U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

0088377

MAY 2 7 2010

10-ESQ-150

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Hedges:

SUBMITTAL OF HANFORD FACILITY RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) PERMIT MODIFICATION NOTIFICATION FORM 24590-LAW-PCN-ENV-09-005

Reference: WA7890008967, "Dangerous Waste Portion of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Part III, Operating Unit 10, 'Waste Treatment and Immobilization Plant.'"

This letter transmits the Hanford Facility RCRA Permit Modification Notification Form 24590-LAW-PCN-ENV-09-005 attached, for the Washington State Department of Ecology review and approval. The form describes a requested Class 1 modification to the Reference.

Modification Notification Form 24590-LAW-PCN-ENV-09-005 submits Corrosion Evaluations for the Low-Activity Waste Facility to replace the permitted Material Safety Data Sheets currently found in Appendix 9.9 of the Reference.

If you have any questions, please contact me, or your staff may contact Gae M. Neath, Environmental Compliance Division, (509) 376-7828.

Sincerely,

WJTaylor

William J. Taylor, Assistant Manager
Office of Environmental Safety and Quality

ESQ:GMN

Attachment

cc: See page 2

H-08

cc w/attach:
B. L. Curn, BNI
B. G. Erlandson, BNI
P. A. Fisher, BNI
S. K. Murdock, BNI
D. C. Robertson, BNI
F. M. Russo, BNI
Administrative Record (WTP H-0-8)
BNI Correspondence
Environmental Portal, LMSI

cc electronic:
M. M. Carhart, Ecology
S. L. Dahl, Ecology (1 hard copy)
T. Z. Gao, Ecology
S. A. Thompson, MSA
A. C. McKarns, RL
D. J. Sommer, SCS

cc w/o attach:
D. M. Busche, BNI
J. Cox, CTUIR
S. G. Harris, CTUIR
G. P. Davis, Ecology
D. McDonald, Ecology
G. P. Bohnee, NPT
K. Niles, Oregon Energy
S. R. Weil, RL
R. Jim, YN

Attachment
10-ESQ-150
(28 Pages - Double Sided)

Hanford Facility RCRA Permit Modification Notification
Form 24590-LAW-PCN-ENV-09-005

Quarter Ending June 30, 2010 24590-LAW-PCN-ENV-09-005

Hanford Facility RCRA Permit Modification Notification Form

Part III, Operating Unit 10

Waste Treatment and Immobilization Plant

Index

Page 2 of 3: Hanford Facility RCRA Permit, Part III, Operating Unit 10, Waste Treatment and Immobilization Plant

Replace LAW Facility Material Selection Data Sheets With Updated Corrosion Evaluations in Appendix 9.9 of the Dangerous Waste Permit (DWP).

Submitted by Co-Operator: Reviewed by ORP Program Office:

DMBusche 4/27/10 GACal 5/14/10

D. M. Busche Date G. A. Girard Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part:
Waste Treatment and Immobilization Plant	**Part III, Operating Unit 10**

Description of Modification:

The purpose of this Class 1 prime modification is to replace Material Selection Data Sheets with updated Corrosion Evaluations for the following LAW Facility systems in Appendix 9.9 of the DWP.

- LFP - LAW Melter Feed Process System
- LOP - LAW Primary Offgas Process System
- LVP - LAW Secondary Offgas/Vessel Vent Process System
- RLD - Radioactive Liquid Waste Disposal System

Appendix 9.9			
Replace:		With:	
	24590-LAW-N1D-LFP-P0004, Rev. 0		24590-LAW-N1D-LFP-00004, Rev. 2
	See discussion below		24590-LAW-N1D-LFP-00006, Rev. 0
	24590-LAW-N1D-LOP-P0003, Rev. 0		24590-LAW-N1D-LOP-00003, Rev. 3
	24590-LAW-N1D-LVP-P0002, Rev. 0		24590-LAW-N1D-LVP-00002, Rev. 2
	24590-LAW-N1D-RLD-P0001, Rev. 1		24590-LAW-N1D-RLD-00001, Rev. 5
	24590-LAW-N1D-RLD-P0002, Rev. 0		24590-LAW-N1D-RLD-00002, Rev. 3
	24590-LAW-N1D-RLD-P0005, Rev. 0		24590-LAW-N1D-RLD-00005, Rev. 4

This modification requests Ecology approval and incorporation into the permit the specific changes that are identified by revision bars that have been issued since the last revision of the permitted version. Revisions are the result of ongoing design review. The following identifies the changes:

24590-LAW-N1D-LFP-00004 (LFP-VSL-00001/-00003, Melter 1 & 2 Feed Preparation Vessels)

- Removed LFP-VSL-00002/-00004 from MSDS and added to Corrosion Evaluation 24590-LAW-N1D-LFP-00006, Rev.0
- Incorporated new Process Corrosion Data Sheet
- Updated Section j -- Erosion
- Added Section p -- Inadvertent Addition of Nitric Acid
- Revised agitator materials recommendation
- Updated References and Bibliography

24590-LAW-N1D-LFP-00006 (LFP-VSL-00002/-00004, Melter 1 & 2 Feed Vessels)

- A Material Selection Data Sheet was not prepared since the Melter 1 & 2 Feed Vessels LFP-VSL-00002/-00004 were previously incorporated into the DWP under 24590-LAW-N1D-LFP-P0004
- Vessels were subsequently removed from 24590-LAW-N1D-LFP-P0004 and placed under Corrosion Evaluation 24590-LAW-N1D-LFP-00006

24590-LAW-N1D-LOP-00003 (LOP-WESP-00001 & LOP-WESP-00002, Melter 1 and 2 WESP)

- Updated wear allowance based on *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*, 24590-WTP-RPT-M-04-0008
- Updated References and Bibliography

Quarter Ending June 30, 2010 24590-LAW-PCN-ENV-09-005

24590-LAW-N1D-LVP-00002 (LVP-TK-00001, Caustic Collection Tank)

- Updated wear allowance based on *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*, 24590-WTP-RPT-M-04-0008
- Updated Section g -- Microbiologically Induced Corrosion (MIC)
- Updated References and Bibliography

24590-LAW-N1D-RLD-00001 (RLD-VSL-00004, C3/C5 Drains/Sump Collection Vessel)

- Updated wear allowance based on *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*, 24590-WTP-RPT-M-04-0008
- Incorporated new Process Corrosion Data Sheet (PCDS)
- PCDS includes data for "Leach" and "No Leach." "Leach" refers to the process of adding caustic to HLW feed to dissolve aluminum
- Added Section p -- Inadvertent Addition of Nitric Acid
- Updated References and Bibliography

24590-LAW-N1D-RLD-00002 (RLD-VSL-00005, SBS Condensate Collection Vessel)

- Updated wear allowance based on *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*, 24590-WTP-RPT-M-04-0008
- Incorporated new Process Corrosion Data Sheet
- PCDS includes data for "Leach" and "No Leach." "Leach" refers to the process of adding caustic to HLW feed to dissolve aluminum
- Added Section p -- Inadvertent Addition of Nitric Acid
- Updated References and Bibliography

24590-LAW-N1D-RLD-00005 (RLD-VSL-00003, Plant Wash Vessel)

- Modified Operating Description
- Updated wear allowance based on *Evaluation of Stainless Steel Wear Rates in WTP Waste Streams at Low Velocities*, 24590-WTP-RPT-M-04-0008
- Incorporated new Process Corrosion Data Sheet
- PCDS includes data for "Leach" and "No Leach." "Leach" refers to the process of adding caustic to HLW feed to dissolve aluminum
- Added Section p -- Inadvertent Addition of Nitric Acid
- Updated References and Bibliography

There are no outstanding change documents associated with this modification.

