CORROSION EVALUATION

LVP-HTR-00001A&B & LVP-HTR-00003A/B (LAW) Melters Offgas HEPA Preheater

- Design Temperature (°F): 250
- Design Pressure (psig): 15/FV
- Location: Room L-304H; out cell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- Equipment is maintainable and replaceable.

Materials Considered:

Material (UNS No.)	Acceptable Material	Unacceptable Material
Carbon Steel		X
Type 304L (S30403)		X
Type 316L (S31603)	X[1]	
6% Mo (N08367/N08926)	X	
Incoloy® 800 (N08800)	X[2]	
Hastelloy® C-22® (N06022)	X	
Ti-2 (R50400)		X

Recommended Material:

- [1]Housing: Type 316 stainless steel (max 0.030% C; dual certified)
  The preheater housing is off-gas piping. Pipe Class N11F (N08367) is specified and is acceptable.
- [2]Heating element sheath: Incoloy 800

Recommended Corrosion Allowance: Housing – Pipe Class N11F (0.0425 inch)
Heater Element Sheath – 0.0 inch

Process & Operations Limitations:

- None

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

Concurrence NA
Operations

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	MET	APPROVER
1	7/18/12	Update design temperature Incorporate revised PCDS Revise mat'l for heater elements; text modified accordingly Recommend Corrosion Allowance New section q-Oxidation Minor edit & format changes Include AEA notice	DLAdler	RBDavis	APR 7/17/12	DJ WILSEY
0	10/27/05	Initial Issue	DLAdler	JRDivine	APR	APRangus

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

The LAW HEPA Preheater uses standard heater element technology: electric element with ceramic oxide packing surrounded by a metallic sheath. The "Commercial Off-The-Shelf" (COTS) heaters are attached to an ASME B16.5 flange, seal welded, and pressure tested. The offgas stream is passed through the HEPA preheaters in order to increase the gas temperature to avoid condensation in the melter offgas HEPA filters.

a General Corrosion
The anticipated dry-air conditions are not conductive to general corrosion and none is expected. The "housing" is the off-gas piping. Either Type 304L or 316L would be satisfactory for the housing. The off-gas piping upwards of the heaters is pipe class N11F (N08367) which is also considered satisfactory. Incoloy® 800 is recommended for the heating elements and sheath because of its oxidation resistance.

Conclusion
Either Type 304L or 316L stainless steel or 6% Mo alloy (N08367) would be satisfactory for the housing. Incoloy® 800 is recommended for the heating elements sheath.

b Pitting Corrosion
Pitting corrosion will only be a concern if moisture is present during normal operation. Shut-down and heat-up thermal transients may allow vapors to condense on the cold surfaces. Locations at crevices, at dead-legs, at low points, and under deposits may host conditions that support corrosion. The constituents in the off-gas vapor phase can be aggressive in oxidizing environments when mixed with moisture. Therefore, a material with a higher pitting corrosion resistance than Type 304L is necessary. Type 316L stainless steel, or better, is recommended for this application.

Conclusion
At the stated operating conditions, pitting corrosion is not a major concern. Recommend Type 316L. Use of N08367 is also acceptable.

c End Grain Corrosion
End grain corrosion only occurs in highly oxidizing acid conditions and is not a concern.

Conclusion:
Not a concern

d Stress Corrosion Cracking
At operations at the stated temperatures, stress corrosion cracking will only be a concern in the presence of moisture. It is assumed that there will be no condensation in the unit during normal operation. Also see Pitting.

Conclusion
At the stated operating conditions, stress corrosion cracking is not a concern.

e Crevice Corrosion
Crevice corrosion will only be a concern if moisture is present. The offgas humidity is controlled so that there will be no condensation.

Conclusion
At the stated operating conditions, crevice corrosion is not a concern.

f Corrosion at Welds
Assuming dry air and proper welding procedures, corrosion at welds is not anticipated.

Conclusion
At the stated operating conditions, weld corrosion is not a concern.

g Microbiologically Induced Corrosion (MIC)
The stated operating conditions are not suitable for microbial growth.

Conclusion
At the stated operating conditions, MIC is not a concern.

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h Fatigue/Corrosion Fatigue
Extreme temperature cycling or fluctuations are not expected.

Conclusion
At the expected operating conditions, corrosion fatigue is not a concern.

i Vapor Phase Corrosion
Components essentially consist entirely of vapor space so general corrosion comments apply.

Conclusion:
See comments under general corrosion.

j Erosion
The velocity and solids content are sufficiently low that erosion is not a concern.

Conclusion
Erosion is not a concern.

k Galling of Moving Surfaces
There are no unlubricated moving surfaces present.

