S

ENGINEERING CHANGE NOTICE		
Page 1 of 7	☒ DM ☐ FM ☐ TM	1a. **ECN** 720708 **R** 0 1b. **Proj. ECN** W- -

2. **Request Information** Record Information on the ECN-1 Form	3a. **Design Inputs** -Record Information on the ECN-2 Form	3b. **Design References** - Record Information on the ECN-3 Form	3c. **Engineering Evaluation / Estimate / Approval to Proceed w/ the Design** - Record Information on the ECN-4 Form

4. **Originator's Name, Organization, MSIN, & Phone No.**	5. **USQ Number**	6. **Date**
ARES Corporation (POC Mike White), 946-3300	No. TF 03-3075AA ☐ N/A Init. JRB Date 6/19/03	6/18/03

7. **Title**	8. **Bldg. / Facility No.**	9. **Equipment / Component ID**	10. **Approval Designator**
241-C-106 Acid Dissolution Material Compatibility Assessment	241-C	WRS	N/A

11. **Document Numbers Changed by this ECN** (For FM or TM Changes Record Information on the ECN-5 Form) Sheet and Rev.	12. **Design Basis Documents?**	13. **Safety Designation**	14. **Expedited / Off-Shift ECN?**
~~RPP-6256~~, Revision ~~1~~ 0 RPP-16286 6-23-03	☐ Yes ☒ No	☐ SC ☐ SS ☒ GS ☒ N/A 6/19/03	☐ Yes ☒ No

15a. **Work Package Number**	15b. **Modification Work Completed**	15c. **Restored to Original Status (TM)**	16. **Fabrication Support ECN?**
N/A	N/A Responsible Engineer / Date	N/A Responsible Engineer / Date	☐ Yes ☒ No

17. **Description of the Change** (Use ECN Continuation pages, as needed)

Revision adds attachments E, F, and G. that were inadvertently left out.

18. **Justification of the Change** (Use ECN Continuation pages, as needed)

This change is required to support the design and operations of the Tank 241-C106 Acid Dissolution Project.

19. **ECN Category**

☐ Direct Revision

☒ Supplemental

ECN Revision Type

☐ Void/Cancel

☐ Closure

☐ Revision

20. **Distribution** (Name and MSIN)

GR Janicek	R3-83
JR Bellomy	R3-83
JG Propson	S7-65
WT Thompson	S7-65
SM O'Toole	S7-65
P Dorsh	R3-83
RD Smith	R1-49
J Ferguson	SO-03

Release Stamp

JUN 25 2003

DATE: HANFORD RELEASE

STA: 4

ID: 21

ENGINEERING CHANGE NOTICE	☒ DM ☐ FM ☐ TM	1a. **ECN** 720708 **R** 0 1b. **Proj. ECN** W- -

21. **Design Check**	22. **Design Verification Required?**	23. **Closeout / Cancel / Void**
Record Information on the ECN-6 Form N/A	☐ Yes ☒ No If Yes, as a minimum attach the one page checklist from TFC-ENG-DESIGN-P-17.	☐ Yes ☒ No If Yes, Record Information on the ECN-7 Form and attach form(s).

24. **Revisions Planned** (Include a brief description of the contents of each revision)
N/A

Note: All Revisions shall have the approvals of the affected organizations as identified in block 9 "Approval Designator," on page 1 of this ECN.

25a. **Commercial Grade Item Dedication Numbers** (associated with this design change)	25b. **Engineering Data Transmittal Numbers** (associated with this design change, e.g., new drawings, new documents)
N/A	EDT ~~6276111~~, RPP-16256 6276011 SL 6-23-03

26a. **Design Cost Estimate**	26b. **Materials / Procurement Costs**	26c. **Estimated Labor Hours**
N/A	N/A	N/A

27. **Field Change Notice(s) Used?** (Used for ECN Revisions only)
☐ Yes ☒ No
If Yes, Record Information on the ECN-8 Form attach form(s) and identify permanent changes.

NOTE: ECN Revisions are required to record and approve all FCN's issued during the field modification work process. If the FCN's have not changed the original design media then they are just incorporated into the ECN file via an ECN revision. If the FCN did change the original design media then the ECN Revision will include the necessary engineering changes to the original design media changes.