WAC 173-303-830 Modification Class:	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Enter wording of WAC 173-303-830, Appendix I Modification citation:

In accordance with WAC 173-303-830(4)(d)(i), this modification notification is requested to be reviewed and approved as a Class [1]1 modification. WAC 173-303-830(4)(d)(ii)(A) states, "Class 1 modifications apply to minor changes that keep the permit current with routine changes to the facility or its operation. These changes do not substantially alter the permit conditions or reduce the capacity of the facility to protect human health or the environment. In the case of Class 1 modifications, the director may require prior approval."

Modification Approved/Concur: ☐ Yes ☐ Denied (state reason below)	Reviewed by Ecology:
Reason for denial:	Kelly Elsethagen Date

R10404278

CORROSION EVALUATION

ISSUED BY
RPP-WTP PDC

LFP-VSL-00001 & LFP-VSL-00003 (LAW)
Melter 1 & 2 Feed Preparation Vessels

- Design Temperature (°F) (max/min): 150/40
- Design Pressure (psig) (max/min): 15/FV
- Location: process cell

Offspring items
LFP-AGT-00001, LFP-AGT-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 filled with waste at up to 150°F.
- The vessel will be washed with demineralized water.

Assumptions:

- No steam ejector
- There will be no acid used in LAW systems (based on information from T Anderson)

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: Vessels: 316 (max 0.030%C; dual certified)
Agitator: Stellite 712, or equivalent

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance)
0.125 inch required on bottom head and shell
(includes erosion and corrosion)

Process & Operations Limitations:

- Develop rinsing/flushing procedure.
- Do not allow untreated process water to remain stagnant in the vessel without approval by Materials Specialist.

Concurrence TD
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
2	10/14/04	Remove LFP-VSL-00002/4 to another CE Incorporate new PCDS Update Section j -- Erosion Add Section p – Inadvertent Addition of Nitric Acid Revise agitator materials recommendation	DLAdler	JRDivine	NA	APRangus

CORROSION EVALUATION

REVISION HISTORY

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
1	7/23/03	Update design temp/pressure/assoc. items Update vessel number and descriptions Eliminate Stellite overlay recommendation Revise CA recommendation Remove reference to open issues Re-format references Append updated MSDS Add DWP note	DLAdler	HMKrafft	NA	APRangus
0	7/8/02	Initial Issue	DLAdler	JRDivine	SS	SMKirk

CORROSION EVALUATION

Corrosion Considerations:

LAW concentrate will be mixed with glass formers and sucrose in these vessels. Mechanical agitators are present in vessel for blending. Agitators are maintainable and replaceable.

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 alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Similar results were observed by Edgemon et al (1995) for the 242-A Evaporator at Hanford.

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. Edgemon et al (1995) did not observe pitting in the 242-A Evaporator but the chloride concentrations were only about 0.2% of those in this system.

Nominal operating temperature is 122°F with a range of 77 to 150°F. At these temperatures, 304L or 316L stainless steels would be acceptable in the proposed alkaline-nitrate waste in the absence of concentrating effects.

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.

Conclusion:
Localized corrosion, such as chloride induced pitting, is common but can be mitigated 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, either 304L or 316L is acceptable. No cracking has been observed in similar waste (Zapp, 1998) at temperatures to about 266°F.

Conclusion:
At the normal operating conditions 304L and 316L stainless are both acceptable, although 316L is recommended.

e Crevice Corrosion
At the proposed operating conditions, 316L is the minimum recommended. 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 the stated operating conditions.

g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

CORROSION EVALUATION

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 assuming agitation, 316L will be required.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities at the walls and bottom of the vessels are expected to be below 10 f/s. The wear of the vessel bottom and wall due to both erosion and corrosion is expected to be below 0.125 inch of 316L stainless steel based on 24590-WTP-M0E-50-00002.

Conclusion:
A minimum corrosion allowance on the bottom head and shell of 0.125 inch is recommended. Agitator blades should be Stellite 712. Ultimet is acceptable if the agitator design takes into consideration Ultimet's higher wear rate.

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.

CORROSION EVALUATION

References:

1. 24590-WTP-M0E-50-00002, *Increases the Wear Rate of Vessels Containing Glass Formers to Account for the Increased Velocities Along the Bottom Head Wall and to Account for Perpendicular Flow Against the Bottom Head and Wall*
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. Edgemon, GL and RP Anantatmula, 1995, *Hanford Waste Tank Degradation Mechanisms*, WHC-SD-WM-ER-414, Rev 0a, Lockheed Martin Hanford corporation, Richland, WA 99352
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

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. Anderson, TD, 21 December 2000, to JR Divine: No provision for adding nitric or other acid.
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. Miles RE, 2001, Telecon to JR Divine, *LAW and HLW Gamma Radiation Exposures Estimates*, RPP-WTP, Richland, WA 99352
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. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Melter 1 & 2 feed prep vessel (LFP-VSL-00001, LFP-VSL-00003)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.10E+01	3.84E+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	2.89E+02			
Nitrite	g/l	8.22E+01	8.93E+01			
Phosphate	g/l	5.93E+01	6.30E+01			
Sulfate	g/l	3.18E+01	3.43E+01			
Mercury	g/l	9.46E-02	3.18E-02			
Carbonate	g/l	1.29E+02	1.11E+02			
Undissolved solids	wt%	43.9%	43.3%			
Other (Pb)	g/l	6.89E-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-LFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: TCP03/LCP01, LFP05
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-LFP-00001, 24590-LAW-M6-LFP-00003, Rev 1
PFD: 24590-LAW-M5-V17T-00001, -00002, Rev 4
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 13.9 to 14.7 (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:

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

6.2.1 Melter 1 and Melter 2 Feed Preparation Vessels (LFP-VSL-00001 and LFP-VSL-00003)

Routine Operations

The melter feed preparation vessels (MFPVs) (LFP-VSL-00001 and LFP-VSL-00003) are designed for mixing LAW concentrate with glass formers and sucrose. The MFPVs are sized to make up melter feed batches that will feed the melter for a minimum of 16 hours when the melters are operating at a glass production rate of 15 t/day/melter. Supporting equipment includes:

- One mechanical agitator
- Vertical pumps
- Pressure indicator
- Density indicator
- Liquid level indicators
- Temperature indicator
- Rotary cleaning jets for periodic wash-down
- Overflow line to C3/C5 drains/sump collection vessel (RLD-VSL-00004)

The agitators will blend the glass formers and concentrate to a homogeneity criteria that ensures the final product will meet qualification requirements.

The agitators and pumps are expected to require maintenance and/or replacement during the life of the plant. The wet process cell is designed to allow for replacement of the vessels (not expected), agitators, and pumps.

Each MFPV interfaces with autosampling system. Before a sample is taken, the concentrate or melter feed will be pumped through a sample circulation loop. The sampler will pull a portion of the process stream after a specified duration of circulating the fluids.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Overflows to RLD-VSL-00004
- Washing required on failure of agitator

R10404275

ISSUED BY RPP-WTP PDC

CORROSION EVALUATION

LFP-VSL-00002 & LFP-VSL-00004 (LAW)

Melter 1 & 2 Feed Vessels

- Design Temperature (°F) (max/min): 150/40
- Design Pressure (psig) (max/min): 15/FV
- Location: process cell

Offspring items

LFP-AGT-00002, LFP-AGT-00004
LFP-PMP-00007 – LFP-PMP-00018

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 waste at up to 150°F
- The vessel will be washed with demineralized water

Assumptions:

- No steam ejector
- There will be no acid used in LAW systems (based on information from T Anderson)

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: Vessels: 316 (max 0.030%C; dual certified)
Agitator: Stellite 712 or equivalent

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance)
0.125 inch required on bottom head and shell
(includes erosion and corrosion)

Process & Operations Limitations:

- Develop rinsing/flushing procedure.
- Do not allow untreated process water to remain stagnant in the vessel without approval by Materials Specialist.

