.

Under acidic or neutral pH conditions, a more pitting resistant alloy may be needed. Depending on the temperature, concentration of the chloride, and the duration of exposure during acid cleaning it might be feasible to use 316L stainless steel. At a normal operating temperature and only residual chlorides during nitric cleaning, 316L would be acceptable.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are expected to remain.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum contents Based on the expected operating conditions and the intent to use acid washes inside the vessels 316L is the minimum acceptable. The presence of crevices in the filter makes 316L the minimum acceptable material for the filters.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not expected to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. With the stated temperature and alkaline conditions, 304L is expected to be satisfactory.

Conclusion.
At the normal operating environment, the alloy recommended is a 304L or 316L stainless with 316L filter tubes to provide added protection from the halides.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system except as noted above.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
The presence of multiple tubes, presumably welded at both ends, is a potential concern. Proper design, using heat exchanger industry standards, will eliminate fatigue and corrosion fatigue concerns.

Conclusions
Not a concern.

i Vapor Phase Corrosion
No significant vapor phase region is expected.

Conclusion:
Vapor phase corrosion is not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be low. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with solids content less than 27.3 wt%.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 2 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 2 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

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PLANT ITEM MATERIAL SELECTION DATA SHEET

CCN 110849
Revised Process Corrosion Data Sheet

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafiltration feed vessels (UFP-VSL-00002 A/B)
Ultrafilter (UFP-FILT-00001,2,3 A/B), Ultrafiltration pulse pot (UFP-PP-00001,2,3,A/B
Facility PTF Ultrafilter Heat Exchangers (UFP-HX-00001A/B)

In Black Cell? Yes (UFP-VSL-00002A/B only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.61E+01	4.79E+01			
Chloride	g/l	1.20E+01	1.44E+01			
Fluoride	g/l	1.43E+01	1.72E+01			
Iron	g/l	1.69E+02	1.15E+02			
Nitrate	g/l	2.29E+02	2.63E+02			
Nitrite	g/l	6.66E+01	7.97E+01			
Phosphate	g/l	4.81E+01	5.63E+01			
Sulfate	g/l	2.56E+01	3.06E+01			
Mercury	g/l	1.18E+00	1.67E+00			
Carbonate	g/l	1.05E+02	1.06E+02			
Undissolved solids	wt%	25%	25%			
Other (NaMnO4, Pb,...)	g/l	1.00E-02				Note 4
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP04, UFP17, UFP39, UFP07
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0002,3, Rev 1
PFD: 24590-PTF-M5-V17T-P0010, Rev 1
Technical Reports: N/A

Notes:
1 Concentrations less than 1x 10^-4 g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 77 °F to 194 °F (24590-PTF-MVC-UFP-00002, Rev 0)
3 Alkaline streams with pH range from approximately 12 to 14
4. NaMnO4 is added for oxidative leaching. The other chemicals should not be effected by oxidative leaching.
Concentrations may be lowered, but for conservatism did not change in this datasheet.

Assumptions:
Assume the NaMnO4 addition was 1.1 Mole per mole of Cr.

Correction to note 2: Normal operating temperature in the Ultrafilter is 77°F and the maximum operating temperature is 86°F. Temperatures shown are specific to the Ultrafilter Feed Vessels (CCN 112293).

4.14.3 Ultrafiltration Feed Vessels (UFP-VSL-00002 A/B), Ultra Filters (UFP-FILT-00001A/B, 2A/B, 3A/B), Ultrafiltration Pulse Pots (UFP-PP-00001A/B,2A/B, 2A/B)

Routine Operations

These two vessels receive the feed from the ultrafiltration feed preparation vessels (UFP-VSL-00001A/B). The feed is then concentrated to 20 % solids by being pumped and recirculated through an ultrafiltration loop. The liquid fraction of the filtered feed is sent to the LAW vitrification facility. The feed containing the 20 % solids is sampled to determine the appropriate treatment steps. Treatment of the solids may include solids washing to remove excess sodium through dilution and ultrafiltration, and/or caustic leaching by adding 19 M NaOH until the solution reaches 3 M, allowing a period of 8 hours for digestion, during which the solution is heated to between 176 °F to 194 °F, and then cooled back to ambient temperature (77 °F). After cooling, the contents are reconcentrated to 20 % solids by ultrafiltration. Ultrafiltration pulse-pots (UFP-PP-00001A/B, UFP-PP-00002A/B, and UFP-PP-00003A/B) are used to perform back-pulsing on the ultrafilter tube units. Back-pulsing may involve adding cleaning chemicals (2 M HNO_3, 2 M NaOH, and process condensate).

Non-Routine Operations that Could Affect Corrosion/Erosion

There is the option to transfer the Sr/TRU solids directly to the HLW blending vessel (HLP-VSL-00028), if necessary.

PLANT ITEM MATERIAL SELECTION DATA SHEET

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R10661550

UFP-VSL-00001A/B (PTF)

Ultrafiltration Feed Preparation Vessel

- Design Temperature (°F)(max/min): 150/40
- Design Pressure (psig) (max/min): 15/-12
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items –

UFP-VSL-00001A –
UFP-PJM-00001 – UFP-PJM-00004
UFP-PJM-00044, UFP-PJM-00053
UFP-PJM-00105 – UFP-PJM-00106
UFP-VSL-00001B –
UFP-PJM-00045 – UFP-PJM-00050
UFP-PJM-00101 – UFP-PJM-00102

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

No maintenance will be performed on these vessels.

Operating Modes Considered:

- Normal operating conditions
- The vessel may be cleaned using 2 N HNO_3 with residual chlorides and fluorides at normal operating temperatures; the condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C, dual certified)

Steam Ejector: high temperature components of steam ejector located inside vessel shall be UNS N06022

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance; localized protection is required as discussed in section j)

Process & Operations Limitations:

- Develop flushing/rinsing procedure for acid and water.

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Waste is maintained at 77°F by use of a chiller jacket. For Envelope C waste only, contents are heated to a temperature of 122°F necessary for Sr/TRU precipitation. A steam ejector is available to maintain the necessary reaction temperature. Chemical reagent additions are 19M NaOH followed by 1.0 M $Sr(NO_3)_2$ followed by 1M $NaMnO_4$. It is anticipated periodic acid cleaning will be necessary.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years. The 304L heat transfer surfaces have failed, however, after about 10 years. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 1 mpy up to about 212°F though Sedriks states the corrosion rate data beyond about 122°F are low due to the presence of oxidizing species.

Ohl & Carlos (1994) found in their review of the 242-A Evaporator, in waste similar to that expected in WTP, that the corrosion of 304L after about two years of operation at 140°F was less than the accepted variability of the original plate. Because of uncertainties in the starting thickness of the metal, a review of the raw data was inconclusive.

There is a concern about excessive corrosion rates during acid cleaning in the presence of the expected levels of fluoride. Acid wash should only be performed at normal operating temperatures in order to reduce the extent of attack by chloride (pitting and crevice corrosion) and general corrosion due to fluoride.

Conclusion:
At temperatures less than about 140°F, 304L or 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. Based on the Savannah River experience with Hanford-like waste at higher temperatures, either 304L or 316L is expected to be satisfactory to 300°F.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media.

Normally the vessel is to operate between 77°F and 122°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. Under acidic or neutral pH conditions, 316L will be more resistant to pitting due to the chloride concentration.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Therefore, controls on washing and rinsing are required.

The high temperature portions of the high pressure steam ejector that are located within the vessel shall be C-22.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum contents. Based on the expected operating conditions and the possibility of acid washes inside the vessels, 316L is recommended.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions. Acid cleaning should be performed only at normal operating temperature.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. It is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Koch (1995) has noted that fluoride exacerbates chloride intergranular stress corrosion cracking. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F. With the low operating temperature and alkaline conditions, 304L and 316L are expected to be satisfactory in regards to resistance to chloride cracking. Davis (1987) suggests caustic cracking is a concern above about 212°F. However, Zapp's work (1998) implies that neither 304L nor 316L will crack in waste.

Conclusion:
Because of the normal operating environment as well as that which can occur during off normal conditions, and possibility of acid washing, 304L is the minimum alloy recommended and 316L may be marginally better.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
The high solids loading may make deposits more common and, consequently, the vessel more susceptible to crevice formation. See Pitting.

Conclusion:
Lower temperatures and higher pH mitigate the formation of crevice corrosion. See also Pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is either too alkaline or too acid. Further, the system is downstream of the main entry points of microbes.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Due to the possibility of solid or acids and solids being present, 316L is recommended. In the case of the steam ejector, a high nickel alloy is needed.

Conclusion:
Not expected to be a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with maximum solids content up to 27.3 wt%. Additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s with normal maximum solids concentrations of 3.8 wt% and maximum solids concentrations of 27.3 wt% with a usage of 56 % operation as documented in 24590-WTP-M0C-50-00004. UFP-VSL-00001A/B requires at least 0.129-inch additional protection. The 27.3 wt% is considered to be conservative. The fraction of time the solids concentration is expected to be at maximum is 10%. During normal operation, 90 % of the time, the solids content of UFP-VSL-00001A/B is expected to be 3.8 wt%.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.087–inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations of 3.8 wt% and a maximum solids concentration of 27.3 wt% with a usage of 56 % operation as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel wall. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly dissimilar metals are present.

Conclusion:
Not expected to be a concern.

PLANT ITEM MATERIAL SELECTION DATA SHEET

a Cavitation
None expected.

Conclusion:
Not believed to be of concern.

• Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0C-50-00004, Rev. D, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. Danielson, MJ & SG Pitman, 2000, *Corrosion Test of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
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11. Ohl, PC & WC Carlos, 1994, *Hanford High-Level Evaporator/Crystallizer Corrosion Evaluation*, Presented at Corrosion 94, NACE International, Houston TX 77218.
12. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
13. Smith, H. D. and M. R. Elmore, 1992, Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW), PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
14. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

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1. Jenkins, CF, 1998, *Performance of Evaporators in High Level Radioactive Chemical Waste Service*, Presented at Corrosion 98, NACE International, Houston TX 77084
2. Jenkins, CF. SRTC, teleconference with JR Divine, RPP-WTP, 16 February, 2000.
3. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
5. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafiltration feed preparation vessel (UFP-VSL-00001A/B)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	7.25E+01	6.91E+01			
Chloride	g/l	2.65E+01	2.93E+01			
Fluoride	g/l	3.14E+01	3.49E+01			
Iron	g/l	5.88E+01	5.98E+01			
Nitrate	g/l	4.98E+02	5.34E+02			
Nitrite	g/l	1.44E+02	1.60E+02			
Phosphate	g/l	1.06E+02	1.15E+02			
Sulfate	g/l	5.58E+01	6.17E+01			
Mercury	g/l	5.66E-01	3.53E-01			
Carbonate	g/l	1.92E+02	2.01E+02			
Undissolved solids	wt%	27.0%	27.3%			Note 3
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 4
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00006, Rev A
Normal Input Stream #: FEP03, HLP12
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0001, Rev 1
PFD: 24590-PTF-M5-V17T-P0009, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 77 °F to 122 °F for Envelope A, B, C, 68 °F to 86 °F for plant wash (24590-PTF-MVC-UFP-00001, Rev 0)
3. Based on HLP12. Other streams entering the vessel will dilute this stream.
4. Mainly alkaline streams with a pH range of approximately 12 to 14.

Assumptions:

4.14.2 Ultrafiltration Feed Preparation Vessel (UFP-VSL-00001A/B)

Routine Operations

Envelope C processing includes solids removal and Sr/TRU precipitation. Therefore, this process is operated separately from the other envelopes (i.e., Envelopes A/D, B/D). Feed during Envelope C processing is received at a target molarity of 6 M sodium. If the feed is received too dilute, the feed may be recycled to the waste feed evaporator feed vessels (FEP-VSL-00017A/B) for further evaporation. Furthermore, if dilution of the feed to 6 M sodium is required, process condensate can be added. Once the vessel level reaches the desired low-level set point for agitation, the pulse jet mixers are activated. The pulse jet mixers run continually until the vessel is emptied below the low level set point.

The precipitation reaction requires a heated solution of 122 °F; therefore, a heating steam ejector is available in the ultrafiltration feed preparation vessel to maintain the necessary reaction temperature. Reagents are added to Envelope C contents in vessels UFP-VSL-00001A or B to commence precipitation. The final concentration of free hydroxide, strontium, and permanganate solutions are 1.0 M OH^-, 0.075 M Sr^{2+}, and 0.05 M MnO_4^-, respectively. The addition also assumes that the initial concentrations are zero in each case. Therefore, the volume of each reagent added is strictly based on the initial liquid level (volume) in the vessel at the beginning of the reaction.

To perform an effective precipitation strike, the reagents are added in the following order. Initially, 19 M NaOH is added, followed by a sufficient amount of 1.0 M $Sr(NO_3)_2$ solution. The resulting solution provides the conditions to precipitate out strontium as $SrCO_3$. Finally, enough 1M $NaMNO_4$ is added to mathematically achieve a 0.05 M MNO_4 solution. The TRU components precipitate out in the floculant. After digestion, the solution is diluted from 6 M to 5 M sodium and to cooled back down to 77 °F through the operation of the chilled water cooling jacket. The cooling and dilution sequences can occur at the same time.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.

PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10591497

UFP-VSL-00062-A/B/C (PTF)

Ultrafilter Permeate Collection Vessel

- Design Temperature (°F)(max/min): 120/40
- Design Pressure (psig) (max/min): 15/-10.29
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

Offspring items

UFP-VSL-00023 – 00025, UFP-VSL-00032 – 00037
UFP-VSL-00072 – 00073, UFP-VSL-00082 – 00084
UFP-VSL-00051, UFP-VSL-00069 – 00070, UFP-VSL-00075
UFP-PJM-00018 – 00022, UFP-PJM-00039 – 00043
UFP-PJM-00051 – 00052, UFP-PJM-00076 – 00078
UFP-PJM-00070, UFP-PJM-00073, UFP-PJM-00107
UFP-RFD-00027 – 00028, UFP-RFD-00030 – 00034
UFP-RFD-00037 – 00039, UFP-RFD-00042 – 00049

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

No maintenance will be performed.

Operating Modes Considered:

- Normal operating conditions are considered.
- The vessel may be cleaned using 2 N HNO_3 with residual chlorides and fluorides at normal operating temperatures; the condition of high temperature and acid is not examined.

Materials Considered:

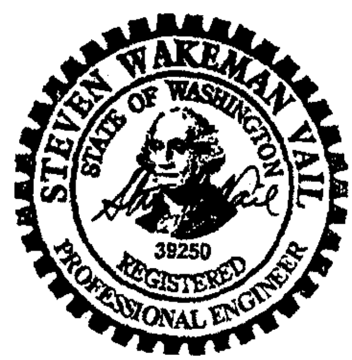
Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water



11/17/05

EXPIRES: 12/07/07

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 6 sheets.

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
2	11/17/05	Issued for Permitting Use	[signature]	[signature]	[signature]
1	1/23/05	Issued for Permitting Use	DLA	JRD	SWV
0	10/15/04	Issued for Permitting Use	DLA	JRD	SWV

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Permeate collected in these vessels is sampled and then routed to the CXP system for further treatment. Permeate collected from solids washing is routed to PWD-VSL-00015 or PWD-VSL-000016.

a General Corrosion
Hammer (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Divine's work (1986) with simulated-radwaste evaporators, six months at 140°F, showed 304L was slightly more resistant to corrosion (<0.2 mpy) than was 316L (<0.6 mpy); Ni 200, pure nickel, was much less resistant (≈7 mpy) probably due to the complexants. Zapp (1998) notes that the Savannah River evaporator vessels, operating at about 300°F, are made of 304L and have suffered no failures in about 30 years; 304L heat transfer surfaces have failed however after about 10 years. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks (1996) states the corrosion rate data beyond about 122°F are too low. Uhlig (1948) has shown that pure nickel is resistant to corrosion by NaOH. However, as Divine (1986) pointed out, the presence of complexing agents may reverse the trend. Agarwal (2000) states that the higher nickel alloys are highly corrosion resistant though specific mention of alkaline media is not made. The general literature mainly discusses cracking problems (see below) rather than uniform corrosion.

The amount of dilution of fluoride during possible acid wash is unknown. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning or should acid be from the Ultrafiltration Feed Vessels. Acid wash should only be performed at normal operating temperatures in order to reduce the extent of attack by chloride (pitting and crevice corrosion) and general corrosion due to fluoride. Properly protected by temperature and fluoride complexants such as Al^{+++}, 304L may be suitable. The more resistant 316L is recommended together with thorough flushing before acid is added.

Conclusion: At temperatures less than about 140°F, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. During acid cleaning, in the presence of fluoride, a more resistant alloy may have to be considered unless steps are taken to reduce the effect of the fluoride. Assuming a limited time of exposure to acid and thorough washing, 0.04 inch corrosion allowance is recommended.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Further, Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 86°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. Under acidic or neutral pH conditions, 316L will be more resistant to pitting due to the chloride concentration.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, though much less frequently in DIW. Therefore, controls on washing and rinsing are required.

Conclusion: Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 304L is expected to be satisfactory. Due to the possibility of acid washes inside the vessels, 316L stainless steel is the minimum recommended.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion: Possible, but not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F but this will depend on conditions. Berhardsson et al (1981) suggest that if the chloride concentration is < 50 ppm, temperatures up to 260 are acceptable whereas temperatures should be less than about 75°F if the chloride concentration approaches 1% (10,000 ppm). At the stated temperature and alkaline conditions, either 304L or 316L is expected to be satisfactory.

Conclusion: Because of the normal operating environment as well as that which can occur during off normal conditions, the minimum alloy recommended is a 304L stainless steel.

PLANT ITEM MATERIAL SELECTION DATA SHEET

e Crevice Corrosion
See Pitting.

Conclusion: See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion: Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the temperature is approximately correct but the pH is either too alkaline or too acid. Further, the system is downstream of the main entry points of microbes.

Conclusion: MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Under the stated operating conditions, corrosion fatigue is a not expected to be a problem in a properly designed vessel.

Conclusions: Not considered to be a concern.

i Vapor Phase Corrosion
Not expected to be a concern.

Conclusion: Not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.004 inch is adequate for components with solids content less than 2 wt%. Because of the negligible concentration of undissolved solids, no localized protection is necessary for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s for a usage of 100 % operation as documented in 24590-WTP-M0C-50-00004.

The PJM nozzle requires no additional protection as documented in 24590-WTP-M0C-50-00004.

Conclusion: The recommended corrosion allowance provides sufficient protection for erosion of the vessel.

k Galling of Moving Surfaces
There are no moving surfaces within the vessels.

Conclusion: Not applicable.

l Fretting/Wear
No contacting surfaces are expected.

Conclusion: Not considered a problem.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion: Not applicable.

n Cavitation
None expected.

Conclusion: Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion: Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion: The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-M0C-50-00004, Rev. D, *Wear Allowance for WTP Waste Slurry Systems*
2. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
3. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
4. CCN 130172, Divine, JR, 1986, Letter to A.J. Diliberto, *Reports of Experimentation*, Battelle, Pacific Northwest Laboratories, Richland, WA 99352
5. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
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7. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
8. Danielson, MJ & SG Pitman, 2000, *Corrosion Tests of 316L and Hastelloy C-22 in Simulated Tank Waste Solutions*, PNWD-3015 (BNFL-RPT-019, Rev 0), Pacific Northwest Laboratory, Richland WA.
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11. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
12. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
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14. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
15. Smith, H. D. and M. R. Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
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17. Zapp, PE, 1998, *Preliminary assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

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1. CCN 130170, Blackburn, LD to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Evaluation of 240-AR Chloride Limit*, August 15, 1991.
2. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
5. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafilter permeate collection vessel (UFP-VSL-00062A/B/C)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.15E+01	3.17E+01			
Chloride	g/l	1.21E+01	1.45E+01			
Fluoride	g/l	1.44E+01	1.73E+01			
Iron	g/l	2.31E+00	2.80E+00			
Nitrate	g/l	2.23E+02	2.59E+02			
Nitrite	g/l	6.69E+01	8.01E+01			
Phosphate	g/l	4.83E+01	5.66E+01			
Sulfate	g/l	2.57E+01	3.08E+01			
Mercury	g/l	7.47E-02	1.94E-02			
Carbonate	g/l	9.03E+01	9.93E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00006, Rev A
Normal Input Stream #: UFP17, UFP33
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-PTF-M6-UFP-P0004, Rev 1
PFD: 24590-PTF-M5-V17T-P0011, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x10⁻⁴ g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 77 °F to max 86 °F (24590-PTF-MVC-UFP-00003, Rev 0)
3. Alkaline pH approximately 12 to 14

Assumptions:

4.14.4 Ultrafilter Permeate Collection Vessel (UFP-VSL-00062 A/B/C)

Routine Operations

Permeate collected in the ultrafilter permeate vessels (UFP-VSL-00062A/B/C) is sampled and then routed to the cesium ion exchange process system (CXP) for further treatment. The permeate collected from solids washing is routed to the acidic/alkaline effluent vessels (PWD-VSL-00015/00016). If necessary, the permeate routed to the CXP system may be diluted with process condensate prior to transferring to meet the 5 M sodium design basis requirement (SpG ~1.25).

Non-Routine Operations that Could Affect Corrosion/Erosion

Off-specification permeate (excessive turbidity) can be routed back to either of the ultrafilter feed preparation vessels (UFP-VSL-00001A/B).

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Drawings and Documents

Attachment 51 – Appendix 8.11
Pretreatment Building
IQRPE Reports

The following drawings have been incorporated into Appendix 8.11 and can be viewed at the Ecology Richland Office. **New drawings are in bold lettering.**

Drawing/Document Number	***Description***
24590-CM-HC4-HXYG-00138-01-01, Rev 0	IQRPE Integrity Assessment Report for Secondary Containment El. -45
24590-CM-HC4-HXYG-00138-01-02, Rev 00C	IQRPE Integrity Assessment Report for Below Grade PWD Ancillary Equipment
24590-CM-HC4-HXYG-00138-01-07, Rev 00B	IQRPE Integrity Assessment Report for Below Grade PWD Tanks
24590-CM-HC4-HXYG-00138-01-13, Rev 00A	IQRPE Integrity Assessment Report for El. 28 Secondary Containment
24590-CM-HC4-HXYG-00138-01-15, Rev 00A	IQRP Integrity Assessment Report for Below Grade PWD Transfer Lines, Secondary Containment, Ancillary Equipment and Corrosion Assessment
24590-CM-HC4-HXYG-00138-01-18, Rev 00A	IQRP Integrity Assessment Report for UFP Vessels
24590-CM-HC4-HXYG-00138-02-00013, Rev 00A	IQRPE Integrity Assessment Report for PWD Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00014, Rev 00A	IQRP Integrity Assessment Report for PWD-VSL-00015/16/44
24590-CM-HC4-HXYG-00138-02-00015, Rev 00A	IQRPE Integrity Assessment Report for RLD-VSL-00017A/B
24590-CM-HC4-HXYG-00138-02-00017, Rev 00A	IQRP Integrity Assessment Report for El. 0 RLD Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00019, Rev 00A	IQRPE Integrity Assessment Report FEP Vessels, Miscellaneous Treatment Units, and Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00020, Rev 00A	IQRPE Integrity Assessment Report for FEP-VSL-00017A/B, FEP-VSL-00005, FEP-SEP-00001A/B, and FEP-RBLR-00001A/B
24590-CM-HC4-HXYG-00138-02-00021, Rev 00A	IQRPE Integrity Assessment Report for TLP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00022, Rev 00A	IQRPE Integrity Assessment Report for El. 56 Miscellaneous Treatment Units Secondary Containment

24590-CM-HC4-HXYG-00138-02-00023, Rev 00A	IQRPE Integrity Assessment Report for TLP Miscellaneous Treatment Units and Vessels
24590-CM-HC4-HXYG-00138-02-00027, Rev 00A	IQRPE Integrity Assessment Report for RDP-VSL-00002A/B/C
24590-CM-HC4-HXYG-00138-02-00028, Rev 00A	IQRPE Integrity Assessment Report RDP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00031, Rev 00A	IQRPE Integrity Assessment Report for El. 77 Miscellaneous Treatment Units Secondary Containment
24590-CM-HC4-HXYG-00138-02-00033, Rev 00A	IQRPE Integrity Assessment Report for CXP Vessels
24590-CM-HC4-HXYG-00138-02-00034, Rev 00A	IQRPE Integrity Assessment Report El. 0 CXP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00035, Rev 00C	IQRPE Integrity Assessment Report El. 0 PVP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00036, Rev 00A	IQRPE Impendent Assessment Report for CNP-VSL-00001/3/4
24590-CM-HC4-HXYG-00138-02-00037, Rev 00B	IQRPE Impendent Assessment Report for CNP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00040, Rev 00A	IQRPE Integrity Assessment Report for RDP-VSL-00004
24590-CM-HC4-HXYG-00138-02-00041, Rev 00A	IQRPE Integrity Assessment Report El. 0 RDP-VSL-00004 Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00046, Rev 00A	IQRPE Impendent Assessment Report for PJV-VSL-00002
24590-CM-HC4-HXYG-00138-02-00047, Rev 00A	IQRPE Impendent Assessment Report for El. 0 PJV Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-00051, Rev 00A	IQRPE Integrity Assessment Report for PVP-VSL-00001, PVP-SCB-00002
24590-CM-HC4-HXYG-00138-02-00054, Rev 00A	IQRPE Integrity Assessment Report for TLP-VSL-00009A/B
24590-CM-HC4-HXYG-00138-02-00045, Rev 00B	IQRPE Integrity Assessment Report CNP Miscellaneous Treatment Units
24590-CM-HC4-HXYG-00138-02-00057, Rev 00A	**IQRPE Integrity Assessment Report for El. -2'.0" RLD Tanks RLD-TK-00006 A/B**
24590-CM-HC4-HXYG-00138-02-01A, Rev A	IQRPE Integrity Assessment Report for El. 0 Secondary Containment
24590-CM-HC4-HXYG-00138-02-02, Rev 00A	IQRPE Integrity Assessment Report for FRP Ancillary Equipment, Rev. 1
24590-CM-HC4-HXYG-00138-02-03, Rev 00B	IQRPE Integrity Assessment Report for FRP-VSL-00002A/B/C/D
24590-CM-HC4-HXYG-00138-02-04, Rev 00B	IQRPE Integrity Assessment Report for

	TCP-VSL-00001
24590-CM-HC4-HXYG-00138-02-05, Rev 00A	IQRPE Integrity Assessment Report for TCP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-06, Rev 00A	IQRPE Integrity Assessment Report for UFP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-09, Rev 00A	IQRPE Integrity Assessment Report for HLP Ancillary Equipment
24590-CM-HC4-HXYG-00138-02-10, Rev 00A	IQRPE Integrity Assessment Report for HLP-VSL-00022, 00027A/B, and 00028
RESERVED	RESERVED

R10656140

COGEMA-IA-083, Rev. 0

STRUCTURAL INTEGRITY ASSESSMENT OF THE PRETREATMENT FACILITY (PTF) ELEVATION (-) 2'-0" SECONDARY CONTAINMENT OF RADIOACTIVE LIQUID WASTE DISPOSAL SYSTEM (RLD) TANKS (RLD-TK-00006 A/B)

Bechtel National, Inc.