28. **Approvals**

	Signature	Date
Design Authority	GR Janicek [signature]	6/23/03
Team Lead/Lead Engr.	JR Bellomy [signature]	6/19/03
Resp. Engineer	J.R. Bellomy [signature]	6/19/03
Resp. Manager	WT Thompson [signature]	6/19/03
Quality Assurance		
IS&H Engineer		
NS&L Engineer	RD Smith [signature]	6/19/03
Environ. Engineer		
Project Engineer	~~P Dorch~~	
Design Checker	M J. Feldmann [signature]	6/18/03
Design Verifier		
Operations		
Radcon	6/19/03	
Other	J. Propson ~~SM O'Toole~~ [signature]	6/19/03
Other		

	Signature	Date
Originator/Design Agent	Mike White, ARES [signature]	6/18/03
Professional Engineer		
Project Engineer		
Quality Assurance		
Safety		
Designer		
Environ. Engineer		
Other		
Other		

DEPARTMENT OF ENERGY / OFFICE OF RIVER PROTECTION

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL SIGNATURES

ECN - 1
ENGINEERING REQUEST FORM

☒ DM ☐ FM ☐ TM

1a. ECN 720708 R0

1b. Proj. ECN W- -

Requestor's Name (Print)	Date	REA Reference
Sara Burton	4/16/03	N/A

Equipment Name	Estimated Need Date
241-C-106	5/30/03

Problem/Issue Statement

Retrieve slurry waste from tank 241-C-106 and transfer to a selected DST using selected Waste Retrieval System

Purpose for the Proposed Modification

To support slurry waste removal using the 241-C-106 Waste Retrieval System

Basis for the Estimated Need Date

TPA Milestone M-45-00

Requestor's Signature	Date	Requestor's Manager's Signature	Date
John Propson [signature]	4/21/03	[signature]	4/21/03

Responsible Manager Approval

Work Package Number (If Known)	Estimated Evaluation ROM Cost	CACN
	$1000.00	501555
Process as a Simple Modification? ☒ Yes ☐ No	***Assigned to (Team Lead)*** Jim Bellomy	***Date*** 4/16/03
Responsible Manager's Signature Cost Account Christopher Burke for KE Carpenter	☒ Approve ☐ Reject	***Date*** 4/18/03

If rejected, explain reason for rejection:

(Once rejected the Responsible Manager returns the request to the Requestor's Manager)

Italicized text items need to be addressed. Standard text items need to be addressed as applicable to the problem/issue described.

A-6003-566 (01/03)

ECN - 5 DRAWING / DOCUMENT CHANGE LIST FORM Sheet 1 of ECN – 5 Page 4 of 7	☒ DM ☐ FM ☐ TM	1a. **ECN** 720708 **R** 0 1b. **Proj. ECN** W- -

List of Engineering Drawings/Documents to be Modified (Use the attached checklist for guidance)

Dwg./Doc. Number (Sheet/Page, Rev)	Title/Type	Shared	Existing Change Document Nos.
RPP-16256 Rev ~~1~~ 0 CLC 6-25-07	Tank 241-C106 Acid Dissolution Material Compatibility Assessment	☐	
		☐	
		☐	
		☐	
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		☐	
		☐	
		☐	
		☐	
		☐	
		☐	

Submitted to Document Service Center Prior to ECN Release?

☐ Yes ☒ No	Team Lead	Date

List of Non-Engineering Documents Needed to be Modified

Document Number/Revision, Sheet/Page (If Available)	Document Title	Document Owner (Organization)	Individual Notified	Method	Date Notified