Concurrence TD
Operations

0	10/4/04	Initial Issue Vessels removed from 24590-LAW-N1D-LFP-00006 due to new Process Corrosion data	DLAdler	JRDivine	APR	APRangus
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

 10 August 2004

CORROSION EVALUATION

Corrosion Considerations:

LFP-VSL-00002 and LFP-VSL-00004 receive blended melter feed consisting of LAW and glass formers. Mechanical agitators are present in vessel for blending. Agitators are maintainable and replaceable

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 alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Similar results were observed by Edgemon et al (1995) for the 242-A Evaporator at Hanford. Recent testing at PNNL (2004) showed corrosion rates of Stellite 12 and 712, Ultimate and 316L to be less than 1 mpy.

In this system, the normal pH, nitrate concentrations and temperatures are such that 304L and 316L stainless steels will be acceptable

Conclusion:
304L, 316L, Ultimet, and Stellite 12 and 712 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 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 Edgemon et al (1995) did not observe pitting in the 242-A Evaporator but the chloride concentrations were only about 0.2% of those in this system.

Nominal operating temperature is 122°F with a range of 77 to 150°F. At this temperature, 304L or 316L stainless steels would be acceptable in the proposed alkaline-nitrate waste in the absence of concentrating effects

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.

Conclusion:
Localized corrosion, such as chloride induced pitting, is common but can be mitigated 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, either 304L or 316L is acceptable. No cracking has been observed in similar waste (Zapp, 1998) at temperatures to about 266°F.

Conclusion:
At the normal operating conditions 304L and 316L stainless are acceptable, although 316L is recommended.

e Crevice Corrosion
At the proposed operating conditions, 316L is the minimum recommended. 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 the stated operating conditions

CORROSION EVALUATION

g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

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 assuming agitation, 316L will be required.

Conclusion:
Not expected to be a concern.

j Erosion
Velocities at the walls and bottom of the vessels are expected to be below 10 f/s. The wear of the vessel bottom and wall due to both erosion and corrosion is expected to be below 0.125 inch of 316L stainless steel based on 24590-WTP-M0E-50-00002.

Conclusion:
A minimum corrosion allowance on the bottom head and shell of 0.125 inch is recommended. Agitator blades should be Stellite 712. Ultimet is acceptable if the agitator design takes into consideration Ultimet's higher wear rate.

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.

CORROSION EVALUATION

References:

1. 24590-WTP-M0E-50-00002, *Increases the Wear Rate of Vessels Containing Glass Formers to Account for the Increased Velocities Along the Bottom Head Wall and to Account for Perpendicular Flow Against the Bottom Head and Wall*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 079661, Perform Scoping Studies To Determine The Suitability Of Construction Materials To Caustic Environments, 12 March 2004
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "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. Edgemon, GL and RP Anantatmula, 1995, *Hanford Waste Tank Degradation Mechanisms*, WHC-SD-WM-ER-414, Rev 0a, Lockheed Martin Hanford corporation, Richland, WA 99352
7. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
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. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
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

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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. Anderson, TD, 21 December 2000, to JR Divine: No provision for adding nitric or other acid.
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. Miles RE, 2001, Telecon to JR Divine, *LAW and HLW Gamma Radiation Exposures Estimates*, RPP-WTP, Richland, WA 99352
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. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Melter 1& 2 feed vessel (LFP-VSL-00002, LFP-VSL-00004)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.10E+01	3.84E+01			
Chloride	g/l	1.18E+01	1.29E+01			
Fluoride	g/l	1.18E+01	1.30E+01			
Iron	g/l	1.82E+00	1.87E+00			
Nitrate	g/l	1.75E+02	1.86E+02			
Nitrite	g/l	5.26E+01	5.75E+01			
Phosphate	g/l	3.80E+01	4.06E+01			
Sulfate	g/l	2.03E+01	2.21E+01			
Mercury	g/l	6.19E-01	2.03E-02			
Carbonate	g/l	8.41E+01	7.12E+01			
Undissolved solids	wt%	44%	43%			
Other (Pb)	g/l	4.50E-01	2.83E-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-LFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LFP05
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-LFP-00001, 24590-LAW-M6-LFP-00003, Rev 1
PFD: 24590-LAW-M5-V17T-00001, -00002, Rev 4
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 13.9 to 14.7 (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:

6.2.2 Melter 1 and Melter 2 Feed Vessels (LFP-VSL-00002 and LFP-VSL-00004)

Routine Operations

The melter feed vessels (MFVs) (LFP-VSL-00002 and LFP-VSL-00004) receive blended melter feed, consisting of LAW and glass formers, from the MFPVs. Each MFV, like each MFPV, is sized to supply melter feed for 16 hours of operation to a melter operating at a glass production rate of 15 t/day/melter. Each MFV is equipped with the following:

- One mechanical agitator with current
- Air displacement slurry (ADS) pumps to transfer feed to the corresponding LAW melter
- One vertical pump
- Liquid level indicators and control
- Density indicator
- Pressure indicator
- Temperature indicator
- Rotary vessel cleaning jets for periodic vessel washdown
- Overflow line to the corresponding MFPV

The agitators will blend the glass formers and concentrate to a homogeneity criteria that ensures that the final product will meet qualification requirements.

The agitators and pumps are expected to require maintenance and/or replacement during the life of the plant. The wet process cell is designed to allow for replacement of the vessels (not expected), agitators, and pumps.

The ADS Pump, lines, and nozzles are water flushed once every 2 to 4 hours, after every pump shutdown and before initiation of feed to the melter. Flush water is transferred directly to melter.

The agitators and pumps are expected to fail within the lifetime of the plant. The facility is designed to allow for replacement of agitators and pumps. ADS pumps were selected for their few moving parts to minimize maintenance. The lines from the ADS pumps to the melter are flexible hoses designed to resist effects of thermal stress and distortions.

Each MFV interfaces with autosampling system ASX-SMPLER-00011 (24590-LAW-M6-ASX-00001). Before a sample is taken, the melter feed is pumped through a sample circulation loop. The sampler will pull a portion of the process stream from the circulation loop.

Non-Routine Operations that Could Affect Corrosion/Erosion

- Overflows to LFP-VSL-00001 or LFP-VSL-00003
- Washing required on failure of agitator

R10526389

24590-LAW-N1D-LOP-00003
Rev. 3

CORROSION EVALUATION

LOP-WESP-00001 & LOP-WESP-00002 (LAW)
Melter 1 and Melter 2 Wet Electrostatic Precipitator (WESP)

- Design Temperature (°F)(max/min): 170/45
- Design Pressure (psig)(max/min): -1/+1
- 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 at stated pH and at minimum stated temperature, 122°F
- The vessel is at stated pH and at maximum stated temperature, 170°F

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

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

Process & Operations Limitations:

- Develop a rinse/flush procedure
- Develop a lay-up strategy

Concurrence DMB
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
3	5/5/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
2	8/11/04	Incorporate new PCDS Add section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
1	1/29/04	Update quantity Update equipment description Update design temp/pressure Re-format references Remove reference to open issues Append updated MSDS Add DWP note	DLAdler	JRDivine	APR	APRangus
0	1/29/02	Initial Issue	JRDivine	DLAdler	NA	BPosta

CORROSION EVALUATION

Corrosion Considerations:

The WESPs provide further removal of aerosols from the offgas after initial aerosol and soluble gas removal in the SBS. Spray wash rings are available for washdown when required. Process air is used to keep the conductors clean and dry.

a General Corrosion
Little uniform corrosion is expected for the stated conditions. Either 304L or 316L would be suitable.