Conclusion:
Galling is not a concern.

l Fretting/Wear
No metal/metal contacting surfaces are expected.

Conclusion:
Fretting is not a concern.

m Galvanic Corrosion
No significantly dissimilar metals are present. Further, it is assumed no moisture is present.

Conclusion:
Galvanic corrosion is not a concern.

n Cavitation
Cavitation is not expected in an off-gas system.

Conclusion:
Cavitation is not a concern.

o Creep
The design conditions are conducive to creep, specifically for the heating elements. Recommend Incoloy® heating elements for creep resistance.

Conclusion
Incoloy recommended for heating elements.

p Inadvertent Addition of Nitric Acid
Addition of nitric acid to the offgas lines is not a plausible scenario.

Conclusion
Not applicable.

q Oxidation
The design conditions are conducive to oxidation. Recommend Incoloy® heating elements for oxidation resistance.

Conclusion
Incoloy® recommended for heating elements.

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References:

1. 24590-WTP-RPT-PR-04-0001, Rev. 0CD, *WTP Process Corrosion Data*

Bibliography:

1. 24590-LAW-MED-LVP-00006, *Mechanical Data Sheet for 24590-LAW-ME-LVP-HTR-00001A, 24590-LAW-ME-LVP-HTR-00001B - Melters Offgas HEPA Preheater*
2. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
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. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158

CORROSION EVALUATION

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) LAW melters offgas HEPA preheaters (LVP-HTR-00001 A/B)

Facility LAW

In Black Cell? No

Chemicals	Unit[1]	Contract Maximum[2]		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/m³					
HCl	g/m³	2.16E-02	2.44E-02			
HF	g/m³	5.66E-02	6.40E-02			
Iron	g/m³					
NO	g/m³	4.85E+00	5.10E+00			
NO2	g/m³	9.75E+00	1.11E+01			
Phosphate	g/m³					
SO2	g/m³	9.79E-02	1.10E-01			
Mercury	g/m³	2.17E-02	7.20E-04			Assumption 1
Carbonate	g/m³					
Particulate	g/m³					Note 5
HNO_3	g/m³	2.2E-02	2.2E-02			Assumption 2
HNO_2	g/m³	2.9E-02	2.9E-02			Assumption 2
Relative Humidity	%	68%	68%			Note 4
Temperature	°F					Note 3

List of Organic Species:

References

System Description: 24590-LAW-3YD-LOP-00001
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normally Associated Streams LVP03, LVP04
Off Normal Stream # (e.g., overflow from other vessels):
P&ID: N/A
PFD: 24590-LAW-M5-V17T-00010
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/m³ do not need to be reported; list concentration values to three significant digits max.
2. Data developed from a mass balance model which has constituents in the plant feed which are important to corrosion, adjusted to contract maximum values, except as noted.
3. The normal operating temperature is 124 °F at the inlet, and 160 °F at the outlet (page 37, 24590-LAW-M4C-LOP-00001, Rev 2A)
   The maximum operating temperature is 128 °F at the inlet, and 162 °F at the outlet (page 41, 24590-LAW-M4C-LOP-00001, Rev 2A).
4. Source: 24590-LAW-M4C-LOP-00001, Rev 2A, page 41 lists inlet relative humidity at 68%, outlet relative humidity at 27%.
5. Source: 24590-LAW-M4C-LOP-00001, Rev 2A, page 44

Assumptions:

1. Mercury concentrations are an assumption based on inputs and assumptions identified in Attachment A of 24590-WTP-M4C-V11T-00005, Rev A.
2. Based on empirical data from testing per Attachment 2B of 24590-LAW-M4C-LOP-00001, Rev 2A, page 170.

* Referenced document 24590-LAW-M4C-LOP-00001 has been revised. These temperatures remain unchanged.

6.4.1 LAW Melters Offgas HEPA Preheaters (LVP-HTR-00001 A/B)

Routine Operations

HEPA filters provide the final particulate removal for the offgas. The combined offgas stream is passed through the HEPA preheaters (LVP-HTR-00001A/B). The electric heaters increase the gas temperature to avoid condensation in the melter offgas HEPA filters (LVP-HEPA-00001A/B, -00002A/B, or -00003).

Non-Routine Operations that Could Affect Corrosion or Erosion

- **Heater element failure** - Heater element failure is detected by measurement of the temperature change across the heaters. These measurements provide a basis to increase power to the other heater. The failed heater is then isolated and full flow would pass through the second one. Failed heater elements are replaced and the heater returned to service.
- **Electrical failure** - The heaters are provided with an uninterruptible power supply (UPS).
- **Heater overheating** - If a heater overheats due to no airflow or heater control failure, an interlock shuts off the heater upon detected high temperature.