Job No. 24590

SUPPLIER DOCUMENT STATUS

1. [X] Work may proceed.
2. [ ] Revise and resubmit. Work may proceed subject to resolution of indicated comments.
3. [ ] Revise and resubmit. Work may not proceed.
4. [ ] Review not required. Work may proceed.

Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the supplier and does not relieve supplier from full compliance with contractual obligations.

REVIEWED: ENG, BHE

G-321 Document Category N/A
[From Supplement A to G-321-E (E) or G-321-V (V), as applicable, or "N/A" if SSRS is used]

Supersedes BNI Document No. N/A Rev.
[When applicable]

Accepted by DC Pfluger (Print Name) [signature] (Signature) 11/27/05 (Date)

Released by N/A (Print Name) (Signature) (Date)
[When applicable]

416 OP&S 7-03

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

24590-CM-HC4-HX4G-00138-02-00057 REV 00A

IQRPE REVIEW
OF
THE PRETREATMENT FACILITY (PTF) ELEVATION (-) 2'-0" SECONDARY CONTAINMENT OF RADIOACTIVE LIQUID WASTE DISPOSAL SYSTEM (RLD) TANKS (RLD-TK-00006 A/B)

"I, Tarlok Hundal have reviewed and certified a portion of the design of a new tank system or component located at the Hanford Waste Treatment Plant, owned/operated by Department of Energy, Office of River Protection, Richland, Washington. My duties were independent review of the current design for the Pretreatment Facility (PTF) Elevation (-) 2'-0" Secondary Containment of RLD Tanks (RLD-TK-00006 A/B) as required by the Washington Administrative Code, *Dangerous Waste Regulations*, Section WAC-173-303-640(3) (a) through (g) applicable components."

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

The documentation reviewed indicates that the design fully satisfies the requirements of the WAC.

The attached review is ten (10) pages numbered one (1) through ten (10).

TARLOK SINGH HUNDAL
STATE OF WASHINGTON
20213
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 02/15/06

Signature

11-29-05

Date

Scope	Scope of this Integrity Assessment	This integrity assessment addresses the Pretreatment Facility (PTF) Secondary Containment of RLD tanks (RLD-TK-00006A/B) located outside the north east end of the main building in an area designated as Area 7 and Room P-0150 at Elev. (-) 2'-0" as shown on Drawings 24590-PTF-P1-P01T-00001 and 24590-PTF-P1-P23T-00107.
References	Drawings	H-2-829714, Rev. 1, Privatization Site Legal Descriptions; 24590-BOF-P1-50-00001, Rev. 5, RPP-WTP Plot Plan; 24590-BOF-C2-C12T-00002, Rev. 6, RPP-WTP Site General Arrangement Plan; 24590-BOF-C0-C12T-00003, Rev. 0, Abbreviations, Symbols and General Notes; 24590-BOF-CG-C12T-00001, Rev. 0, Final Grading Key Plan; 24590-BOF-CG-C12T-00007, Rev. 0, Final Grading Plan Area 7; 24590-PTF- P1- P01T- 00001, Rev. 6, Pretreatment Facility General Arrangement Plan at El. 0'-0"; 24590-PTF- P1- P01T- P0012, Rev. 6, Pretreatment Facility General Arrangement Sect. F-F and Sect. G-G; 24590-PTF- P1- P01T- P0013, Rev. 5, Pretreatment Facility General Arrangement Sect. H-H and Sect. J-J. 24590-PTF-MT-RLD-00001, Rev. B, Equipment Assembly Process Condensate Tanks RLD-TK-00006A & 6B; 24590-PTF-P1-P23T-00107, Rev. 4, Pretreatment Facility Equipment Location Plan at El. 0'-0"/Area 7; 24590-PTF-DB-S13T-00025, Rev. A, Pretreatment Facility Structural Concrete Forming RLD Tanks Secondary Cont. Foundation and Floor Plan; 24590-PTF-DB-S13T-00026, Rev. A, Pretreatment Facility Structural Concrete Forming RLD Tanks Secondary Containment Sections; 24590-PTF-DB-S13T-00027, Rev. A, Pretreatment Facility Structural Concrete Forming RLD Tanks Secondary Containment Sections & Details; 24590-PTF-DG-S13T-00028, Rev. A, Pretreatment Facility Structural Concrete Reinforcement RLD Tanks Secondary Containment Foundation and Floor Plan; 24590-PTF-DG-S13T-00029, Rev. A, Pretreatment Facility Structural Concrete Reinforcement RLD Tanks Secondary Cont. Sections & Details; 24590-WTP-D0-S13T-00002, Rev. 2, Civil/Structural Standards General Notes; 24590-WTP-D0-S13T-00003, Rev. 2, Civil/Structural Standards Abbreviations and Legend; 24590-WTP-D0-S13T-00004, Rev. 2, Civil/Structural Standards Concrete Notes; 24590-WTP-DG-S13T-00001, Rev. 0, Civil/Structural Standards Concrete Reinforcement Details; 24590-WTP-DG-S13T-00005, Rev. 3, Civil/Structural Standards Concrete Reinforcement Details.

Summary of Assessment	For each item of "Information Assessed" (i.e., Criteria) on the following pages, the items listed under "Source of Information" were reviewed and found to furnish adequate design requirements and controls to ensure that the design fully satisfies the requirements of Washington Administrative Code, WAC-173-303-640, *Dangerous Waste Regulations* for Tank Systems.

Information Assessed		Source of Information	Assessment
Foundation Design	Description of subsurface conditions and soil bearing capacity are adequate.	Drawings listed above under References; 24590-PTF-MTD-RLD-00001, Rev. B Mechanical Data Sheet for Tanks (RLD-TK-00006A/B); 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A); 24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; 24590-PTF-S0C-S15T-00010, Rev. 1, Pretreatment Building-Soil Springs; 24590-BOF-3PS-CE00-T0001, Rev. 0, Site Work. 24590-BOF-3PS-CE01-T0001, Rev. 5, Engineering Specification for Excavation and Backfill; 24590-BOF-3PS-C000-T0001, Rev. 3, Engineering Specification for Material Testing Services.	The Mechanical Data Sheet for Radioactive Liquid Waste Disposal system (RLD) tanks (RLD-TK-00006A/B) lists the Quality Level as Commercial Grade (CM) and Seismic Category as SC-III for these tanks. The Quality Level and Seismic Category of the secondary containment structure for these tanks are also appropriately identified as CM and SC-III, respectively, in the drawings and in the Secondary Containment for RLD Tanks (structural design calculations). The Structural Design Criteria and Pretreatment Building-Soil Springs documents provide adequate applicable design guidance for the foundation designs based on the site soil properties determined based on the current geotechnical investigation reports for the WTP facility. The Structural Design Criteria recommends to design the mat on elastic foundation using soil springs. The Secondary Containment for RLD Tanks (structural design calculations) used the soil spring constants as determined in the Pretreatment Building-Soil Springs document. The specifications Site Work and Excavation and Backfill identify the limits and to remove unsuitable materials under the foundations. The Specification for Excavation and Backfill provides structural backfill requirements based on the geotechnical investigation report and applicable codes and standards for the selection, placing, compacting, and backfill testing of candidate fill materials and completed backfills. The Specification for Material Testing Services provides adequate codes and standards for testing of the candidate structural fill materials and in-situ testing of structural fills as they are placed. The codes and standards are consistent with those called out in the Specification for Excavation and Backfill. The subsurface conditions and soil bearing capacities (soil springs) are adequately described and or computed for the secondary containment foundation design.

Information Assessed		Source of Information	Assessment
Foundation Design	Foundation design loads (including full tanks) and estimated settlement are adequately considered.	24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; ASCE 7-98, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers; ACI 318-99, Building Code Requirements for Structural Concrete, American Concrete Institute; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	The Structural Design Criteria uses current adequate standards to define design loads and load combinations (ASCE 7-98 and ACI 318-99). Dead and fluid loads are included in these loads and load combinations. Settlement design parameters are included in the Structural Design Criteria subsection on "geotechnical design parameters and foundation design." Review of the Secondary Containment for RLD Tanks (structural design calculations) shows that the full loads of the tanks have been appropriately considered in the foundation design.
	Design calculation approach and design basis of footings with design standard references (e.g., ACI) are adequate.	24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; ACI 318-99, Building Code Requirements for Structural Concrete, American Concrete Institute; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A). 24590-WTP-VV-ST-01-001, Rev. 4, Verification and Validation Test Plan and Test Report for GTSTRUDL.	The Structural Design Criteria references current adequate design criteria for the design of concrete foundations and footings. ACI 318-99 is referenced for the design of SC-III structures. Review of the Secondary Containment for RLD Tanks (structural design calculations) provides the design approach, basis, and methodology used for the design of the secondary containment foundations/footings. The above mentioned codes and standards, design approach, methodology, and basis delineated are appropriate and adequate for the foundation design. The input parameters used in the GTSTRUDL computer code utilized for this secondary containment design are appropriates and the output results have been appropriately validated via the Verification and Validation Test Plan and Test Report document.

Information Assessed		Source of Information	Assessment
Foundation Design	Foundation material is compatible with the soil.	Drawings listed above under References; 24590-WTP-3PS-DB01-T0001, Rev. 7, Engineering Specification for Furnishing and Delivering Ready-Mix Concrete; 24590-WTP-3PS-DG00-T0001, Rev. 3, Engineering Specification for Reinforcing Steel; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A); 24590-BOF-3PS-C000-T0001, Rev. 3, Engineering Specification for Material Testing Services; 24590-WTP-DB-ENG-01-001, Rev. 1C, Basis of Design.	The materials for secondary containment structure and backfill used under it are consistently identified in the specifications, drawings, and calculations. The Specification for Furnishing and Delivering Ready-Mix Concrete provides adequate current testing requirements for the selection of coarse and fine aggregates and the procurement of cementitious materials. Adequate test procedures are provided in the Material Testing Services specification for testing candidate aggregates for chemical reactivity. Instructions for mixing and delivering ready-mix concrete are adequate and current. As noted in the Basis of Design document (Section 4.7), the groundwater table is more than 250 feet below the ground surface; therefore, no compatibility problem is expected between the concrete foundations and the surrounding backfill materials used under and around it.
Frost Heave	Foundation will withstand the effects of frost heave	Drawings listed above under References; 24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria.	The Structural Design Criteria includes adequate provisions to preclude frost heave in the section addressing lateral earth pressure loads. All structural foundations are required to extend into the soil below the frost line to preclude frost heave. The frost line depth is 30 in. below the finished grade. The structural drawings show that the thickness of concrete foundation mat of Room P-0150 varies from 4.5 ft to 3.25 ft and its bottom elevation is at least 39 in. below the finished grade or below the finished concrete elevation, therefore, the foundation mat will not be subject to frost heave effects.

Information Assessed		Source of Information	Assessment
Seismic Design	Seismic considerations have been adequately addressed.	24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; 24590-WTP-SRD-ESH-01-001-02, Rev. 3x, Safety Requirements Document (SRD) Volume II. ACI 318-99, Building Code Requirements for Structural Concrete, American Concrete Institute; UBC-97, Uniform Building Code, International Conference of Building Officials; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	This secondary containment structure is classified as seismic category SC-III structure. The Structural Design Criteria and SRD documents provide codes and standards applicable for the design of SC-III structures. These documents require using the ACI 318-99 concrete code utilizing the UBC-97 code to determine the seismic forces for the design of SC-III structures. The ACI 318-99 code identifies all loads and load combinations for design of the secondary containment reinforced concrete foundations and structures. These codes and standards are adequate and acceptable for addressing seismic considerations. Review of the Secondary Containment for RLD Tanks (structural design calculations) shows that the applicable seismic codes and standard requirements have been appropriately considered and complied with the design of this secondary containment structure.
Compatibility	The stored waste is compatible with its Secondary Containment and leak detection hardware based on a detailed chemical and physical analysis of the wastes used and other information sources.	24590-WTP-DB-ENG-01-001, Rev. 1C, Basis of Design; 24590-WTP-PER-CSA-02-001, Rev. 7, Secondary Containment Design. 24590-WTP-PER-M-02-001, Rev. 3, Material Selections for Building Secondary Containment/Leak Detection; Bechtel National, Inc. (BNI) CCN # 126217, RLD Tank Secondary Containment Coating Considerations-Response to IQRPE Questions (T Coutts email message to DC Pfluger, dated Nov. 23, 2005, 10:23 AM); 24590-WTP-3PS-AFPS-TP006, Rev. 1, Engineering Specification for Field Applied Special Protective Coatings for Secondary Containment Areas.	The Basis of Design states that tank system shall provide for sump and leak detection equipment which are appropriately lined and any spills are removed and flushed within 24-hr or as timely as possible. The Secondary Containment Design document provides details for application of special protective coatings for this secondary containment area. Based on the detailed analysis of the corrosive properties of the expected waste process operations and evaluation of potential leak scenarios, the Material Selections and BNI CCN # 126217 documents identify appropriate and adequate environmental and corrosion resistant materials requirements for secondary containment coatings, liners, sumps and leak detection equipment. The Engineering Specification for Field Applied Special Protective Coatings (SPCs) provides the selection test criteria used to determine acceptable approved coating systems. These test criteria include chemical resistance endurance requirements and wear abrasion resistance criteria. The above mentioned documents provide adequate information that the materials and hardware used are compatible with the waste.