Conclusion:
304L or 316L would be acceptable for the conditions stated.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. The normal operating range of temperature for this vessel is 122 °F to 140 °F at a pH in the range 0.71 to 1.57. Data from Phull et al (2000) imply that with these conditions, a 6% Mo alloy or the equivalent will be needed at temperatures above 150°F. With the higher temperature, and expected pH below about 6, a more resistant alloy than 304L or 316L is required.

In addition, because of the high electrical potentials involved, the environment may be more oxidizing than is common. Consequently a strongly pitting resistant alloy is needed.

Further, there would be a tendency to pit if the vessel were filled with process water and left stagnant. 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 caused by residual chlorides. Pitting is less likely for the higher alloys such as a 6% Mo alloy. The use of an alloy with ≤ 0.5% Cu is recommended to minimize the effects of mercury.

Conclusion:
Based on the stated operating conditions, 6% Mo is the minimum alloy acceptable.

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. For the normal operating conditions with good flushing, 316L would be satisfactory. However, with the possible off-normal conditions where there will be a tendency to concentrate salts, a 6% Mo alloy is recommended.

Conclusion:
For the normal operating environment, 316L is satisfactory. However, off normal conditions dictate the necessity for a more resistant alloy such as a 6% Mo.

e Crevice Corrosion
WESPs are known to accumulate solid deposits. Because the solids will probably contain halides, crevice corrosion will be likely. A 6% Mo is recommended. Also see pitting.

Conclusion:
A 6% Mo should be used.

f Corrosion at Welds
Weld corrosion is not expected to be a problem.

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

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.

CORROSION EVALUATION

h Fatigue/Corrosion Fatigue
Corrosion fatigue is not a concern in a properly designed unit.

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.

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 Addition of Nitric Acid
This equipment normally operates at low pH.

Conclusion:
Not applicable.

CORROSION EVALUATION

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. 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

Bibliography:

1. 24590-WTP-3PS-MKE0-T0001, *Engineering Specification For Wet Electrostatic Precipitators*
2. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
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. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000
7. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
8. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
9. 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
10. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
11. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
12. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) WESP (LOP-WESP-00001, LOP-WESP-00002)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	6.57E-03	6.97E-03			
Chloride	g/l	7.10E-01	7.15E-01			
Fluoride	g/l	4.88E-01	5.66E-01			
Iron	g/l	1.39E-03	1.41E-03			
Nitrate	g/l	2.35E+00	1.96E+00			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt %	0.1%	0.1%			
Other (Pb)	g/l	4.52E-03	3.00E-04			
Other	g/l					
pH	N/A					Note 2
Temperature	°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 #: LOP07
Off Normal Input Stream # (e.g., overflow from other vessels):
P&ID: 24590-LAW-M6-LOP-00001, 24590-LAW-M6-LOP-00002, Rev 1
PFD: 24590-LAW-M5-V17T-00007, -00008 Rev. 4
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. pH approx. 0.71 to 1.57(24590-101-TSA-W000-0009-111-02, Rev 00B, pp. T-29 -T31)

3. T operation 122 °F to 140 °F (24590-WTP-M4C-V11T-00005, Rev A) Tmax 170 °F (24590-WTP-3PS-MKE0-T0001)

Assumptions:

6.3.2 Wet Electrostatic Precipitators (LOP-WESP-00001,2)

Routine Operations

After initial aerosol and soluble gas removal in the SBS is routed to the wet electrostatic precipitator (LOP-WESP-00001/2) for further removal of aerosols. Each melter system has a dedicated WESP.

The offgas enters the unit and passes through a distribution plate. The evenly distributed saturated gas then flows upward through the tubes of the WESP. The tubes act as positive electrodes. Each tube also has a single negatively charged electrode that runs down the center of the tube. A high voltage transformer/rectifier supplies the power to these electrodes. A strong electric field is generated along the electrode, giving a negative charge to aerosols as they pass through the tubes. The negatively charged aerosols move towards the positively charged tube walls and are intercepted. The inlet is also provided with an inlet spray to enhance rundown and cleaning. The condensate then drains into the C3/C5 drain/sump collection vessel (RLD-VSL-00004). Each WESP is equipped with a spray wash ring for washdown when required.

Process air is added through the electrical ducts to keep the conductors clean and dry. Downstream of the WESPs, the individual offgas lines and the vessel vent header join.

Non-Routine Operations that Could Affect Corrosion/Erosion

- **Loss of electrical power** - Loss of power, whether offsite or in the WESP electrical system, causes the system to pass particulates, therefore loading the HEPA filters faster. The melter is idled until power is restored.
- **Loss of one or more electrodes** - Loss of one or more electrodes results in lowered equipment efficiency, causing a more rapid HEPA loading. To correct the problem, the melter is idled and the maintenance bypass is used until repairs are made on the WESP. If decreased efficiency is not significant, maintenance is performed at the next melter changeout.

CORROSION EVALUATION

R10526392

LVP-TK-00001 (LAW)
CAUSTIC COLLECTION TANK

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F)(max/min): 180/50
- Design Pressure (psig): per Code
- Location: outcell

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: 0.04 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

Concurrence DMB
Operations

2	5/20/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
1	7/8/04	Change item number from VSL to TK Correct description Update design temp/pressure Incorporate new PCDS Information regarding inadvertent nitric acid addition Re-format references Add DWP note	DLAdler	JRDivine	APR	APRangus
0	3/6/02	Initial Issue	JRDivine	DLAdler	NA	SKirk
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

 9 February 2005

CORROSION EVALUATION

Corrosion Considerations:

The tank receives scrubbing liquid from LVP-SCB-00001. It will operate at about 140 to 150 °F and range in pH from 7 to 12 with a nominal value of 9.

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 are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Indications are that in the present system, the uniform corrosion rate is negligible.

Conclusion:
304L or 316L are acceptable for use in the stated conditions.

b Pitting Corrosion
Chloride is likely to cause pitting in acid and slightly alkaline solutions. Berhardsson et al (1981) suggest that at chloride concentrations of a few hundred parts per million, a temperature of 150°F would compatible with 316L. At the stated concentrations of 800 to 1900 ppm chloride and the given temperatures, pitting will be a strong function of pH. At the nominal pH or 9 or higher, 316L is satisfactory. Should the halide concentrations rise above nominal, the pH of the solution will need to be adjusted to at least 12.

If the solution will remain below about pH 7 for any length of time at 150°F, 6% Mo or better should be used. Phull et al (2000) note that 6% Mo is acceptable to about pH 5 and 150°F in high chloride environments. Lower pH values and higher temperatures would require Hastelloy C-22 or the equivalent.

Conclusion:
Localized corrosion, such as pitting, is a concern. However, 316L is satisfactory for the nominal halide concentrations, pH and temperature and assuming that the pH will be adjusted should the halide concentrations rise above nominal.

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. Berhardsson (1981) suggests that 316L is acceptable under these conditions up to a temperature of about 150°F.