ECN - 5 DRAWING / DOCUMENT CHANGE LIST FORM	☒ DM ☐ FM ☐ TM	1a. ECN 720708 R 0 1b. Proj. ECN W- -

Drawings/Documents to be Modified Checklist

System Design Description	☐ Yes ☒ No ☐ N/A	Operating Procedure	☐ Yes ☒ No ☐ N/A
Functional Design Criteria	☐ Yes ☒ No ☐ N/A	System/Subsystem Specifications	☐ Yes ☒ No ☐ N/A
Functional Requirements	☐ Yes ☒ No ☐ N/A	Engineering Flow Diagram Drawing	☐ Yes ☒ No ☐ N/A
Operating Specification	☐ Yes ☒ No ☐ N/A	General Arrangement Drawing	☐ Yes ☒ No ☐ N/A
Criticality Specification	☐ Yes ☒ No ☐ N/A	Material Specification	☐ Yes ☒ No ☐ N/A
Conceptual Design Report	☐ Yes ☒ No ☐ N/A	Sampling Plan	☐ Yes ☒ No ☐ N/A
Detailed Design Report	☐ Yes ☒ No ☐ N/A	Inspection Plan	☐ Yes ☒ No ☐ N/A
Equipment Specification	☐ Yes ☒ No ☐ N/A	Radiation Control Procedure	☐ Yes ☒ No ☐ N/A
Procurement Specification	☐ Yes ☒ No ☐ N/A	Spare Parts List	☐ Yes ☒ No ☐ N/A
Construction Specification	☐ Yes ☒ No ☐ N/A	Test Specification	☐ Yes ☒ No ☐ N/A
Vendor Information	☐ Yes ☒ No ☐ N/A	Test Plan	☐ Yes ☒ No ☐ N/A
Operations / Maintenance Manual	☐ Yes ☒ No ☐ N/A	Acceptance Test Procedure	☐ Yes ☒ No ☐ N/A
Safety Analysis / FSAR / SAR / DSA	☐ Yes ☒ No ☐ N/A	Pre-Operational Test Procedure	☐ Yes ☒ No ☐ N/A
Technical Safety Requirement	☐ Yes ☒ No ☐ N/A	Operational Test Procedure	☐ Yes ☒ No ☐ N/A
Master Equipment List	☐ Yes ☒ No ☐ N/A	ASME Coded Item / Vessel	☐ Yes ☒ No ☐ N/A
Safety Equipment List	☐ Yes ☒ No ☐ N/A	Human Factor Consideration	☐ Yes ☒ No ☐ N/A
Radiation Work Permit	☐ Yes ☒ No ☐ N/A	Automated Control Configuration Procedure	☐ Yes ☒ No ☐ N/A
Environmental Requirement	☐ Yes ☒ No ☐ N/A	Computer / Automated Control Software Plan	☐ Yes ☒ No ☐ N/A
Environmental Permit	☐ Yes ☒ No ☐ N/A	Raceway / Cable Schedules	☐ Yes ☒ No ☐ N/A
Seismic / Stress / Structural Analysis	☐ Yes ☒ No ☐ N/A	Work Control Procedure	☐ Yes ☒ No ☐ N/A
Design Report	☐ Yes ☒ No ☐ N/A	Corrective Maintenance Procedure	☐ Yes ☒ No ☐ N/A
Interface Control Drawing	☐ Yes ☒ No ☐ N/A	Process Control Plan	☐ Yes ☒ No ☐ N/A
Calibration Procedure	☐ Yes ☒ No ☐ N/A	Process Control Procedure	☐ Yes ☒ No ☐ N/A
Preventive Maintenance Procedure	☐ Yes ☒ No ☐ N/A	Flow Sheet	☐ Yes ☒ No ☐ N/A
Engineering Procedure	☐ Yes ☒ No ☐ N/A	Purchase Requisition	☐ Yes ☒ No ☐ N/A
Security Plan	☐ Yes ☒ No ☐ N/A	Hazards Analysis	☐ Yes ☒ No ☐ N/A
Emergency Plan	☐ Yes ☒ No ☐ N/A	JCS PM Activity Datasheet	☐ Yes ☒ No ☐ N/A
Engineering Document	☒ Yes ☐ No ☐ N/A		☐ Yes ☐ No ☐ N/A
	☐ Yes ☐ No ☐ N/A		☐ Yes ☐ No ☐ N/A

ECN - 6
DESIGN CHECK LIST

☒ DM ☐ FM ☐ TM

1a. **ECN** 720708 **R** 0

1b. **Proj. ECN** W- -

Design Details/Attributes (to be filled out by the change originator) identified in the ECN.