Information Assessed		Source of Information	Assessment
Strength	The design shows that the Secondary Containment has sufficient strength and thickness to prevent failure owing to pressure gradients, static head during a release, physical contact with the waste, climatic conditions, and the stress of daily operations (e.g., vehicular traffic).	Drawings listed above under References; 24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; 24590-WTP-PER-M-02-001, Rev. 3, Material Selections for Building Secondary Containment/Leak Detection, Bechtel National, Inc. (BNI) CCN # 126217, RLD Tank Secondary Containment Coating Considerations-Response to IQRPE Questions (T Coutts email message to DC Pfluger, dated Nov. 23, 2005, 10:23 AM); 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	The Structural Design Criteria document identifies adequate and appropriate design codes and standards and all applicable load cases from site specific conditions that must be considered in the design. Factors that were considered for special protective coating (SPC) material selection are adequately discussed in the Material Selections and BNI CCN # 126217 documents. Review of the Secondary Containment for RLD Tanks (structural design calculations) shows that all components of the secondary containment have been adequately designed for the applicable loads including static head, light traffic and equipment applications, and other natural phenomenon hazards. No heavy vehicular traffic is expected inside the bermed wall area. The thickness of SPC is adequately designed to sustain applicable stress and/or loading and environmental conditions. The structural design calculations show that the foundation mat is adequately designed to sustain the applicable loads imposed by the RLD-TK-0006A/B tanks to the mat at the interface of tank bottom and top of concrete pad. However, the integrity assessment of the tank including its anchoring system to the concrete pad is out of scope of this assessment. Integrity assessment of tanks is conducted in a separate report.

Information Assessed		Source of Information	Assessment
Strength	The Secondary Containment system has sufficient strength in the presence of operational stresses from site-specific conditions (i.e., traffic, heavy equipment, precipitation, frost).	Drawings listed above under References; 24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; 24590-WTP-PER-M-02-001, Rev. 3, Material Selections for Building Secondary Containment/Leak Detection; Bechtel National, Inc. (BNI) CCN # 126217, RLD Tank Secondary Containment Coating Considerations-Response to IQRPE Questions (T Coutts email message to DC Pfluger, dated Nov. 23, 2005, 10:23 AM); 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	The Structural Design Criteria document identifies adequate and appropriate design codes and standards and all applicable load cases (operational stresses) from site specific conditions that must be considered in the design. The Material Selections document considers mechanical factors including foot traffic, fork lift operations, and dropping of equipment. No heavy traffic or heavy equipment are expected within the secondary containment walls, however, precipitation and other applicable inclement weather and natural environmental effects have been considered in the Material Selections and BNI CCN # 126217 documents. The Secondary Containment for RLD Tanks (structural design calculations) document shows that it has adequate strength to sustain all applicable loads. The structural drawings show that the thickness of concrete foundation mat of Room P-0150 varies from 4.5 ft to 3.25 ft and its bottom elevation is at least 39 in. below the finished grade or below the finished concrete elevation, therefore, the foundation mat will not be subject to frost heave effects.

Information Assessed		Source of Information	Assessment
Foundation Integrity	The Secondary Containment is properly supported by a foundation or base in order to prevent failure from settlement, compression, or uplift, including the residual effects of installation.	Drawings listed above under References; 24590-WTP-DC-ST-01-001, Rev. 9, Structural Design Criteria; 24590-BOF-3PS-CE00-T0001, Rev. 0, Site Work. 24590-BOF-3PS-CE01-T0001, Rev. 5, Engineering Specification for Excavation and Backfill; 24590-BOF-3PS-C000-T0001, Rev. 3, Engineering Specification for Material Testing Services; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	The Structural Design Criteria adequately identifies the applicable parameters to be used for the foundation design. The design requirements, codes and standards, and documents specified are adequate to satisfy the performance goals of the secondary containment structure. The technical specifications for Site Work and Excavation and Backfill adequately provide adequate details for base material used under the foundation and for its proper installation. The drawings show the secondary containment location, boundaries, and details. The specifications for Site Work and Excavation and Backfill identify the removal of unsuitable materials under the foundations. Specification for Excavation and Backfill also identify inspections, and materials and compaction testing requirements to ensure adequate base support for the foundation to prevent its failure due to settlement, compression, or uplift including residual effects of installation. The Specification for Material Testing Services provides current adequate codes and standards for testing of the candidate structural fill materials, and in-situ testing of structural fills as they are placed. Review of the Secondary Containment for RLD Tanks (structural design calculations) shows that the design process appropriately considered all applicable factors for the foundation design.
	The placement, structural support, and type of material used for backfill around and below the Secondary Containment are appropriate.	Drawings listed above under References; 24590-BOF-3PS-CE01-T0001, Rev. 5, Engineering Specification for Excavation and Backfill; 24590-BOF-3PS-C000-T0001, Rev. 3, Engineering Specification for Material Testing Services. 24590-WTP-PER-CON-02-001, Rev. 5, Installation of Tank Systems and Miscellaneous Unit Systems.	The drawings and Specification for Excavation and Backfill provide specific material to be used under and around the secondary containment foundations and contain placing and backfilling requirements. The Material Testing specifications contain current adequate industry standards for selecting and testing fill materials, and testing not less than once each lift to ensure adequate compaction. Requirements for testing and record keeping are current and adequate for the backfill around and below the secondary containment. Furthermore, the certification of construction by an independent inspector as required per the Installation of Tank System document will ensure that all tank system units including secondary containment structural support and backfill placement comply with the applicable documents.

Information Assessed		Source of Information	Assessment
Infiltration	The design or operation (e.g., diking & curbing) prevents run-on or infiltration of precipitation into the Secondary Containment system unless the collection system has sufficient excess capacity (25 yr rainfall) to contain the run-on precipitation.	Drawings listed above under References; 24590-WTP-DB-ENG-01-001, Rev. 1C, Basis of Design; 24590-PTF-DGC-S13T-00035, Rev. A Secondary Containment for RLD Tanks, (including Engineering Calculation Change Notice, ECCN # 24590-PTF-DGE-S13T-00026, to Rev. A).	The Basis of Design document requires that secondary containment structure shall be capable to contain 100% liquid volume of the largest tank in the group of tanks plus the precipitation from a 25-year, 24-hour rainfall event. The Secondary Containment for RLD Tanks (structural design calculations) and the drawings details show that the secondary containment concrete foundation and walls are adequate to contain the required volume of the liquid waste identified above and will prevent infiltration from external run-ons.
	The design includes an external moisture barrier or other means to prevent moisture from entering the cell.	Drawings listed above under References; 24590-WTP-DB-ENG-01-001, Rev. 1C, Basis of Design.	Drawings show that water stops are installed at the intersection of the berm walls and the foundation slab, which will prevent migration of moisture to and from the secondary containment structure. Furthermore, the Basis of Design document (Section 4.7) states that the groundwater table is more than 250 feet below the ground surface. Therefore, external moisture entering the bermed area is of no concern.
Liner System	The containment area is free of cracks or gaps and the design discusses methods of their minimization.	Drawings listed above under References; Bechtel National, Inc. (BNI) CCN # 126217, RLD Tank Secondary Containment Coating Considerations-Response to IQRPE Questions (T Coutts email message to DC Pfluger, dated Nov. 23, 2005, 10:23 AM); 24590-WTP-3PS-AFPS-TP006, Rev. 1, Engineering Specification for Field Applied Special Protective Coatings for Secondary Containment Areas.	The drawings and BNI CCN # 126217 document identify the Special Protective Coating (SPC) for the inside surfaces of Room P-0150 to be an SC-N material coating system designation as described in the Engineering Specification for Field Applied Special Protective Coatings. This specification also provides details addressing the installation of acceptable approved SPC systems. These details address surface preparation, patching and filler materials for cracks and gaps, and application rules for multi-layer coatings. All these details and methods of installation ensure mitigation of cracks and gaps.

Information Assessed		Source of Information	Assessment
Liner System	The design has considered the compatibility of the concrete liner or coatings and waste and presents information on coatings planning to be used from the manufacturer addressing compatibility with the stored waste. The lining or coating must prevent the waste from migrating into the concrete.	Drawings listed above under References; Bechtel National, Inc. (BNI) CCN # 126217, RLD Tank Secondary Containment Coating Considerations- Response to IQRPE Questions (T Coutts email message to DC Pfluger, dated Nov. 23, 2005, 10:23 AM); 24590-WTP-3PS-AFPS-TP006, Rev. 1, Engineering Specification for Field Applied Special Protective Coatings for Secondary Containment Areas; 24590-WTP-PER-M-02-001, Rev. 3, Material Selections for Building Secondary Containment/Leak Detection; 24590-WTP-PER-J-02-001, Rev. 4, Leak Detection-Sump Level Measurement in Secondary Containment System; 24590-PTF-PER-M-04-0009, Rev. 0, Sump Data for PT Facility Room P-0150; 24590-PTF-3YD-PWD-00001, Rev. 1, System Description for Plant Wash and Disposal System and Radioactive Liquid Waste Disposal System RLD.	The drawings and BNI CCN # 126217 documents identify the Special Protective Coating for the inside surfaces of Room P-0150 to be an SC-N material coating system designation as described in the Engineering Specification for Field Applied Special Protective Coatings document. The Material Selections including the BNI CCN # 126217 document contains adequate and appropriate information on the compatibility of planned secondary containment SPC with the waste. The Engineering Specification for Field Applied Special Protective Coatings provides appropriate selection test criteria used to determine acceptable approved coating systems. The test criteria include chemical resistance endurance requirements and wear abrasion resistance criteria to ensure that the applied SPC system will prevent migration of waste to and protect the secondary containment concrete. Furthermore, the Leak Detection document provides detailed liquid level measurement requirements to monitor any leak directed to and collected in the sump (RLD-SUMP-0003). Specific details of the sump are described in the Sump Data document and as shown on the drawings. The System Description document provides the requirements to monitor the sump level and to pump out any liquid waste within 24 hours of its leak, which also help prevent any migration of waste to the secondary containment concrete.

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Drawings and Documents

Attachment 51 – Appendix 9.8
Low Activity Waste Building
Engineering Calculations

The following drawings have been incorporated into Appendix 9.8 and can be viewed at the Ecology Richland Office. **New drawings are in bold lettering.**

Drawing/Document Number	***Description***
~~24590-LAW-PER-M-02-002, Rev 5~~	~~Flooding Volume for LAW Facility~~
24590-LAW-PER-M-02-002, Rev 6	**Flooding Volume for LAW Facility**
RESERVED	RESERVED

R10680049

Document title: **Flooding Volume for LAW Facility**

Contract number: DE-AC27-01RV14136

Department: Mechanical Systems

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History Sheet

Rev	Date	Reason for revision	Revised by
0	7/16/02	Issued for permitting use.	J. Rewari
1	9/20/02	Revised to include +3 ft elevation and Appendix A	J. Rewari
2	12/05/02	Revised Appendix A	J. Rewari
3	3/27/03	Revised Section 3, Appendix A & Issued for permitting use.	J. Rewari
4	3/23/04	Revised to include +28 ft elevation and remove Melter 3 tankage. Issued for permitting use.	J. Rewari
5	02/08/05	Revised to include changes to -21 and +28 ft elevations.	D.F. Miller
6	05/06/06	Revised to correct inconsistencies between text and appendix A	R. Hanson

Contents

Appendices

Figures

1 Introduction

The Washington Administrative Code, WAC 173-303, requires that secondary containment be designed and operated to contain 100 % of the capacity of the largest tank within its boundary for tank systems containing dangerous waste. This report discusses the assessment of flooding volume that is required to be contained for the low-activity waste vitrification (LAW) facility.

2 Applicable Documents

- WAC 173-303. *Dangerous Waste Regulations*. Washington Administrative Code.

3 Description

3.1 Flooding Volume Description for LAW Facility at −21 Ft Elevation

The only vessel in the LAW facility containing dangerous waste at −21 ft elevation is the C3/C5 drains/sump collection vessel (RLD-VSL-00004). In the event of a line break, vessel failure, or tank overflow, flooding could occur in the cell. The C3/C5 drains/sump collection vessel (RLD-VSL-00004) is in an enclosed C3/C5 cell area, in room L-B001B (C3/C5 drain collection cell).

To conservatively calculate the available area of the cell where the flooding volume could leak, the largest cross-sectional area of the vessel is subtracted from the cross-sectional area of the rectangular cell. The required height of the liner is equal to the flooding volume divided by the available cross-sectional area of the room.

In order to calculate the minimum height of C3/C5 drain collection cell (room L-B001B) stainless steel liner, the following 2 scenarios are considered.

a Leakage and spillage of the C3/C5 drains/sump collection vessel (RLD-VSL-00004) when the total volume of fluid contained in the vessel is discharged into the cell. The flooding volume is the larger of 110 % (used as a conservative criteria) of the maximum operating volume of the largest vessel, or 100 % of the total volume of the largest vessel. The vessel total volume is defined as internal volume of the vessel including the shell and both heads. The total vessel volume of 1034 ft^3 is greater than 110 % of the maximum operating volume. Fire sprinklers are provided in this cell; therefore, 246 ft^3 of fire water from 20 minutes of sprinklers in the cell is added to the flooding volume. Thus, 1280 ft^3 is the total volume used for calculating the cell liner height. Minimum liner height required for this case is 3.4 ft.

b The vessel is full and intact so only fire water runoff from higher elevation floor drains is considered for the flooding volume. This scenario is based on the design of the LAW facility systems and uses a conservative volume of water for calculation of the liner height, almost 3 times the volume required in WAC 173-303. As shown in Figure 1, several of the LAW facility floor drains, sumps, and overflow lines drain to the C3/C5 drains/sump collection vessel (RLD-VSL-00004). In the event of a fire, the fire water would collect on the higher elevations and drain to the tank. Since the tank is full and not leaking in this scenario, fire water would flow out of the tank and into the cell via the overflow nozzle. The fire area used in this scenario is the largest design requirement for the LAW facility. Volume of 30 minutes of fire water outside of the cell is calculated to be 21,420 gallons or 2864 ft^3. Minimum liner height required for this case is 9.3 ft.