Conclusion:
Under the normal operating environment, 316L is recommended.

e Crevice Corrosion
Although crevice corrosion is possible, the same alloy choices as for pitting are acceptable. Also 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)
Typically, MIC is not encountered in operating systems.

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.

CORROSION EVALUATION

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. Because solids or acids and solids may be present, a 316L or better would be preferred.

Conclusion:
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:
Erosion is 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 a concern.

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

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
At this time, nitric acid reagent is not available in this system.

Conclusion:
Not applicable.

CORROSION EVALUATION

References:

1. 24590-LAW-MKE-LVP-00004, *LAW Melters Offgas Caustic Scrubbers (LVP-SCB-00001) Process Conditions And Requirements*
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. 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
5. CCN 088587, Meeting Minutes from 6/1/2004 meeting with the following purpose: LAW Caustic Scrubber pH Requirements to Address ICD-6 and Material Selection, by Scott Colby
6. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
7 Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
8. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
9. Phull, BS, WL Mathay, RW Ross, 2000, *Corrosion Resistance of duplex and 4-6% Mo-Containing Stainless Steels in FGD Scrubber Absorber Slurry Environments*, Corrosion 2000, Paper 00578, NACE International, Houston, TX 77218
10. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

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 Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, 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

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Caustic Scrubber (LVP-SCB-00001), Caustic Collection Tank (LVP-TK-00001)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l	8.64E-01	1.87E+00			
Fluoride	g/l	2.21E+00	4.78E+00			
Iron	g/l					
Nitrate	g/l	3.84E+00	8.28E+00			
Nitrite	g/l					
Phosphate	g/l					
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt %					
Other (Pb)	g/l					
Other	g/l					
pH	N/A					
Temperature	°F					Note 2

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 #: LVP17
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-LVP-00002, Rev 0
PFD: 24590-LAW-M5-V17T-00011, Rev 4
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. Normal inlet offgas temp is 560 °F maximum unquenched inlet offgas temp is 1025 °F per 24590-LAW-MKD-LVP-00011, Rev C.; caustic scrubber blowdown 142 °F to 149 °F (24590-WTP-M4C-V11T-00005, Rev A).

Assumptions:

Note 3: Tank has a nominal pH of 9 (24590-LAW-MKE-LVP-00001). Should high halides, greater than 0.3 g/l (CCN 088587), be detected in the scrubber upstream, the pH will be raised to 14.

6.4.9 Caustic Scrubber and Caustic Collection Tank (LVP-SCB-00001, LVP-TK-00001)

Routine Operations

The caustic scrubber (LVP-SCB-00001) further treats the offgas by removing acid gases such as SO_x and CO_2. It also provides offgas cooling.

The offgas stream enters the bottom side of the scrubber and flows upward through a packed bed. The offgas flows countercurrent to the scrubbing liquid, which is introduced through a distributor at the top of the packed section of the column and flows downward through the packing media. Contaminants in the offgas stream are absorbed into the liquid.

The offgas is cooled through the scrubber by evaporation of scrubbing liquid and exits at nearly 100 % relative humidity. The scrubbing liquid drains into the caustic collection tank (LVP-TK-00001). This liquid is recirculated to the top of the column using the caustic scrubber recirculation pumps (LVP-PMP-00001A/B)

The vessel is fitted with radar type liquid level instrumentation. Density, temperature, and flow are measured on the recirculation line. Capability for sampling the vessel is provided using a tap from the recirculation pump line. The vessel is vented to the room. The caustic collection vessel (LVP-VSL-00001) overflows to the berm around the vessel.

Water is added directly to the vessel at a rate sufficient to maintain a specific gravity in the scrubbing fluid consistent with a maximum of 10 % dissolved solids. Suspended solids are not expected.

Offgas from the caustic scrubber is environmentally monitored (stack discharge monitoring [rad and non-rad] system [SDJ]) then released via the stack.

Non-Routine Operations that Could Affect Corrosion/Erosion

- The caustic scrubber has provisions for process water addition for startup and to provide makeup water as necessary. A spray wash ring is also provided for washdown during maintenance periods.
- If the caustic scrubber needs maintenance, a bypass line is provided to allow continued operation of the main offgas system after the melters are idled.
- **Loss of caustic flow to the collection tank** - Loss of caustic flow results in decreased pH of the scrubber bottoms. If the problem can be resolved readily, the scrubber column can continue operating, since the pH decreases slowly. If the problem is more serious, the melters are idled and the caustic scrubber bypass is activated until caustic flow is reestablished.
- **Loss of recirculation pumps** - Loss of recirculation results in the inability to remove acid gases and iodine. An installed spare pump is provided to quickly restore flow to the column.
- **Plugging of packed bed** - If the pressure drop across the packed bed increases beyond a normal range, the melters are idled, the column is bypassed, and the bed is flushed to remove deposits. If this is not effective, the melters are idled, the bypass opened, and the bed replaced.
- **Caustic collection vessel overflow** - The vessel overflows to the berm around the tank. The berm drains to the plant wash vessel (RLD-VSL-00003).

CORROSION EVALUATION

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

- **Solids buildup in the caustic collection vessel** - Minimal solids are expected in the caustic collection vessel. When not transferring to the PT facility, the transfer pumps recirculates back to the collection tank. Caustic is injected into the pump suction to maintain the correct pH in the tank. Any solids are removed from the vessel, and the liquid is transferred to the PT facility.
- **Loss of transfer pump** - If the primary pump fails, the backup pump is activated and operated while the failed pump is replaced.

CORROSION EVALUATION

RLD-VSL-00004 (LAW)
C3/C5 Drains/Sump Collection Vessel

ISSUED BY
RPP-WTP PDC

R10433505

- Design Temperature (°F)(max/min): 183/-20
- Design Pressure (psig) (max/min): 15/FV

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Can be maintained, not replaced, during the 40 y design life. No method of totally removing solids or heels is present.

Operating Modes Considered:

- The tank is filled with waste at 115°F and drain waste
- Rinsed with plant water, a heel is expected to remain

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). Bottom head to be clad with 0.1 inch of Inco 625 (UNS N06625) material or better.

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch erosion allowance)

Process & Operations Limitations:

- Develop lay-up strategy

Concurrence DMB
Operations

5	3/28/06	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	HMKrafft	NA	SWVail
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

 6 February 2006

CORROSION EVALUATION

REVISION HISTORY

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
4	7/1/04	Incorporate new PCDS Add Section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
3	4/3/03	Update design temp/pressure Append updated MSDS Add DWP note Extensive revisions to the text; no revision bars used.	DLAdler	JRDivine	NA	MHoffmann
2	9/17/02	Remove wording regarding open issues	DLAdler	JRDivine	SS	MHoffmann
1	4/29/02	Modify Material Recommendation	DLA	JRD	SS	SK
0	4/2/02	Initial Issue	DLAdler	JRDivine	NA	SK

CORROSION EVALUATION

Corrosion Considerations:

RLD-VSL-00004 is designed to receive fire water from the C3/C5 area in case the sprinkler system is activated. RLD-VSL-00004 also collects liquid purge drained from the LOP-WESP-00001/2. It could also possibly receive overflow from the concentrate receipt vessels and washes from various other vessels.

a General Corrosion
Wilding and Paige (1976) have shown that in 5% nitric acid with 1,000 ppm fluoride at 290°F, the corrosion rate of 304L and 316L can be kept as low as 5 mpy by the use of Al^{+++}. The fluoride concentration in this situation is 566 ppm, the normal operating pH ranges from 0.71 to 1.57, and the normal operating temperature is 115°F. Based on the available data, the uniform corrosion rate will be small.