1. Issue/Problem Statement included	☒ Yes ☐ No ☐ N/A	*21. Basis for Selected Alternative explained, including assumptions*	☐ Yes ☐ No ☒ N/A
2. Safety/Commitment/Programmatic Impacts identified – NEPA Documentation completed	☐ Yes ☐ No ☒ N/A	*22. Potential Component/System Impacts identified and resolved*	☐ Yes ☐ No ☒ N/A
3. System/Equipment/Personnel Impacts identified	☐ Yes ☐ No ☒ N/A	*23. Potential Software Impacts identified and resolved*	☐ Yes ☐ No ☒ N/A
4. Technical Evaluation included	☒ Yes ☐ No ☐ N/A	*24. Potential Safety Impacts are identified and resolved (e.g., energized electrical equipment)*	☐ Yes ☐ No ☒ N/A
5. Compliance w/ Design Basis identified	☒ Yes ☐ No ☐ N/A	*25. Modification is Constructible and can be implemented*	☒ Yes ☐ No ☐ N/A
6. Assumptions/Sources clearly identified	☒ Yes ☐ No ☐ N/A	*26. Design considers Operational Impacts*	☐ Yes ☐ No ☒ N/A
7. Affected Documents and Databases clearly identified	☒ Yes ☐ No ☐ N/A	*27. Contamination Controls are planned*	☐ Yes ☐ No ☒ N/A
8. Inputs Verified	☒ Yes ☐ No ☐ N/A	*28. Pre-Installation/Mockup/Prototype Testing planned*	☐ Yes ☐ No ☒ N/A
9. Required Function(s) / changes clearly identified	☒ Yes ☐ No ☐ N/A	*29. Sketches/Drawings for Tools/Fabricated Components included*	☐ Yes ☐ No ☒ N/A
10. Safety Basis/Commitments/Concerns evaluated	☒ Yes ☐ No ☐ N/A	*30. Hardware Design described*	☐ Yes ☐ No ☒ N/A
11. Application of Industry Standards/Codes explained	☐ Yes ☐ No ☒ N/A	*31. Software/Firmware Design described*	☐ Yes ☐ No ☒ N/A
12. Proper Analytical Techniques employed	☐ Yes ☐ No ☒ N/A	*32. Inspections (per Codes & Standards) / Quality Checks included*	☐ Yes ☐ No ☒ N/A
13. Interfaces evaluated and identified	☒ Yes ☐ No ☐ N/A	*33. Dimensions and Tolerances included*	☐ Yes ☐ No ☒ N/A
14. Material/Component Compatibility evaluated	☐ Yes ☐ No ☒ N/A	*34. Sketches/Drawings for Installation included*	☐ Yes ☐ No ☒ N/A
15. ALARA/Radiological controls/chemical hazards evaluated	☒ Yes ☐ No ☐ N/A	*35. Housekeeping/Personnel Safety Requirements identified*	☐ Yes ☐ No ☒ N/A
16. Human/Machine Interface evaluated	☐ Yes ☐ No ☒ N/A	*36. Walkdown(s) performed/Labeling Correct*	☐ Yes ☐ No ☒ N/A
17. Program impacts evaluated	☐ Yes ☐ No ☒ N/A	*37. Acceptance Test generated and Acceptance Criteria included*	☐ Yes ☐ No ☒ N/A
18. Design Basis Calculations updated	☐ Yes ☐ No ☒ N/A	*38. M&TE Requirements identified*	☐ Yes ☐ No ☒ N/A
19. Alternatives described/evaluated and address resolution of problem	☐ Yes ☐ No ☒ N/A	*39. Training/Qualification of Test Personnel identified*	☐ Yes ☐ No ☒ N/A
20. Impacts on Maintenance and OPS described	☐ Yes ☐ No ☒ N/A	*40. Safety and Hazards Analysis assessed*	☐ Yes ☐ No ☒ N/A

Design Originator (Print/Sign): M.A. White [signature]

Date: 6/18/03

ECN - 6 **DESIGN CHECK LIST** Sheet 2 of ECN – 6 Page 7 of 7	☒ **DM** ☐ **FM** ☐ **TM**	1a. **ECN** 720708 **R** 0 1b. **Proj. ECN** W- -

Design Check Method (Select method(s) and provide explanation of how to be performed):

☒ **Peer Check**	☐ **Design Check Team***	☐ **Other** ____________

Design Check Explanation:

Peer check will assure changes were correctly made.