Based on these scenarios, the cell is lined with stainless steel plates to a minimum height of 9.3 ft. The calculation for the volume of fire water includes a safety factor of 1.4 for conservatism and to compensate for construction tolerances. The largest cross-sectional area of the vessel is used to conservatively calculate the cross-sectional area of the rectangular cell, even though the cross-sectional area of the vessel at the bottom is much smaller. Additionally, the actual liner height will be rounded up to the next half-foot.

3.2 Flooding Volume Description for LAW Facility at +3 Ft Elevation

LAW facility has the following vessels, containing dangerous waste, in the process cells, and effluent cell rooms, at +3 ft elevation:

Process Cell Room L-0123

LCP-VSL-00001	melter 1 concentrate receipt vessel
LFP-VSL-00001	melter 1 feed preparation vessel
LFP-VSL-00002	melter 1 feed vessel
LOP-VSL-00001	melter 1 submerged bed scrubber (SBS) condensate vessel
LOP-WESP-00001	melter 1 wet electrostatic precipitator (WESP)
LOP-SCB-00001	melter 1 SBS

Process Cell Room L-0124

LCP-VSL-00002	melter 2 concentrate receipt vessel
LFP-VSL-00003	melter 2 feed preparation vessel
LFP-VSL-00004	melter 2 feed vessel
LOP-VSL-00002	melter 2 SBS condensate vessel
LOP-WESP-00002	melter 2 WESP
LOP-SCB-00002	melter 2 SBS

Effluent Cell Room L-0126

RLD-VSL-00003	plant wash vessel
RLD-VSL-00005	SBS condensate collection vessel

3.2.1 Process Cells

The process cells have 6 vessels in each cell. Both process cells are identical in size and contain a similar set of vessels.

For calculating the minimum height of stainless steel liners for process cell rooms L-0123, and L-0124, the following scenario is considered:

The total volume of fluid contained in the largest vessel is discharged by leakage or spillage into the cell.

To conservatively calculate the available area of the cell where the flooding volume could leak, the largest cross-sectional area of each of the vessels are subtracted from the cross-sectional area of the rectangular cell. The required height of the liner is equal to the flooding volume divided by the available cross-sectional area of the room.

The liners are sized to hold 100 % of the total volume of the largest vessel or 110 % of its maximum operating volume, whichever is greater. In all cases, the total volume is used because this is larger than 110 % of the volume up to the overflow nozzle.

The largest vessel in each cell is the concentrate receipt vessel, (LCP-VSL-00001, -00002), and the total volume for each is 2428 ft^3. This is the volume used for calculating the process cell room (L-0123 and L-0124) liner height. The available cross-sectional area of the room into which the liquid could flow is calculated to be 1279 ft^2. The liner height is calculated by dividing the volume of the largest vessel (2428 ft^3) by the available area of the room (1279 ft^2).

The minimum liner height required for each process cell is 1.9 ft. Conservative values for the vessel volume are used in the calculation of the liner height by using the volume of the vessel without subtracting the volume of the internal equipment. The largest cross-sectional area of the vessel is used to conservatively calculate the cross-sectional area of the rectangular cell, even though the cross-sectional area of the vessel at the bottom is much smaller. Additionally, the actual liner height will be rounded up to the next half-foot.

3.2.2 Effluent Cell

Effluent cell room L-0126 has 2 vessels in it. Both vessels are identical in size. Using the same method as for the process cells, the total volume of each of these vessels is 3445 ft^3. The available cross-sectional area of the room into which the liquid could flow was calculated to be 799 ft^2. The liner height is calculated by dividing the volume of the largest vessel (3445 ft^3) by the available area of the room (799 ft^2).

The minimum liner height required for effluent cells is 4.4 ft. Conservative values for the vessel volume are used in the calculation of the liner height by using the volume of the vessel without subtracting the volume of the internal equipment. The largest cross-sectional area of the vessel is used to conservatively calculate the cross-sectional area of the rectangular cell, even though the cross-sectional area of the vessel at the bottom is much smaller. Additionally, the actual liner height will be rounded up to the next half-foot.

3.3 Flooding Volume Description for LAW Facility at +28 Ft Elevation

LAW facility has the following tank, containing dangerous waste, at +28 ft elevation:

Caustic Scrubber Blowdown Pump Room, Room L-0218

LVP-TK-00001 caustic collection tank

3.3.1 Room L-0218

Caustic Scrubber Blowdown Pump Room, Room L-0218, at elevation +28 contains the caustic collection tank (LVP-TK-00001). The tank sets on a 6" high octagonal pedestal. Also located in this room are 4 pumps on individual pedestals. The room's concrete walls with special protective coating are provided to contain liquid in case of leakage. For simplicity, these walls will be referred to as the "secondary containment".

For calculating the minimum height of the secondary containment walls, the following scenario is considered:

The total volume of the fluid contained in the tank is discharged by leakage or spillage in to the secondary containment. In addition to this, if there is a fire in the area during this event, the automatic fire protection sprinkler system will activate and add fire protection water to the fluid discharged from the tank. Therefore, the secondary containment wall is sized to handle the volume of the fire protection water from the sprinkler system over the design area for a period of 20 minutes in addition to the 100% capacity of the tank.

To calculate the minimum secondary containment wall height, the available volume of the room and the volume of fire water must also be calculated; altogether, the calculation is done in four steps.

Step 1: Calculate the volume of available secondary containment up to 6". This step excludes the 6" tank pedestal and the 4-6" pump pedestals from the available area.

Step 2: Calculate the volume of available secondary containment from 6" to 2'- 5 1/4". This excludes the area above the 4 pump pedestals to the height of the pump discharge. This area is conservatively considered unavailable for the pumps themselves.

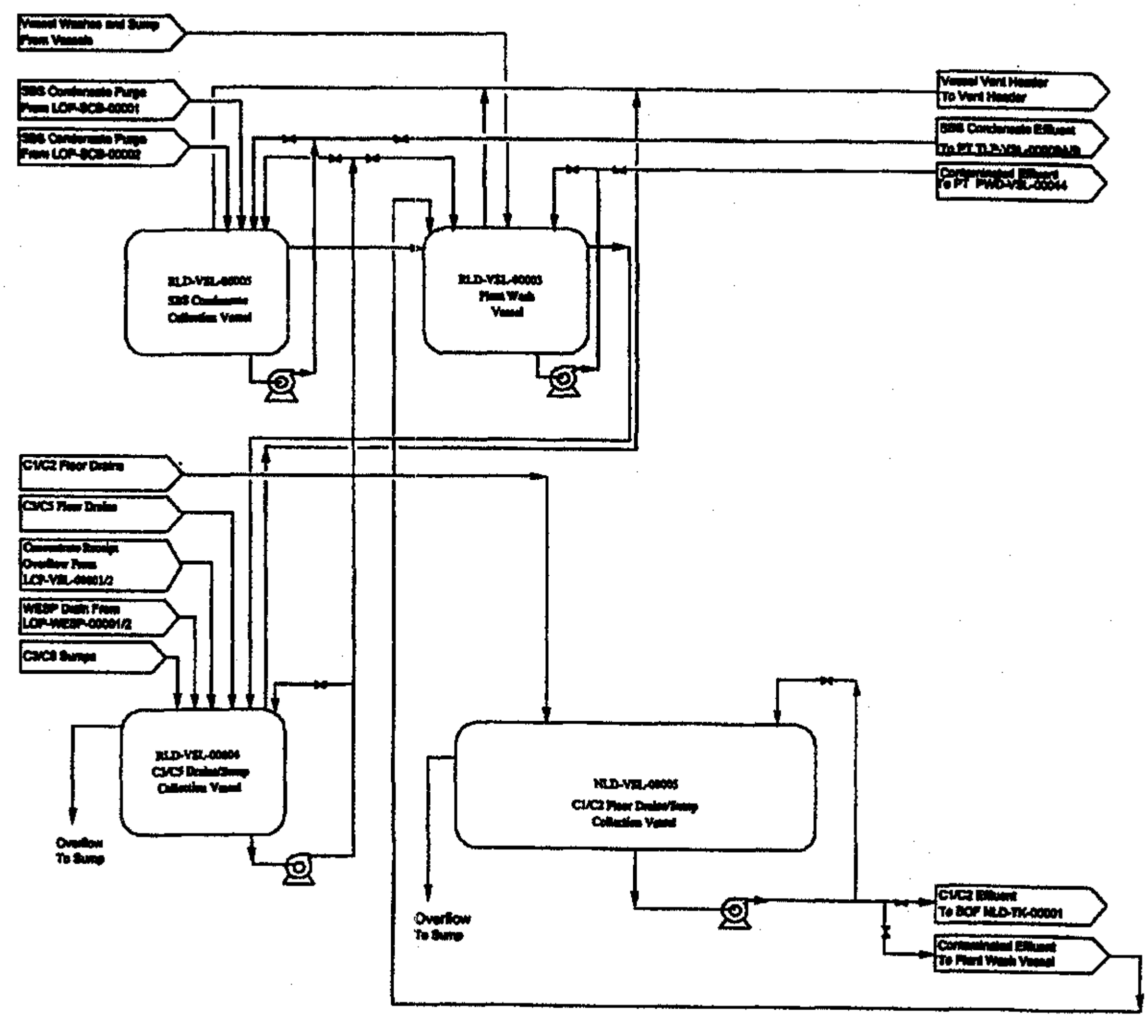
Step 3: Calculate the additional height of the secondary containment wall (above the first 2' - 5 1/4") required to accommodate the remaining total tank volume: (Volume of the tank minus the volume calculated in Steps 1 and 2) divided by the area of the room.

Step 4: Calculate the volume of 20 minutes of fire water from the sprinkler system, multiplied by a safety factor of 1.4. Calculate the height of the secondary containment wall for fire water by dividing the volume of fire water by the area of the room.

The secondary containment wall height required is then: 2' - 5 1/4" (Steps 1 and 2) plus additional height of the wall (Step 3) plus height required for fire water (Step 4).

The minimum secondary containment wall height required for this room is 4 ft.

Figure 1 LAW Effluent General Flow Diagram



Appendix A

Calculation of Volume and Liner Height

Appendix A: Calculation of Volume and Liner Height

1 Purpose

The purpose of this calculation is to size the height of the liners in the process cells for LAW vitrification facility at elevation −21 ft and elevation +3 ft. C3/C5 drains/sump collection vessel (RLD-VSL-00004) room L-B001B is shown at elevation −21 ft on drawing 24590-LAW-P1-P01T-P0001 (*LAW Vitrification Building General Arrangement Plan at El. −21' 0"*). Process cell rooms L-0123 and L-0124 and effluent cell room L-0126 on elevation +3 ft are shown on drawing 24590-LAW-P1-P01T-P0002 (*LAW Vitrification Building General Arrangement Plan At El 3' 0"*).

Additionally, this calculation will size the height of the secondary containment with protective coating required for the caustic scrubber blowdown pump room, Room L-0218 on elevation +28. This room is shown on drawing 24590-LAW-P1-P01T-P0004 (*LAW Vitrification Building General Arrangement Plan At El 28' 0"*).

2 Criteria and Design Input

2.1 Process and Effluent Cell Liner Height

To provide the worst case scenario, the vessels are conservatively assumed to be completely filled (including the top head) and sitting on the floor, and that the largest vessel total volume is used as the volume in determining the liner height. To allow for the worst case scenario, the volume of the vessel is assumed to leak completely onto the floor.

The liners are sized to hold 100 % of the total volume of the largest tank or 110 % of its maximum operating volume, whichever is larger. In all cases, the total volume is used because this is larger than 110 % of the volume up to the overflow nozzle.

In the case of C3/C5 drain collection cell (room L-B001B, El. (-) 21), 2 scenarios are considered: namely, leakage and spillage of the C3/C5 drains/sump collection vessel (RLD-VSL-00004), and collection of fire water from higher elevation floor drains when the vessel is full.

In the case of the process cells and the effluent cells, the largest vessel total volume is used as the volume in determining the liner height.

The following vessels are contained within the process and effluent cells.

LCP-VSL-00001	melter 1 concentrate receipt vessel	Room L-0123	El. +3'
LCP-VSL-00002	melter 2 concentrate receipt vessel	Room L-0124	El. +3'
LFP-VSL-00001	melter 1 feed preparation vessel	Room L-0123	El. +3'
LFP-VSL-00002	melter 1 feed vessel	Room L-0123	El. +3'
LFP-VSL-00003	melter 2 feed preparation vessel	Room L-0124	El. +3'
LFP-VSL-00004	melter 2 feed vessel	Room L-0124	El. +3'

RLD-VSL-00003	plant wash vessel	Room	L-0126	El. +3'
RLD-VSL-00005	SBS condensate collection vessel	Room	L-0126	El. +3'
LOP-VSL-00001	melter 1 SBS condensate vessel	Room	L-0123	El. +3'
LOP-SCB-00001	melter 1 SBS vessel	Room	L-0123	El. +3'
LOP-VSL-00002	melter 2 SBS condensate vessel	Room	L-0124	El. +3'
LOP-SCB-00002	melter 2 SBS vessel	Room	L-0122	El. +3'
LOP-WESP-00001	melter 1 WESP	Room	L-0123	El. +3'
LOP-WESP-00002	melter 2 WESP	Room	L-0124	El. +3'

Location and size of the C3/C5 drain collection cell (room L-B001B) is based on drawing 24590-LAW-P1-P01T-P0001 (*LAW Vitrification Building General Arrangement Plan at El. -21' 0"*). Location and size of process rooms L-0123, and L-0124 and effluent room L-0126, at elevation 3 ft are shown on drawing 24590-LAW-P1-P01T-P0002 (*LAW Vitrification Building General Arrangement Plan at El. 3' 0"*).