Conclusion:
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 encourage pitting of stainless steel and related alloys in acid and neutral solutions. Alloys with higher molybdenum contents are more resistant to pitting. The stated conditions of pH and chloride conditions for this vessel are sufficient to cause 316L to be a marginal choice. However, with the cladding of the bottom head with a more resistant alloy, 316L is deemed satisfactory.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated, if caused by chlorides, by alloys with higher nickel and molybdenum contents. Based on the expected operating conditions, 316L would be expected to be satisfactory with the addition of cladding of the bottom head.

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

Conclusion:
End grain corrosion, as normally defined, is not a concern.

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. 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. Further, the "L" grade stainless steels are more resistant. With the proposed conditions, 316L will be acceptable.

Conclusion:
For the normal operating environment, a 316L is the minimum recommended.

e Crevice Corrosion
Though the solids content is not excessive under normal operations, there is no good method for removing all deposits or heels. At the proposed operating temperature, 304L and 316L alone are not acceptable. Either cladding the bottom head of the vessel is necessary or 6% Mo alloy or better is recommended. In addition, 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.

g Microbiologically Induced Corrosion (MIC)
The normal operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

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

Conclusions
Not a concern.

CORROSION EVALUATION

i Vapor Phase Corrosion
Vapor phase corrosion will be a function the degree of agitation, solution chemistry, and temperature. Under normal operating conditions, vapor phase corrosion is not expected to be a concern.

Conclusion:
Not believed to be a concern. 316L is expected to be satisfactory.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.016 inch for components with solids content up to 27.3 wt% at velocities less than 4 mps is based on 24590-WTP-RPT-M-04-0008. Although the solids content can reach 43.9 wt% during non-routine operations, the vessel normally has solids content less than 0.1 wt% and 0.016 inch is considered an adequate erosion wear allowance.

Conclusion:
Not expected to be a problem.

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. Additionally, the vessel sees low pH under normal operating conditions.

Conclusion:
Not applicable.

CORROSION EVALUATION

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 092184, Memo from Dolores Mitchell to Jim Divine, 11 June 2004, "Update to RLD-VSL-00004 Process Corrosion Data"
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", 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. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
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

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. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
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

CORROSION EVALUATION

CCN 092184
UPDATE TO RLD-VSL-00004
PROCESS CORROSION DATA

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) C3/C5 drains/sump collection vessel (RLD-VSL-00004)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine (Note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	6.57E-03	6.97E-03	4.10E+01	3.84E+01	
Chloride	g/l	7.10E-01	7.15E-01	1.84E+01	2.00E+01	
Fluoride	g/l	4.88E-01	5.66E-01	1.84E+01	2.01E+01	
Iron	g/l	1.39E-03	1.41E-03	2.84E+00	2.90E+00	
Nitrate	g/l	2.35E+00	1.96E+00	2.73E+02	2.89E+02	
Nitrite	g/l			8.22E+01	8.93E+01	
Phosphate	g/l			5.93E+01	6.30E+01	
Sulfate	g/l			3.16E+01	3.43E+01	
Mercury	g/l			9.48E-02	3.16E-02	
Carbonate	g/l			1.29E+02	1.11E+02	
Undissolved solids	wt %	0.1%	0.1%	43.9%	43.3%	
Other (Pb)	g/l	4.52E-03	3.00E-04	6.89E-01	2.94E-02	
Other	g/l					
pH	N/A					Note 4, Note 5
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-LAW-3YD-30-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream # LOP10 (or LOP07 from WESP)
Off Normal Input Stream # (e.g., overflow from other vessels): Note 3
P&ID: 24590-LAW-M6-RLD-00002, Rev 3
PFD: 24590-LAW-M5-V17T-00014, Rev 4
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 routine Operation 115°F (cooling occurs via transfer and from other input/flush streams).
3. Non-routine is max concentration from overflow of LCP, LFP vessels, and RLD-VSL-00003.
4. pH 0.71 to 1.57 (24590-101-TSA-W000-0009-111-02, Rev. 00B, ppT30,T32)
5. Non-routine pH 1 to 8, same as RLD-VSL-00003.

Assumptions:

6.6.2 C3/C5 Drains/Sump Collection Vessel (RLD-VSL-00004)

Routine Operations

The C3/C5 drains/sump collection vessel (RLD-VSL-00004) and its cell are designed to contain the most probable maximum amount of fire protection water necessary to cover the largest C3/C5 area, approximately 30,000 gallons. In the event of a fire and activation of the sprinkler system, the fire water will drain into the vessel through floor drains. Once the volume reaches the overflow level of the vessel, the contents will overflow onto the floor of the C3/C5 cell. The sump pump transfers the contents of the cell to the plant wash vessel (RLD-VSL-00003).

The C3/C5 drains/sump collection vessel also collects a constant liquid purge gravity drained from the wet electrostatic precipitators (LOP-WESP-00001 and LOP-WESP-00002).

The vessel is equipped with:

- A centrifugal transfer pump
- Vessel mixing eductors
- A centrifugal pump
- Level instruments
- Density instruments
- Temperature instruments pressure

The C3/C5 drains/sump collection vessel pumps are centrifugal pumps and are used to discharge to the SBS condensate collection vessel (RLD-VSL-00005) or to the plant wash vessel (RLD-VSL-00003). Routine process-related effluent from WESP drains can be pumped out daily to the SBS condensate collection vessel (RLD-VSL-00005). Effluent generated from other sources will be periodically pumped to the plant wash vessel (RLD-VSL-00003) when it reaches a predetermined level. Sampling capability is provided using a sampling leg off the pump recirculation line to an autosampler unit.

Non-Routine Operations that Could Affect Corrosion/Erosion

The overflow from the concentrate receipt vessels (LCP-VSL-00001 and LCP-VSL-00002) and the melter feed preparation vessels (LFP-VSL-00001 and LFP-VSL-00003) is also routed to this vessel.

The C3/C5 drains/sump collection vessel (RLD-VSL-00004) overflows to a sump (RLD-SUMP-00028) in the same cell. This sump is emptied by a pump (RLD-PMP-00004) into the plant wash vessel (RLD-VSL-00003)

The vessel can also be washed down with internal spray nozzles (RLD-NOZ-00006, RLD-NOZ-00007). If chemical adjustment is needed, reagents can be introduced through the spray nozzles.

The C3/C5 drains/sump collection vessel also receives washes from vessels.

Eductors in the C3/C5 drains/sump collection vessel (RLD-VSL-00004) and pumps with recirculation capability are operated to suspend captured solids. Suspended solids are entrained into the effluent and are periodically removed from the vessels when the vessel contents are pumped to the specified vessel in PT. If necessary, vessels can be flushed with water.

CORROSION EVALUATION

RLD-VSL-00005 (LAW)
SBS Condensate Collection Vessel

Offspring items

RLD-AGT-00002, RLD-PMP-00003A/B

- Design Temperature (°F)(max/min): 200/40
- 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

There is an agitator but there is no method for totally removing deposits or heels.

Operating Modes Considered:
- Only operation to the design temperature is assumed.

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/N08926
Top head: 316 (max 0.030% C; dual certified)

The pH, high chloride, and solids require a 6% Mo material for body of vessel and an Alloy 22 or 6% Mo material for the process nozzles consistent with the connecting piping.