* Design check team members other than the originating organization normally should consist of personnel representing: Operations, Maintenance & Reliability Engineering, Maintenance Management, Maintenance Crafts, Safety, and Projects.

Design Check Details

Design inputs correctly identified?	☒ Yes ☐ No ☐ N/A	*Design changes properly documented?*	☒ Yes ☐ No ☐ N/A
Calculations checked and are correct?	☐ Yes ☐ No ☒ N/A	*Test procedures reviewed and are correct?*	☐ Yes ☐ No ☒ N/A
Design assumptions are stated and verified?	☒ Yes ☐ No ☐ N/A	*Is the design change adequate?*	☒ Yes ☐ No ☐ N/A
Design criteria incorporated into the design?	☒ Yes ☐ No ☐ N/A	*Is the design change complete?*	☒ Yes ☐ No ☐ N/A
Interfaces clearly identified in the design?	☒ Yes ☐ No ☐ N/A	*Is the design change correct?*	☒ Yes ☐ No ☐ N/A
EQRG pre-release review required?	☐ Yes ☒ No	EQRG Pre-release Approval	Date

Comments:

Reference TFC-ENG-DESIGN-P-17, Design Verification

Design Checker (Print/Sign) Monika J. Feldmann	***Date*** 6/18/03

241-C-106 Acid Dissolution Material Compatibility Assessment

M.A. White
CH2MHILL Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

EDT/ECN: 720708-R0 UC: N/A
Cost Center: N/A Charge Code: 501555
B&R Code: N/A Total Pages: 41

Key Words: acid dissolution, material compatibility, acid, oxalic acid, sludge dissolution, 241-C-106, C-106

Abstract: This document assesses the compatibility of various new and existing components related to the 241-C-106 Acid Dissolution Retrieval Project.

See next page for list of trademarks.

Release Approval 6/25/03 Date Release Stamp

Approved For Public Release

RECORD OF REVISION

(1) Document Number
RPP-16256

Page 1

(2) Title
241-C-106 Acid Dissolution Material Compatibility Assessment

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
	(7)		
0	EDT-627611	JG Propson	WT Thompson 6/4/03
1 RS	ECN-720708 Rev. 0	JG Propson	~~JG Propson~~ W.T. THOMPSON 6/19/03

241-C-106 ACID DISSOLUTION MATERIAL COMPATIBILITY ASSESSMENT

TABLE OF CONTENTS

ATTACHMENTS

241-C-106 ACID DISSOLUTION MATERIAL COMPATIBILITY ASSESSMENT

1.0 INTRODUCTION

1.1 Background

Tank 241-C-106 is one of twelve 100-series single-shell tanks (SSTs) located in the 241-C Tank Farm. The tank was constructed during 1943 and 1944 with a nominal capacity of 530,000 gal (approximately 2 million liters). The tank is underground, and is constructed as a cylindrical, reinforced concrete shell with a domed roof and a "dished" bottom. The interior of the tank contains a 75 ft (23 m) diameter liner constructed of mild steel, extending up the tank wall to a height of 18 ft (5.5 m). The concrete shell of tank 241-C-106 maintains the structural integrity of the steel liner by protecting it from soil loads.

Tank 241-C-106 was placed in service in 1947 and received waste from various sources during its operation. The tank was declared inactive in 1979. In 1999, approximately 186,000 gal of liquid/sludge were removed from the tank by past-practice sluicing to resolve a high-heat safety issue, leaving some free liquid, sludge, and a "hard heel" in the tank. Equipment installed for the recent sluicing retrieval or prior operations remains in the tank as well. The tank is considered sound (i.e., non-leaking) and "partial interim isolated".

Tank 241-C-106 contains approximately 9 kgal of residual sludge waste in the form of hardpan and broken solids. Based on successful retrievals completed at Savannah River and laboratory tests, oxalic acid has been chosen to mobilize this type of waste for retrieval. Oxalic acid will be added to the tank in 30,000 gallon increments. The soak time of the first acid addition is anticipated to be approximately two days. Subsequent acid additions will remain in the tank for up to one week. During the soak time, the acid will be gently agitated/re-circulated within the tank. All spent acid additions will be transferred to tank 241-AN-106 prior to each fresh acid addition.