For the C3/C5 drain collection cell (room L-B001B), the fire protection system fire water runoff from higher elevation floor drains has been calculated on the basis of 3000 ft^2 of fire area. The density of the fire water spray is 0.17 gal/min/ft^2, for 30 minutes and multiplied by a safety factor of 1.4.

2.2 Secondary Containment Wall Height

The caustic collection tank (LVP-TK-00001) is located in the caustic scrubber blowdown tank room L-0218 at elevation +28'-0". The containment wall is sized to handle the volume of fire-protection water from the fire protection system over the design area for a period of 20 minutes in addition to the 100% capacity (or total volume) of the tank. The fire protection water automatic sprinkler design density is 0.17 gpm/sq. ft. Location and size of room L-0218 at elevation +28 ft is shown on drawing 24590-LAW-P1-P01T-P0004 (*LAW Vitrification Building General Arrangement Plan at El. 28' 0"*).

3 Assumptions

None.

4 Methodology

As stated above in the criteria and design input section, to calculate for worst case, the calculation methodology assumes that the vessels are completely filled and sitting on the floor and that the largest tank leaks completely into the room. For the C3/C5 drain collection cell (room L-B001B), the maximum leakage volume to the cell is fire water input from higher elevation floor drains to a filled C3/C5 drains/sump collection vessel (RLD-VSL-00004).

4.1 Basic Equations

$\pi = 3.14$
Area of a Rectangle = Length x Width
Area of Circle $= \pi \frac{D_i^2}{4}$
Volume of Cylinder= $\frac{\pi}{4} \cdot D_i^2 \cdot h$
Volume of Rectangular Room = Length x Width x Height

Area of a Regular Polygon = 1/2 x a x p (where a = apothem and p = perimeter)
Volume of Firewater = Area of Room x fire water spray density x 20 minutes x 1.4 safety factor

4.2 Room Dimension Equations and Symbology

L = length of room (ft)

W = width of room (ft)

H = height of room (ft)

A = area of room (ft^2)

4.3 Volume Calculation

Volume of a vessel or tank is calculated by using the following equations:

$$V_s = \frac{\pi * D_i^2}{4} * L_{T-T}$$

where:

V_s = volume of the cylindrical portion of the vessel or tank

D_i = inside diameter

L_{T-T} = tangent to tangent length

Volume (V_h) of 1 F&D (flanged and dished) head is calculated using the following equation:

$$V_h = 0.0847 * D_i^3$$
$$d = 0.162 * D_i$$

d is the depth of the F&D head

Refer to *Pressure Vessel Design Manual* (Moss, 1987).

Volume (V_c) of conical head is calculated using the following equation:

$$V_c = (1/3)*\{(\pi/4)*(D_i)^2\}*d$$

d is the height of the conical head

The total volume of the vessel or tank = volume of the cylindrical portion + volume of top head + volume of bottom.

4.4 Available Area for Liquid Containment

a) For Cells:

To calculate the possible area that the liquid in the vessel could leak into, the sum of the cross sectional areas of the vessels is subtracted from the cross sectional area of the room.

Area available = area of the room minus sum of the cross sectional areas of the vessels (ft^2)

The height of liner is equal to the volume of the largest vessel divided by the available area of room. This excludes the cross sectional area of the leaking vessel.

Height of the liner (ft) = volume of the largest vessel / area available

b) For Room L-0218:

Room L-0218 contains 4 pumps and 1 tank. To calculate the possible area that the liquid could leak into, the available volume of the room and the volume of the firewater must be calculated. This is done in four steps, calculating available volume by height.

1. Available volume up to 6" excluding pump and tank pedestals.
2. Available volume from 6" to 2'- 5 1/4" excluding area above pump pedestals to the height of the pump discharge.
3. Calculate additional height required to accommodate the remaining total tank volume. Volume of the tank minus the volume calculated in steps 1 and 2 divided by the area of room.
4. Calculate the volume of 20 minutes of firewater from the sprinklers multiplied by safety factor of 1.4. Calculate the height of the containment wall for fire water by dividing the volume of firewater by the area of the room.

The secondary containment wall height required is then: 2' - 5 1/4" (Steps 1 and 2) plus additional height of the wall (Step 3) plus height required for fire water (Step 4).

5 Calculations

Complete calculations for the liner height are as follows for each individual cell:

5.1 C3/C5 Drain Collection Cell, Room L-B001B, Elevation −21 ft

Vessel Number	Diameter (D_1) ft	L_{T-T} ft	Head Type (Flange and Dished)	Total Height (including bottom and top head) ft	Remark
RLD-VSL-00004	10	11	F&D (bottom and top)	14.24	

Volume of RLD-VSL-00004 = volume of cylindrical portion + volume of heads = 1034 ft^3

Two scenarios are considered:

a Collection of fire water runoff when the vessel is full and intact with a safety factor of 1.4

b Leakage and spillage of the C3/C5 drains/sump collection vessel RLD-VSL-00004

5.1.1 Calculations

A Volume of fire water runoff from higher elevation floor drains will flow into the vessel, and if the vessel is already full, water will overflow into the room (L-B001B). The calculation for the liner height is based on the 3000 ft^2 of fire area with 0.17 gal/min/ft^2 of fire water spray density for 30 minutes multiplied by a safety factor of 1.4.

Volume of fire water = 3000 $ft^2 \times 0.17$ gal/min/$ft^2 \times 30$ minutes $\times 1.4$ = 21,420 gallons = 2864 ft^3
Area of the room available = $(16.58 \times 23.33) - \pi/4 \times (10)^2 = 309$ ft^2
Liner height required = 2864/309= 9.3 ft

B If only the vessel fails (including 20 minutes of fire water from the in cell sprinkler system, multiplied by a safety factor of 1.4), and there is no fire water runoff from higher elevation floor drains, then the liner height is calculated as follows: (total area of the cell, including vessel cross-sectional area is used)

Total volume of vessel RLD-VSL-00004 (using formula given in 4.32 above)
= Volume of the cylindrical portion + volume of top head + volume of bottom
= $[\pi/4 \times (10)^2 \times 11] + [0.0847 \times (10)^3] + [0.0847 \times (10)^3]$
= 863.94 + 84.7 + 84.7 = 1033.34, rounded to 1034 ft^3
Area of the room = $(16.58 \times 23.33) = 387$ ft^2
Volume of fire water from in cell sprinkler system
= Area of room x fire water spray density x 20 minutes x 1.4 safety factor
= 387 ft^2 x 0.17 gal/min/ft^2 x 20 min x 1.4 = 1842 gal = 246 ft^3
Liner height required = (1034 + 246)/387 = 3.31 ft, rounded up to 3.4 ft

Thus, based on the calculation in section A, the minimum required liner height is 9.3 ft.

5.2 Melter 1 and 2 Process Cells, Rooms L-0123 and L-0124, Elevation +3 ft

The dimensions of these vessels are as follows:

Room Number	Vessel Number	Diameter (D_i) ft	L_{T-T} ft	Head Type	Total Height (including bottom and top head) ft	Remark
L-0123	LCP-VSL-00001	14	12.75	F&D (bottom and top)	17.29	Largest vessel in the room
	LFP-VSL-00001	11	10.46	F&D (bottom and top)	14.02	
	LFP-VSL-00002	11	10.46	F&D (bottom and top)	14.02	
	LOP-VSL-00001	12	8.12	F&D (bottom and top)	12	
	LOP-WESP-00001	7	17	F&D (bottom and top)	19	
	LOP-SCB-00001	10	6.5	F&D (bottom and top)	9.74	
L-0124	LCP-VSL-00002	14	12.75	F&D (bottom and top)	17.29	Largest vessel in the room
	LFP-VSL-00003	11	10.46	F&D (bottom and top)	14.02	
	LFP-VSL-00004	11	10.46	F&D (bottom and top)	14.02	
	LOP-VSL-00002	12	8.12	F&D (bottom and top)	12	
	LOP-WESP-00002	7	17	F&D (bottom and top)	19	
	LOP-SCB-00002	10	6.5	F&D (bottom and top)	9.74	
	*					

Volume of largest vessel from table above = volume of cylindrical portion + volume of heads
$= [\pi/4 \times (14)^2 \times 12.75] + [0.0847 \times (14)^3] + [0.0847 \times (14)^3]$
$= 1962.71 + 232.41 + 232.41 = 2428\ ft^3$

Area of the room available $= (38.33 \times 48.33) - [\pi/4 \times \{(7)^2 + (11)^2 + (12)^2 + (10)^2 + (11)^2 + (14)^2\}]$
$= 1279\ ft^2$
(Area of the leaking vessel was also subtracted for conservatism.)

Liner height required = 2428/1279 = 1.9 ft

* Melter 3 room and tankage deleted from table.

5.3 Effluent Cell Calculations, Room L-0126, Elevation +3

Room Number	Vessel Number	Diameter (D_i) ft	L_{T-T} ft	Head Type	Total Height (including bottom and top head) ft	Remark
L-0126	RLD-VSL-00003	16	14.66	Flat top and F&D bottom	18	Both vessels in this room

	RLD-VSL-00005	16	14.66	Flat top and F&D bottom	18	

Volume of the largest vessel from above table
= volume of the plant wash/SBS condensate collection vessel (RLD-VSL-00003/RLD-VSL-00005)
= volume of cylindrical portion + volume of F&D bottom + volume of flat head (cylindrical) portion
= $[\pi/4 \times (16)^2 \times 14.66] + [0.0847 \times (16)^3] + [\pi/4 \times (16)^2 \times \{18 - 14.66 - (0.162 \times 16)\}]$
= 2947.57 + 346.93 + 150.39
= 3445 ft^3

Area of the room available = $(38.33 \times 31.33) - [\pi/4 \times \{(16)^2 + (16)^2\}] = 799\ ft^2$
(Area of the leaking vessel was also subtracted for conservatism.)

Liner height required = 3445 / 799 = 4.32 ft, round up to 4.4 ft

5.4 Caustic Scrubber Blowdown Pump Room, Room L-0218, Elevation + 28

Room Number	Tank Number	Diameter (D_i) ft	$L_{T\text{-}T}$ ft	Head Type	Total Height (including top head) ft	Remark
L-0218	LVP-TK-00001	13	14.32	Flat bottom and conical top with 1: 6 slope	15.41	d = height of conical head portion $d = (D_i/2) \times (1/6)$ (due to 1:6 slope)

Volume of the tank from above table
= Volume of the caustic collection tank (LVP-TK-00001)
= Volume of cylindrical portion + volume of conical head portion
= $[\pi/4 \times (13)^2 \times 14.32] + [1/3 \times \pi/4 \times (13)^2 \times \{1.08\}]$
= 1899.76 + 47.76
= 1948 ft^3

Dimensions of the pump pedestals, 4 each, are as follows:
5.0 ft by 1.83 ft

Step 1: The secondary containment area has a 0.5 ft high octagonal pedestal for the tank and the distance between the parallel sides of the pedestal is 15 ft. Each side of this octagonal pedestal is 6.21 ft.

Using the equation for a regular polygon:
The area of the tank pedestal is = $1/2 \times 7.5 \times 8 \times 6.21 = 186\ ft^2$

The area of Room L-0218 can be calculated by dividing the room into three rectangles. Refer to the general arrangement drawing for elevation +28 (see References).

The area of the room available for secondary containment up to 0.5 ft height is

= {Area of the room} – {cross sectional area of pump pedestals} – {cross sectional area of the tank pedestal)
= {(9.19 × 21.25) + (15.25 × 22.33) + (5.35 × 19.25)} – {4(5 × 1.83)} – {186.42}
= {(195.29) + (340.53) + (102.99)} – {36.60} – {186.42}
= 638.81 – 36.60– 186.42 = 415.79 ft^2
Volume of liquid contained by 6" high containment wall = 415.79 × 0.5 = 207.90 ft^3

Step 2: Calculate the volume of available secondary containment from 6" to 2'- 5 1/4" (the height of the pump discharge). This excludes the area above the 4 pump pedestals to the height of the pump discharge.

= {(Area of Room) - (Cross sectional area of pump pedestals)} × {height of containment wall}
= {(638.81) – (36.60)} × {1.94}
= 1168.29 ft^3

Total volume of liquid contained by 2' - 5 1/4" high containment wall = 207.90 + 1168.29 = 1376.19 ft^3

Step 3: The height of wall required to accommodate the remaining total tank volume (above the first 2' - 5 1/4"):
= {(Volume of the Tank) – (1376.19)} / {Area of the room}
={(1949.97) – (1376.19)} / {638.81}
= 573.78 / 638.81 = 0.9 ft.

Step 4: If there is fire in the area during this event and the fire water sprinklers activate, the volume of water added to the secondary containment will be based on the fire water spray density of 0.17 gal/min/ft^2 for 20 minutes multiplied by a safety factor of 1.4.

Volume of fire water = Area of containment in ft^2 × 0.17 gal/min/ft^2 × 20 minutes × 1.4
= 638.81 ft^2 × 0.17 gal/min/ ft^2 × 20 minutes × 1.4
=3040.74 gallons = 406.49 ft^3

Therefore, additional height of containment wall required to accommodate firewater volume
= Volume of firewater / {Area of the room}
= 406.49 / 638.81 = 0.64 ft

Therefore containment wall height required = 2.44 + 0.9 + 0.64 = 3.98 rounded off to 4 ft.