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
- Develop rinsing/flushing procedure

Concurrence DMB
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
3	5/25/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
2	6/23/04	Incorporate new PCDS Add Section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
1	11/18/03	Update format and assoc. items Append updated MSDS Editorial changes Add DWP note	DLAdler	JRDivine	NA	APRangus
0	10/16/02	Initial Issue	DLAdler	JRDivine	SS	SMKirk

 10 February 2005

CORROSION EVALUATION

Corrosion Considerations:

This vessel receives effluent from SBS column vessels, SBS condensate vessels, the C3/C5 drains/sump collection vessel, and the plant wash vessel as well as vessel washings. Agitators are present to maintain solids in suspension.

a General Corrosion
Wilding and Paige (1976) have shown that in 5% nitric acid with 1,000 ppm fluoride at 290°F, the corrosion rate of 304L and 316L 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 and 316L is over 4,000 mpy. The fluoride concentration in this situation is about 2870 ppm , the nitric acid concentration is about 0.3 M, and the highest normal operating temperature is 104°F. Based on the available data, the uniform corrosion rate will be small.

Conclusion:
At the given conditions, 304L or 316L are both acceptable based on uniform corrosion.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Phull (2000) has shown that at pH 5, 9,000 ppm chloride, and a temperature of about 122°F, a 6% Mo alloy is satisfactory. In this situation, the pH is significantly lower, as low as 1 rather than 5, and the chloride concentration is significantly higher. According to Sedriks (1996), a 6% Mo is acceptable to about 160°F though if the welds are not properly cleaned, the temperature at which pitting initiates can drop to about 85°F. Wilding & Paige (1976) have shown that in 42% nitric acid, concentrations of over 4,000 ppm chloride have no effect on 304L stainless steel. If the effect is assumed linear and if it is assumed 316L can accept twice as much chloride as 304L without a negative effect, then in 0.3 M nitric acid (≈2%), the maximum allowable chloride concentration should be about 400 ppm which is much less than the concentrations stated to be present during normal operating conditions.

Conclusion:
It is known that nitrate mitigates the effects of chloride to a degree. Even if the protective effect was linear, more chloride is present and the pH is lower than is acceptable for 316L. Therefore an alloy such as a 6% Mo or equivalent is necessary.

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 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 proposed conditions, 316L will not be acceptable. More resistant alloys such as 6% Mo alloys or better will be needed.

Conclusion:
A 6% Mo alloy or better is necessary.

e Crevice Corrosion
Most alloys are expected to be susceptible to crevice corrosion with alloys higher than 300 series stainless steels being less susceptible. See also 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 microbial growth but the system is downstream of the main entry points of microbes.

Conclusion:
MIC is not considered a problem.

CORROSION EVALUATION

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem if the piping and nozzles are properly supported.

Conclusions
Not a concern.

i Vapor Phase Corrosion
Vapor phase corrosion is not expected to be a concern.

Conclusion:
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. Because of the low pH, the agitator blade can be Ultimet but it is not considered necessary. Using the same material for the agitator as the vessel is satisfactory.

Conclusion:
Not expected to be a problem.

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 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 vessel sees low pH under normal operating conditions.

Conclusion:
Not applicable.

CORROSION EVALUATION

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. 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
6. 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. 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
2. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
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. Speidel, MO, 1981, *Stress Corrosion Cracking of Stainless Steels in NaCl Solutions*, Met. Trans. A, 12A, 779-789
7. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

CORROSION EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) SBS condensate collection vessel (RLD-VSL-00005)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine (Note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	5.06E-02	5.11E-02	4.06E-02		
Chloride	g/l	1.22E+01	1.34E+01	1.17E-02		
Fluoride	g/l	2.60E+00	2.87E+00	7.04E-03		
Iron	g/l	2.62E-02	2.54E-02	1.37E-03		
Nitrate	g/l	2.35E+00	1.96E+00	1.58E-01		
Nitrite	g/l			3.13E-02		
Phosphate	g/l			2.41E-02		
Sulfate	g/l			1.20E-02		
Mercury	g/l	9.91E-01	3.44E-02	6.19E-04		
Carbonate	g/l			8.41E-02		
Undissolved solids	wt %	1.4%	1.3%			
Other (Pb)	g/l	6.10E-03	3.84E-04	3.02E-04		
Other	g/l					
pH	N/A					Note 4
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-LAW-3YD-30-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: LOP05, LOP10
Off Normal Input Stream # (e.g., overflow from other vessels): Note 3
P&ID: 24590-LAW-M6-RLD-00001, Rev 2
PFD: 24590-LAW-M5-V17T-00014, Rev 4
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 59 °F (BOD) to 104 °F (24590-LAW-3YD-20-00001, Rev 0, p. C-4)
3. Non-routine receives transfer from RLD-VSL-00003.
4. pH 1 to 7.83 (CCN 063606)

Assumptions:

6.6.3 SBS Condensate Collection Vessel (RLD-VSL-00005)

Routine Operations

This vessel is designed for approximately a 2-day hold-up of the SBS column purge effluent. A transfer can be made daily to the PT facility during normal operations.

The SBS condensate collection vessel (RLD-VSL-00005) receives effluent from SBS column vessels (LOP-SCB-00001 and LOP-SCB-00002); SBS condensate vessels (LOP-VSL-00001 and LOP-VSL-00002); the C3/C5 drains/sump collection vessel (RLD-VSL-00004); vessel washings; and the plant wash vessel (RLD-VSL-00003).

The SBS condensate collection vessel (RLD-VSL-00005) is equipped with a mechanical agitator (RLD-AGT-00002) to maintain solids in suspension. The vessel is vented into a common vessel ventilation header.

The SBS condensate collection vessel discharge pumps are vertical in-vessel pumps (RLD-PMP-00003A/B) and can be routed to various locations through the pump bulge (RLD-BULGE-00004). Sampling capability is provided using a supply line from the pump recirculation line to an autosampler unit. The SBS condensate collection vessel discharge pumps (RLD-PMP-00003A/B) can pump the effluent daily to the PT LAW SBS condensate receipt vessels (TLP-VSL-00009A/B). In the event that the PT LAW SBS condensate receipt vessels (TLP-VSL-00009A/B) cannot receive the effluent, the effluent may be transferred to the LAW plant wash vessel (RLD-VSL-00003).

The SBS condensate collection vessel (RLD-VSL-00005) can be transferred to the PT facility through the LAW pump bulge (RLD-BULGE-00004) through two inter-facility lines. One of the lines is normally the transfer line from the LAW SBS condensate collection vessel (RLD-VSL-00005) to the PT facility LAW SBS condensate receipt vessels (TLP-VSL-00009A/B). The other line is normally the transfer line from the plant wash vessel (RLD-VSL-00003) to the PT facility plant wash vessel (PWD-VSL-00044).

Non-Routine Operations that Could Affect Corrosion/Erosion

The SBS condensate collection vessel (RLD-VSL-00005) overflows to the plant wash vessel (RLD-VSL-00003), which is located next to it in the same room.

The vessel can be washed down with internal spray nozzles (RLD-NOZ-00004, RLD-NOZ-00005). The chemistry can also be adjusted by introducing reagents into the vessel through the spray nozzles. Mechanical agitators on the SBS condensate collection vessel (RLD-VSL-00005) and pumps with recirculation capability are operated to suspend captured solids. Suspended solids are entrained into the effluent and are periodically removed from the vessels when the vessel contents are pumped to the specified vessel in the PT facility. If necessary, vessels can be flushed with water.

CORROSION EVALUATION

R10667995

RLD-VSL-00003 (LAW)
Plant Wash Vessel

Offspring items

RLD-AGT-00001

- Design Temperature (°F)(max/min): 200/-23
- 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:

- 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

Material Required: UNS N08367/N08926

Top head: 316 (max 0.030% C; dual certified)

Note: Vessel upgraded to 6% Mo because it will be used as a back-up for RLD-VSL-00005.