1.2 Purpose

Several material compatibility assessments have been performed. The purpose of these evaluations were to ensure that appropriate materials are included within the design of the acid dissolution waste retrieval system to preclude premature equipment failure (new and existing) due to the acid solutions utilized in the waste retrieval process. These assessments focused on two transfer system safety-related components, the leak detectors, and the back flow pressure transmitters. Additionally, the assessment considered the new transfer pumps, the tank ventilation system, the flush system, and miscellaneous equipment down stream of the HEPA filters.

2.0 MATERIAL COMPATIBILITY ASSESSMENT

Oxalic acid will be added to tank 241-C-106 in 30,000 gallon increments for the sludge dissolution project. The soak time of the first acid addition is anticipated to be approximately one day. Subsequent acid additions will remain in the tank for up to one week. It has been determined that approximately 180,000 to 210,000 gallons of 0.9 molar (0.9M) oxalic acid are needed and will be added in seven shipments over a period of approximately ten weeks. The temperature of the oxalic acid will be added to the tank at approximately 70°F to 80°F.

The material compatibility assessment process included determination of the chemical resistance or compatibility of the various materials that may be wetted by the oxalic acid solution based on operating temperatures and acid concentration. This process utilized a review of reference material from the Hanford Technical Library, text and reference material, corrosion and material degradation literature, vendor information, reports from the Savannah River Site acid dissolution retrievals, Russian sludge dissolution/corrosion experiments from the Russian Scientific Technology Center and Pacific Northwest National Laboratory reports. Where corrosion-rate data references were in conflict, the worst-case scenario data was used to estimate exposure effects on materials. When the exact environment a component was expected to see was unknown, the worst-case environmental conditions were assumed. These assessments have been included as attachments to this document.

2.1 Component Assessments

2.1.1 Transfer System Safety Related Components

The assessment determined that the pressure transmitter and its attendant sheathed cable should operate satisfactorily for the anticipated life of the pumping system. The Pump Pit and Heel Pit leak detectors should operate effectively for short-term exposures (up to five-days based on engineering judgment). After any leak is resolved, the detector should be inspected/replaced to ensure consistent operation. The new pump is expected to operate satisfactorily given the low temperatures expected (<120°F, 50°C), and the specified materials of construction. Refer to Attachments A, B, and C for a more detailed discussion of the material compatibility of these components.

2.1.2 Ventilation System Components

The assessment of the ventilation system for compatibility with anticipated oxalic acid vapors and aerosols concludes there will be negligible oxalic acid vapor that enters the ventilation system. Using Henry's Law, the molar concentration (or molar fraction) of oxalic acid in the vapor space was determined to be 2.096×10^{-9}, confirming that the oxalic acid vapors are negligible. The molar concentration analysis will be included in the acid dissolution project design summary report (RPP-16708).

It was also concluded that due to the design of the in-tank chemical mixing assembly and acid addition system, few aerosols will be created during waste retrieval using the acid dissolution process. The drop leg that will be utilized for oxalic acid additions discharges into a 10-inch schedule 40 pipe which projects the acid into the tank within a few inches of the tank bottom. Oxalic acid may also be introduced to the tank through the eductor, which is located at the bottom of the tank, minimizing aerosols. During acid mixing, the eductor is submerged in the acid-waste mixture, also minimizing aerosols.

All components in the ventilation system and its condensate return system are expected to operate satisfactorily for the duration of the acid dissolution campaign. The majority of the components of the ventilation system are stainless steel with a few items being carbon steel. The stainless steel components have been determined to be acceptable for the life of the project. Stainless steels, both 304 and 316, are expected to have similar corrosion rates. Stainless steels and carbon steels are generally rated unsatisfactory for oxalic acid for long-term use due to corrosion rates greater than 50 mils per year and 200 mils per year at 60°F, respectively, with greater corrosion rates at elevated temperatures. However, due to the shortened life of this project (approximately 3 months), and low operating temperature (70 to 90°F) stainless and carbon steel components are not expected to suffer significantly. Additionally, these corrosion rates are given for materials immersed in oxalic acid. Components in the ventilation system will not be immersed in oxalic acid and will only be exposed to minimal/negligible oxalic acid vapors and aerosols. Other components consist of neoprene, Cilran, Teflon, polyester and Buna-N. These components are not expected to be significantly affected by the oxalic acid.