6 Summary

The minimum required liner heights using the method above for the rooms are as follows:

Table of Liner Height			
Cell	Room Number	Minimum Liner Height	Liner Height Rounded Up to Nearest Half Foot
C3/C5 Drain Collection Cell	L-B001B	9.3 ft	9.5 ft
M1 Process Cell	L-0123	1.9 ft	2.0 ft
M2 Process Cell	L-0124	1.9 ft	2.0 ft
Effluent Cell	L-0126	4.4 ft	4.5 ft

Table of Secondary containment Wall Height with Special Protective Coating			
Room	Room Number	Minimum Wall Height	Wall Height Rounded Up to Nearest Half Foot
Caustic Scrubber Blowdown Pump Room	L-0218	3.98 ft	4 ft

7 References

24590-LAW-P1-P01T-P0001, *LAW Vitrification Building General Arrangement Plan at El. -21'0"* Rev. 2

24590-LAW-P1-P01T-P0002, *LAW Vitrification Building General Arrangement Plan at El. 3'0"* Rev. 3

24590-LAW-P1-P01T-P0004, *LAW Vitrification Building General Arrangement Plan at El. 28'0"* Rev. 1

Moss, Dennis R. 1987. *Pressure Vessel Design Manual*, Gulf Publishing Co.

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Drawings and Documents

Attachment 51 – Appendix 9.9
Low Activity Waste Building
Material Selection Documentation

The following drawings have been incorporated into Appendix 9.9 and can be viewed at the Ecology Richland Office. See Appendix 7.9 for material selection documentation common to the Pretreatment, LAW, HLW, and Laboratory buildings. **New drawings are in bold lettering.**

Drawing/Document Number	*Description*
~~24590-LAW-N1D-LCP-P0001, Rev 0~~	~~Material Selection Data Sheet for LCP-VSL-00001/2~~
24590-LAW-N1D-LCP-P0001, Rev 1	**Material Selection Data Sheet for LCP-VSL-00001/2**
24590-LAW-N1D-LFP-P0004, Rev 0	Material Selection Data Sheet for LFP-VSL-00001/2/3/4
~~24590-LAW-N1D-LOP-P0001, Rev 0~~	~~Material Selection Data Sheet for LOP-SCB-00001/2~~
24590-LAW-N1D-LOP-P0001, Rev 1	**Material Selection Data Sheet for LOP-SCB-00001/2**
~~24590-LAW-N1D-LOP-00002, Rev 0~~	~~Material Selection Data Sheet for LOP-VSL-00001/2/3~~
24590-LAW-N1D-LOP-00002, Rev 1	**Material Selection Data Sheet for LOP-VSL-00001/2/3**
24590-LAW-N1D-LOP-P0003, Rev 0	Material Selection Data Sheet for LOP-WESP-00001/2
24590-LAW-N1D-LOP-P0004, Rev 0	Material Selection Data Sheet: LOP Offgas piping (downstream of film cooler to SBS entry)
24590-LAW-N1D-LVP-P0002, Rev 0	Material Selection Data Sheet for LVP-TK-00001
24590-LAW-N1D-RLD-P0001, Rev 1	Material Selection Data Sheet for RLD-VSL-00004
24590-LAW-N1D-RLD-P0002, Rev 0	Material Selection Data Sheet for RLD-VSL-00005
24590-LAW-N1D-RLD-P0005, Rev 0	Material Selection Data Sheet for RLD-VSL-00003
RESERVED	RESERVED

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10668000

LCP-VSL-00001 & LCP-VSL-00002 (LAW)
LAW Concentrate Receipt Vessel

- Design Temperature (°F)(max/min): 150/40
- Design Pressure (psig) (max/min): 15/FV
- Location: process cell

Offspring items
LCP-AGT-00001 -- LCP-AGT-00002

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Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Cannot be maintained during the 40 year design life.

Options Considered:

- The vessel is filled with waste at up to 122°F.
- The vessel will be washed with process water or caustic.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch general erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.
- Develop lay-up strategy.

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1	3/14/06	Issued for Permitting Use	[signature]	HMK	[signature]
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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Vessels receive waste for melter feed. Operating temperature range is 77 to 150°F, with a nominal operating temperature of 122°F, and operating pH range is 11 to 14.5. Spray nozzles are present to spray inside of vessel with demineralized water. NaOH is also available to the spray nozzles. Vessels have mechanical agitators and internal transfer pumps.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He also states 316 (and 316L) has a rate of less than 2 mpy in 50% NaOH at temperatures up to 122°F. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. The corrosion rate for 304L in pure NaOH is expected to be less than about 1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect due to the presence of oxidizing agents.

In this system, the normal pH, nitrate concentrations and temperatures are such that 304L and 316L stainless steels will be acceptable.

Conclusion:
304L or 316L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting of stainless steels and related alloys in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices such as might form after partial removal of deposits during multiple rinse cycles. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media.

The nominal operating temperature for these vessels is 122 °F. At this temperature, 304L or 316L stainless steels would be acceptable in the proposed alkaline-nitrate waste.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, probably because residual chlorides are likely to remain.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated, if caused by chlorides, using alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 316L is expected to be satisfactory.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable to this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, the environment and also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140 °F. With the proposed temperatures, 316L is recommended.

Conclusion:
At the normal operating conditions, 316L stainless is the minimum recommended.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system under normal operating conditions.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are not conducive to microbial growth.

Conclusion:
Not a concern.

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion will be a function of the degree of agitation, solution chemistry, and temperature. Under the stated conditions, and with the presence of wash rings in the vessel, vapor phase corrosion does not appear to be a concern.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be small. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with solids content less than 27.3 wt%.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
At this time, the design does not provide for the presence of nitric acid reagent in this system.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, in "Metals Handbook", ASM International, Metals Park, OH 44073
4. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
6. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
7. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

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4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084
8. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) LAW concentrate receipt vessel (LCP-VSL-00001, LCP-VSL-00002)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.87E+01	3.63E+01			
Chloride	g/l	1.84E+01	2.00E+01			
Fluoride	g/l	1.84E+01	2.01E+01			
Iron	g/l	2.84E+00	2.90E+00			
Nitrate	g/l	2.73E+02	2.69E+02			
Nitrite	g/l	8.22E+01	6.93E+01			
Phosphate	g/l	5.93E+01	6.30E+01			
Sulfate	g/l	3.16E+01	3.43E+01			
Mercury	g/l	9.46E-02	3.16E-02			
Carbonate	g/l	1.29E+02	1.11E+02			
Undissolved solids	wt%	5.0%	4.6%			
Other (Pb)	g/l	6.69E-01	2.94E-02			
Other	g/l					
pH	N/A					Note 2
Temperature	°F					Note 3, Note 4

List of Organic Species:

References

System Description: 24590-LAW-3YD-LCP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: TCP03/LCP01
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-LAW-M6-LCP-P0001, 24590-LAW-M6-LCP-P0002, Rev 1
PFD: 24590-LAW-M5-V17T-P0001, -P0002, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. pH 11 to 14.5 (24590-WTP-M4C-V11T-00005, Rev A)
3. T operation 77 °F to 150 °F, T nominal 122 °F(24590-LAW-MVC-LFP-00001, Rev C)
4. The 150 F is maximum temperature from pretreatment and no additional design margin is required.

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

6.1.1. LAW Concentrate Receipt Vessels (LCP-VSL-00001 and LCP-VSL-00002)

Routine Operations

LAW concentrate receipt vessels (CRV) are designed for receiving waste for melter feed. The equipment associated with the CRVs that promote decontamination and decommissioning includes:

- The internal spray nozzles that spray the inside of the vessel with demineralized water
- Flushing the inside of the vessel with demineralized water (from spray nozzles or transfer from the PT facility) draining of the vessel heel, use of other decontamination solutions (NaOH and so on) through header connections to the spray nozzles during final decontamination and decommissioning

Each LAW CRV is equipped with the following:

- Mechanical agitator (LCP-AGT-00001, -00002)
- Two 100 % pumps (LCP-PMP-00001A/B, -00002A/B) to transfer LAW concentrate
- Internal rotary spray nozzles for periodic wash-down
- Overflow to RLD-VSL-00004, C3/C5 drains/sump collection vessel via a common overflow header
- Pressure, level (redundant), temperature, and density instruments

Non-Routine Operations that Could Affect Corrosion/Erosion

- Overflows to RLD-VSL-00004
- Washing required on failure of agitator

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10672008

LOP-SCB-00001 & LOP-SCB-00002 (LAW)
Melter 1 and Melter 2 Submerged Bed Scrubbers (SBS)

- Design Temperature (°F)(max/min): 237/41
- Design Pressure (psig) (max/min): 15/FV
- Location: process cell

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Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operation at pH 3 at the normal operating temperature
- Normal operation at pH 8 at the normal operating temperature
- Vessel is at pH 3 and the temperature reaches 167°F due to loss of cooling jacket function

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64		X
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: Hastelloy C-22 or the equivalent; packing is a ceramic

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop lay-up strategy

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PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Offgas from the film cooler at a nominal temperature of 572 °F is directed into the SBS column vessel for cooling and solids removal. A cooling jacket located on the outside of the scrubber vessel maintains the required temperatures. Loss of cooling jacket function could allow the solution temperature to rise as high as 167 °F.

a General Corrosion
Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy; C-22 has a corrosion rate of about 75 mpy. While the anticipated pH in this case is higher, there are regions in the system where the pH is low or where there could be excess fluoride without the presence of aluminum. Consequently, corrosion resistant alloys such as Hastelloy C-22 will be required.

The dissolution rate of the ceramic components in the proposed environment is unknown. However, data from Clark and Zoitos (1992) suggest Al_2O_3, SiC, and ZrO_2 ceramics will have little reactivity in the proposed solutions. The effect of fluoride and the varying temperatures is unclear but the uniform corrosion rate is expected to be larger.

Conclusion:
Hastelloy C-22 or the equivalent is recommended to protect the regions in the scrubber that are exposed to excessive temperatures and concentrations. A high-fired alumina, silicon carbide (reaction bonded and with no free silicon), or zirconia is expected to be a suitably resistant ceramic for the packing.

b Pitting Corrosion
Chloride is known to cause pitting of stainless steels and related alloys in acid and neutral solutions. Normally the vessel is to operate at 113°F at a pH of 3 to 8. Furthermore, the temperature could rise to about 167°F in the case of loss of cooling jacket function. Data from Phull et al (2000) imply that with these conditions, Hastelloy C-22 or equivalent will be needed as a minimum.

Further, if the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain. Pitting is less likely for the higher alloys such as C-22.

Conclusion:
Hastelloy C-22 or equivalent is recommended.

c End Grain Corrosion
End grain corrosion only occurs in concentrated acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, the environment, and because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. For the proposed conditions, Hastelloy C-22 or equivalent is required because of its greater resistance to SCC.

Conclusion:
Because of the normal operating environment as well as that which can occur during off normal conditions, the minimum alloy recommended is Hastelloy C-22.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
It is expected that the heat tint will be removed during normal operation.

Conclusion:
Weld corrosion is not considered a problem for this system.

PLANT ITEM MATERIAL SELECTION DATA SHEET

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth. The system is downstream of the main entry points of microbes and the air streams are heated to over 500°F.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern. The pressures encountered are so low and the strength of the material is so comparatively high that corrosion fatigue is not a problem.

Conclusions
Should not be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is expected the region will be sufficiently washed to prevent solids deposits.

Conclusion:
Vapor phase corrosion is not believed to be of concern.

j Erosion
Velocities within the vessel are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not believed to be of concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No metal/metal contacting surfaces expected.

Conclusion:
Not believed to be of concern.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not believed to be of concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
At this time, the design does not provide for the presence of nitric acid reagent in this system. Additionally, the scrubbers see low pH under normal operating conditions.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
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4 Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218.
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
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4. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
5. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
7. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
8. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
9. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
10. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) SBS and SBS condensate collection vessels (LOP-VSL-00001, LOP-VSL-00002, LOP-SCB-00001, LOP-SCB-00002)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	5.07E-02	5.12E-02			
Chloride	g/l	1.22E+01	1.35E+01			
Fluoride	g/l	2.81E+00	2.88E+00			
Iron	g/l	2.62E-02	2.54E-02			
Nitrate	g/l	5.85E-02	6.60E-02			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l	9.93E-01	3.45E-02			
Carbonate	g/l					
Undissolved solids	wt%	1.4%	1.3%			
Other (Pb)	g/l	6.11E-03	3.85E-04			
Other	g/l					
pH	N/A					Note 2
Temperature (note 2)	°F					Note 3

List of Organic Species:

References

System Description: 24590-LAW-3YD-LOP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LOP01, LOP04
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-LAW-M6-LOP-P0001, 24590-LAW-M6-LOP-P0002, Rev 1
PFD: 24590-LAW-M6-V17T-P0007, -P0008, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. pH 3 to 8 (CCN 026060)
3. Tmin 41, T nominal 113 °F. If loss of cooling jacket function assume 167 °F (24590-LAW-MVC-LOP-00001, Rev B)

Assumptions:

6.3.1 SBS and SBS Condensate Vessels (LOP-SCB-00001,2 and LOP-VSL-00001,2)

Routine Operations

Offgas from the film cooler flows through the offgas line then enters the SBS column, which is enclosed in the SBS column vessel (LOP-SCB-00001/2) for further cooling and solids removal. Each melter has a dedicated SBS. The SBS is a passive device designed for aqueous scrubbing of entrained radioactive particulate from melter offgas plus cooling and condensation of melter vapor emissions.