Recommended Corrosion Allowance: 0.04 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure
- Develop lay-up strategy

Concurrence DMB
Operations

4	3/14/06	Modify operating description	DLAdler	HMKrafft	NA	SWVail
REV	**DATE**	**REASON FOR REVISION**	**PREPARER**	**CHECKER**	**MET**	**APPROVER**

CORROSION EVALUATION

REVISION HISTORY

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
3	5/25/05	Update wear allowance based on 24590-WTP-RPT-M-04-0008	DLAdler	JRDivine	NA	APRangus
2	6/30/04	Incorporate new PCDS Add Section p – Inadvertent Addition of Nitric Acid	DLAdler	JRDivine	NA	APRangus
1	11/18/03	Update design temp/pressure Specify mat'l for top head Append updated MSDS Editorial Changes Re-format references Add DWP note	DLAdler	JRDivine	NA	APRangus
0	4/22/02	Initial Issue	JRDivine	DLAdler	SS	BPosta

CORROSION EVALUATION

Corrosion Considerations:

RLD-VSL-00003 routinely receives effluent and overflow from the SBS condensate collection vessel, effluent from the C1/C2 and the C3/C5 drains/sump collection vessels and sump discharges. During off-normal events, RLD-VSL-00003 receives off-spec feed from the concentrate receipt vessels. While the normal operating temperature ranges from 59 to 68 °F, an overflow or transfer from RLD-VSL-00005 could take the temperature up to 104 °F. This condition is considered non-routine. Vessel is equipped with a mechanical agitator to keep solids in suspension.

a General Corrosion
In the proposed pH operating range, no specific information was found for the general/uniform corrosion of stainless steels or other material in the given waste. However, the austenitic and higher alloy steels typically have low corrosion rates, < 1 mpy, in the given environment even at the maximum temperature. This lack of data is not critical because the alloys needed for the system generally fail by pitting, crevice corrosion, or cracking.

Assuming the stated normal operating conditions are correct, 304L will be acceptable with a small uniform corrosion rate.

Conclusion:
Under normal operating conditions, 304L, 316L, or better will be acceptable.

b Pitting Corrosion
Normally the vessel is to operate between 59 and 68°F at a pH range of 1 to 8 with a minimum of halides. Berhardsson (1981) et al conclude 304L or 316L could be used based on temperatures and stated low-chloride conditions. However, at the stated non-routine concentrations of halides, a 6% Mo would be desirable.

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.

Conclusion:
Based on the stated normal operating conditions, 304L and 316L are 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 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 proposed conditions, 304L will be acceptable.

Conclusion:
304L is expected to be satisfactory.

e Crevice Corrosion
Few solids are expected under normal conditions and crevice corrosion should be a minimum.

Conclusion:
Also 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 microbial growth, but the system is downstream of the main entry points of microbes.

Conclusion:
MIC is not considered a problem.

CORROSION EVALUATION

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem if the piping and nozzles are properly supported.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion is not expected to be a concern.

Conclusion:
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. Because of the low pH, the agitator blade can be Ultimet but it is not considered necessary. Using the same material for the agitator as the vessel is satisfactory.

Conclusion:
Not expected to be a problem.

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 applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

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

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 vessel sees low pH under normal operating conditions.

Conclusion:
Not applicable.

CORROSION EVALUATION

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. 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. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

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. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
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. 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. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
8. Van Delinder, LS (Ed), 1984, Corrosion Basics, NACE International, Houston, TX 77084
9. 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

CORROSION EVALUATION

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

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Plant wash vessel (RLD-VSL-00003)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum		Non-Routine (Note 3)		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.06E-02		5.06E-02	5.11E-02	
Chloride	g/l	1.17E-02		1.22E+01	1.34E+01	
Fluoride	g/l	7.04E-03		2.80E+00	2.87E+00	
Iron	g/l	1.37E-03		2.62E-02	2.54E-02	
Nitrate	g/l	1.58E-01		2.35E+00	1.96E+00	
Nitrite	g/l	3.13E-02				
Phosphate	g/l	2.41E-02				
Sulfate	g/l	1.20E-02				
Mercury	g/l	6.19E-04		9.91E-01	3.44E-02	
Carbonate	g/l	8.41E-02				
Undissolved solids	wt %			1.4%	1.3%	
Other (Pb)	g/l	3.02E-04		6.10E-03	3.84E-04	
Other	g/l					
pH	N/A					Note 4
Temperature	°F					Note 2, Note 3

List of Organic Species:

References

System Description: 24590-LAW-3YD-30-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: RLD25
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: 24590-LAW-M6-RLD-00001, Rev 2
PFD: 24590-LAW-M5-V17T-00014, Rev 4
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 59 °F (BOD) to 88 °F (24590-LAW-3YD-20-00001, Rev 0, p. C-2)
3. Non routine: T operation 59 °F to 104 °F is overflow or transfer from RLD-VSL-00005.
4. pH 1 to 8 (CCN 063607)

Assumptions:

CORROSION EVALUATION

Plant Wash Vessel (RLD-VSL-00003)

Routine Operations

The plant wash vessel is normally empty, but effluent sources for the plant wash vessel (RLD-VSL-00003) include:

- Vessel washes
- Off-specification batches and washdown from the concentrate receipt vessels, melter feed prep vessels and melter feed vessels
- Effluent from the SBS condensate collection vessel (RLD-VSL-00005) under off-normal operations
- Effluents from the C1/C2 drain/sump collection vessel (NLD-VSL-00005)
- Effluent from the C3/C5 drain/sump collection vessel (RLD-VSL-00004)
- The overflow from the SBS condensate collection vessel (RLD-VSL-00005)
- Sump discharges from the process cells and the liquid effluent cells

This vessel is designed to handle the largest volume from any vessel/equipment wash or drain in the LAW vitrification facility. The largest volume is from the SBS condensate collection vessel (RLD-VSL-00005). If both the plant wash vessel (RLD-VSL-00003) and the SBS condensate collection vessel (RLD-VSL-00005) are full and sample results have not been determined, or if the PT facility cannot receive the contents, then transfer will not be initiated. The plant wash vessel (RLD-VSL-00003) and the SBS condensate collection vessel (RLD-VSL-00005) are located in the same room.

The vessel is equipped with a mechanical agitator to maintain solids in suspension.

The plant wash pumps (RLD-PMP-00001A/B) are in-vessel vertical pumps and can be routed to various locations via the RLD pump bulge (RLD-BULGE-00004). Sampling capability is provided using a sampling leg off the pump recirculation line to an autosampler unit. The collected effluent, including plant wash vessel (RLD-VSL-00003) vessel washings, will be periodically pumped to the PT facility plant wash vessel (PWD-VSL-00044).

Non-Routine Operations that Could Affect Corrosion/Erosion

- The vessel can also be washed via internal spray nozzles.
- Receives overflows from RLD-VSL-00005.
- Though not a routine operation, if the need arises, the plant wash vessel (RLD-VSL-00003) contents can be transferred to the SBS condensate collection vessel (RLD-VSL-00005), and vice versa.
- Though not expected to be a routine operation, reagents can be introduced into the vessel through the spray nozzles for chemical adjustment of the vessel contents.

Mechanical agitators on the plant wash vessel (RLD-VSL-00003) and pumps with recirculation capability are operated to suspend captured solids. Suspended solids are entrained into the effluent and are periodically removed from the vessels when the vessel contents are pumped to the specified vessel in the PT facility. If necessary, vessels can be flushed with water.