The SBS has two offgas inlets, one for the normal operations line and one for the standby line. The inlet pipes run down through the bed to the packing support plate. The bed-retaining walls extend below the support plate, creating a lower skirt to prevent gas from bypassing the packing. A hold-down screen is used to prevent the bed from being carried out by upward flow through the bed. Gas bubbles are formed as the gas passes through holes in the support plate. The bubbles rise through the packed bed and cause the liquid to circulate up through the packing, and hence downward in the annular space outside the packed bed. The packing breaks larger bubbles into smaller ones to increase the gas-to-water contact area and helps increase the particulate removal and heat transfer efficiencies.

The scrubbed offgas discharges through the top of the SBS. The liquid circulation helps to prevent buildup of captured material in the bed by constantly washing the material away. A cooling jacket located on the outside of the scrubber vessel and cooling coils located inside the vessel maintain the scrubbing liquid at required temperatures.

As the offgas cools, water vapor condenses and increases the liquid inventory. The liquid overflows into the SBS condensate vessel (LOP-VSL-00001/2) located next to the SBS column vessel, thereby maintaining a constant liquid depth in the SBS column vessel. The SBS condensate vessel has a cooling jacket to further cool the condensate. This cooled condensate, when recycled (pumps

LOP-PMP-00001/4) to the SBS column vessel, contributes to the cooling of the SBS condensate and keeps collected solids mobilized for removal. The condensate vessel has the capacity to hold about 2 days of condensate. Venting of this vessel is via the SBS column vessel into the main offgas discharge pipe.

To help remove solids, the recirculated stream is pumped through eight lances that agitate the bottom of the SBS column vessel and consolidate the solids near the pump suction. To suspend the solids accumulated in the SBS condensate vessel, an eductor is used, powered by a side stream from the recirculation line.

Condensate produced and solids captured in the SBS column vessels are removed periodically.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Both the SBS and SBS condensate vessels contain spray nozzles that are used during startup to fill the vessels and for decontamination. If maintenance of the offgas line, SBS, or WESP is required during the lifetime of the melter, a maintenance bypass line is provided from the standby offgas line in the wet process cell to the standby line on the other melter. The other melter must be idled for this to occur since the standby line must be open to the SBS, but none of the treatment steps are bypassed.
- **Solids buildup in SBS bed** - This may cause the offgas to bypass the bed with reduced quenching and decontamination. Higher pressure differential indicates a buildup. Depending on the reduction of function, the maintenance bypass is activated and the SBS is flushed out, the bed is fluidized by increasing offgas flow, or the bed is replaced at the next melter changeout.

PLANT ITEM MATERIAL SELECTION DATA SHEET

- **Chilled water failure in the SBS** - If the chilled water flow to the SBS fails, the scrubbing solution temperature begins to increase. If the chilled water flow is not restored in a reasonable period, the solution temperature rises and liquid begins to evaporate. The equilibrium temperature reached is about 165 °F (74 °C). Demineralized water is added to either the SBS column or the condensate vessel via the wash header to compensate for water evaporated.
- **Solids buildup in SBS** - This results in reduced liquid flow through the bed, with reduced quenching and decontamination. A higher offgas temperature indicates this problem. Depending on the reduction of function, the melter is idled, the maintenance bypass opened, and the SBS isolated and flushed out. If the problem is not severe, the corrective action may be deferred until the next melter changeout.
- **Loss of SBS pump** - Loss of the SBS water purge pump (LOP-PMP-00003A/6A) interrupts the periodic transfer from the SBS column vessel to the SBS condensate collection vessel. Pump LOP-PMP-00003B/6B acts as a backup and periodically pumps accumulated condensate to the SBS condensate collection vessel until the failed pump is replaced. The spare pump in the SBS condensate vessel (LOP-PMP-00002/5) can also be used to transfer liquid from the system to the SBS condensate collection vessel.
- **Loss of SBS condensate vessel pump** - The SBS condensate vessel has two pumps that have the capability of either recirculating condensate to the SBS or pumping it to the SBS condensate collection vessel. If one fails, the other one acts as a backup until the failed pump is replaced.
- **Loss of eductor in the SBS condensate vessel** - If the eductor fails, the melter is idled, the maintenance bypass is activated, and the offgas line is isolated by closing the isolation valve downstream of the WESP. The eductor is then replaced.

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10672007

ISSUED BY
RPP-WTP PDC

LOP-VSL-00001 & LOP-VSL-00002 (LAW)
Melter 1 & Melter 2 SBS Condensate Vessel

- Design Temperature (°F)(max/min): 237/40
- Design Pressure (psig) (max/min): 15/FV
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Normal operation at pH 3 at stated nominal operating temperature
- The vessel is pH 8 at stated nominal operating temperature
- Vessel is at pH 3 and temperature reaches 167°F due to loss of cooling function
- Vessel is at pH 8 and temperature reaches 167°F due to loss of cooling function

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18		X
6% Mo (N08367/N08926)	7.64		X
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: UNS N06022

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop lay-up strategy

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PROFESSIONAL ENGINEER
4/18/06
EXPIRES: 12/07/07

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 8 sheets.

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
1	4/18/06	Issued for Permitting Use	[signature]	[signature]	[signature]
0	1/29/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

Vessels receive liquid overflow from the SBS column vessels. Nominal operating temperature is 113°F with an expected maximum of 167°F.

a General Corrosion
Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy; C-22 or equivalent has a corrosion rate of about 75 mpy. Because of the possibility of hot, low pH contents with a low Al^{+++}/F ratio, an alloy more corrosion resistant than the 300 series stainless steels, such as Hastelloy C-22 or equivalent, will be required. With the expected pH ranging between 3 and 8 and the concentration of chloride, 316L is marginally acceptable.

Conclusion:
316L is marginally acceptable with a 6% Mo alloy or Hastelloy C-22 better. C-22 or the equivalent is recommended to protect the vessel from off-normal conditions.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Normally the vessel is to operate at 113 °F at a pH range of 3 to 8. However, the temperature could approach boiling. Data from Phull et al (2000) imply that with these conditions, 6% Mo is marginal and Hastelloy C-22 or equivalent will be needed as a minimum.

Further, if the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain. Pitting is less likely for the higher alloys such as Hastelloy C-22 or equivalent.

Conclusion:
Hastelloy C-22 or the equivalent is recommended.

c End Grain Corrosion
End grain corrosion only occurs in high acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, the environment, and also because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. However, with the proposed off-normal conditions where there will be a tendency to concentrate salts, Hastelloy C-22 or equivalent is required.

Conclusion:
Because of the normal operating environment as well as that which can occur during off-normal conditions, the minimum alloy recommended is Hastelloy C-22 or equivalent.

e Crevice Corrosion
See Pitting. The nominal operating temperature is well above the critical crevice corrosion temperature for 316L and marginal for 6% Mo.

Conclusion:
See Pitting

f Corrosion at Welds
Weld corrosion is not considered a problem for C-22. 316L welds corrode significantly faster than the bulk alloy.

Conclusion:
Not a concern with C-22.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth – the average operating temperature is approximately correct but the pH is too acid.

Conclusion:
MIC is not considered a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not expected to be a concern.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be splashed with particles of waste. Hastelloy C-22 is sufficiently resistant. Vapor phase corrosion is not a concern.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No metal/metal contacting surfaces expected.

Conclusion:
Not expected to be a concern.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
At this time, the design does not provide for the presence of nitric acid reagent in this system. Additionally, the vessels see low pH under normal operating conditions.

Conclusion:
Not applicable.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. Davis, JR (Ed), 1994, *Stainless Steels*, in ASM Metals Handbook, ASM International, Metals Park, OH 44073
4. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
6. Phull, BS, WL Mathay, & RW Ross, 2000, *Corrosion Resistance of Duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Presented at Corrosion 2000, Orlando, FL, March 26-31, 2000, NACE International, Houston TX 77218
7. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
8. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

Bibliography:

1. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000, *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Berhardsson, S, R Mellstrom, and J Oredsson, 1981, *Properties of Two Highly corrosion Resistant Duplex Stainless Steels*, Paper 124, presented at Corrosion 81, NACE International, Houston, TX 77218
3. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
5. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
6. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
7. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) SBS and SBS condensate collection vessels (LOP-VSL-00001, LOP-VSL-00002, LOP-SCB-00001, LOP-SCB-00002)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	5.07E-02	5.12E-02			
Chloride	g/l	1.22E+01	1.35E+01			
Fluoride	g/l	2.61E+00	2.88E+00			
Iron	g/l	2.62E-02	2.54E-02			
Nitrate	g/l	5.85E-02	6.80E-02			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l	8.93E-01	3.45E-02			
Carbonate	g/l					
Undissolved solids	wt%	1.4%	1.3%			
Other (Pb)	g/l	6.11E-03	3.86E-04			
Other	g/l					
pH	N/A					Note 2
Temperature (note 2)	°F					Note 3

List of Organic Species:

References
System Description: 24590-LAW-3YD-LOP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LOP01, LOP04
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-LAW-M6-LOP-P0001, 24590-LAW-M6-LOP-P0002, Rev 1
PFD: 24590-LAW-M6-V17T-P0007, -P0008, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. pH 3 to 8 (CCN 025050)
3. Tmin 41, T nominal 113 °F. If loss of cooling jacket function assume 167 °F (24590-LAW-MVC-LOP-00001, Rev B)

Assumptions:

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

6.3.1 SBS and SBS Condensate Vessels (LOP-SCB-00001,2 and LOP-VSL-00001,2)

Routine Operations

Offgas from the film cooler flows through the offgas line then enters the SBS column, which is enclosed in the SBS column vessel (LOP-SCB-00001/2) for further cooling and solids removal. Each melter has a dedicated SBS. The SBS is a passive device designed for aqueous scrubbing of entrained radioactive particulate from melter offgas plus cooling and condensation of melter vapor emissions.

The SBS has two offgas inlets, one for the normal operations line and one for the standby line. The inlet pipes run down through the bed to the packing support plate. The bed-retaining walls extend below the support plate, creating a lower skirt to prevent gas from bypassing the packing. A hold-down screen is used to prevent the bed from being carried out by upward flow through the bed. Gas bubbles are formed as the gas passes through holes in the support plate. The bubbles rise through the packed bed and cause the liquid to circulate up through the packing, and hence downward in the annular space outside the packed bed. The packing breaks larger bubbles into smaller ones to increase the gas-to-water contact area and helps increase the particulate removal and heat transfer efficiencies.

The scrubbed offgas discharges through the top of the SBS. The liquid circulation helps to prevent buildup of captured material in the bed by constantly washing the material away. A cooling jacket located on the outside of the scrubber vessel and cooling coils located inside the vessel maintain the scrubbing liquid at required temperatures.

As the offgas cools, water vapor condenses and increases the liquid inventory. The liquid overflows into the SBS condensate vessel (LOP-VSL-00001/2) located next to the SBS column vessel, thereby maintaining a constant liquid depth in the SBS column vessel. The SBS condensate vessel has a cooling jacket to further cool the condensate. This cooled condensate, when recycled (pumps LOP-PMP-00001/4) to the SBS column vessel, contributes to the cooling of the SBS condensate and keeps collected solids mobilized for removal. The condensate vessel has the capacity to hold about 2 days of condensate. Venting of this vessel is via the SBS column vessel into the main offgas discharge pipe.

To help remove solids, the recirculated stream is pumped through eight lances that agitate the bottom of the SBS column vessel and consolidate the solids near the pump suction. To suspend the solids accumulated in the SBS condensate vessel, an eductor is used, powered by a side stream from the recirculation line.

Condensate produced and solids captured in the SBS column vessels are removed periodically.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Both the SBS and SBS condensate vessels contain spray nozzles that are used during startup to fill the vessels and for decontamination. If maintenance of the offgas line, SBS, or WESP is required during the lifetime of the melter, a maintenance bypass line is provided from the standby offgas line in the wet process cell to the standby line on the other melter. The other melter must be idled for this to occur since the standby line must be open to the SBS, but none of the treatment steps are bypassed.
- Solids buildup in SBS bed – This may cause the offgas to bypass the bed with reduced quenching and decontamination. Higher pressure differential indicates a buildup. Depending on the reduction of function, the maintenance bypass is activated and the SBS is flushed out, the bed is fluidized by increasing offgas flow, or the bed is replaced at the next melter changeout.

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- **Chilled water failure in the SBS** - If the chilled water flow to the SBS fails, the scrubbing solution temperature begins to increase. If the chilled water flow is not restored in a reasonable period, the solution temperature rises and liquid begins to evaporate. The equilibrium temperature reached is about 165 °F (74 °C). Demineralized water is added to either the SBS column or the condensate vessel via the wash header to compensate for water evaporated.
- **Solids buildup in SBS** - This results in reduced liquid flow through the bed, with reduced quenching and decontamination. A higher offgas temperature indicates this problem. Depending on the reduction of function, the melter is idled, the maintenance bypass opened, and the SBS isolated and flushed out. If the problem is not severe, the corrective action may be deferred until the next melter changeout.
- **Loss of SBS pump** - Loss of the SBS water purge pump (LOP-PMP-00003A/6A) interrupts the periodic transfer from the SBS column vessel to the SBS condensate collection vessel. Pump LOP-PMP-00003B/6B acts as a backup and periodically pumps accumulated condensate to the SBS condensate collection vessel until the failed pump is replaced. The spare pump in the SBS condensate vessel (LOP-PMP-00002/5) can also be used to transfer liquid from the system to the SBS condensate collection vessel.
- **Loss of SBS condensate vessel pump** - The SBS condensate vessel has two pumps that have the capability of either recirculating condensate to the SBS or pumping it to the SBS condensate collection vessel. If one fails, the other one acts as a backup until the failed pump is replaced.
- **Loss of eductor in the SBS condensate vessel** - If the eductor fails, the melter is idled, the maintenance bypass is activated, and the offgas line is isolated by closing the isolation valve downstream of the WESP. The eductor is then replaced.