Some components that were initially of concern were the pre-filter, HEPA filter, gel seal and Garlock 3000 gasket. The Garlock 3000 gasket is composed of aramid fibers with a nitrile binder. The aramid fibers will degrade quickly at elevated temperatures ($T \geq$ 210°F or 99 °C) in oxalic acid. However, with the expected operating temperature ($T \approx$ 70-80°F or 20-25 °C), short project life and inclusion of nitrile binder, the gasket is unlikely to be significantly affected. Refer to Attachment D for additional details regarding each components compatibility assessment. The filters are discussed in the next section, Ventilation System Safety Related Components.

The heater coil and fins are constructed of stainless steel. Stainless steel is not recommended for long term use, with corrosion rates of 50 mils per year, increasing with temperature. If aqueous oxalic acid droplets come into contact with these components, there may be some pitting. Eventually, the aqueous oxalic acid droplets will evaporate leaving behind the powder form of oxalic acid, which is not a corrosion concern.

Methods to evaluate the impact of the oxalic acid on the portable exhauster will be developed and applied by the project to determine the future usability of the unit.

2.1.3 Ventilation System Safety-Related Components

Approximately 99 percent of the oxalic acid aerosols will be removed by the demister, protecting the pre-filter and HEPA filter. In addition, the heater upstream of the filters is expected to raise the temperature of the air stream 10+ °F, which will minimize condensation of oxalic acid on the filter media. The demisters, heater and HEPA filters will protect the continuous air monitor (CAM) and subsequent equipment down stream of the HEPA filters from contact with the acid aerosols.

The sample tubing and internal components of the CAM sample head have been evaluated and will maintain operability for the minimum required 10 minutes (as required by HNF-SD-WM-SAR-067 Rev. 3) in the event that the HEPA filters breach. Refer to Attachment G for the record of conversation detailing the AMS-4 CAM resistance to oxalic acid.

2.1.4 Flush System

The flush system is designed to carry water to the Flygt pump for the purpose of flushing waste lines and will be used to introduce acid into the tank for the dissolution process. Therefore, the flush system was investigated for material compatibility. The majority of the system is constructed of 316 stainless steel with some brass and carbon steel components. Non-metallic components are Ethylene Propylene Diene Terpolymer (EPDM). These components would be a concern in a long-term design life (>1 year) or at temperatures >300°F (150 °C), but are adequate for short-term use at the expected operating temperature (T = 70-80° F or 20-25 °C). Refer to Attachment E for a component-by-component assessment of the ability of the flush system to function in oxalic acid.

2.1.5 Miscellaneous Equipment

The Enraf assembly will be used to detect liquid levels within the tank. Accordingly, components of the Enraf assembly were evaluated for compatibility with oxalic acid. The displacer body, or plummet, for this assembly is constructed of ultra-high molecular weight polyethylene (UHMWPE). UHMWPE is rated acceptable for use with oxalic acid. Other components that were addressed consist of the snap wire and the level gage wire. The snap wire is comprised of 300 series SST and is rated satisfactory, as it is not expected to be immersed in oxalic acid. The level gauge measuring wire material is comprised of platinum –20 percent iridium. There is no reference data readily available to provide a corrosion rate for this material. Platinum in general is resistant to acid attack and data for platinum –10 percent iridium is rated as resistant. However, it is recommended that the Enraf assembly be used for periodic manual level detection, providing additional protection to the associated wires.

3.0 REFERENCES

HNF-SD-WM-SAR-067, Rev. 3, *Tank Waste Remediation System (TWRS) Final Safety Analysis Report (FSAR)*, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-16708, *241-C-106 Acid Dissolution Waste Retrieval System Design Summary Report*, CH2M Hill Hanford Group, Inc., Richland, Washington.

Attachment A

Materials Compatibility – Pump Components and Materials

Date: April 2, 2003

To: M. White cc. M. Feldmann

From: E. B. Schwenk

Subject: **MATERIALS COMPATIBILITY – PUMP COMPONENTS AND MATERIALS**

INTRODUCTION

Single-shell tank (SST) 241-C-106 has had its liquid waste pumped out with the plan that the remaining waste solids will be removed by in-tank oxalic acid-dissolution and pump-out. The 530 kgal tank retains a residual sludge waste that is estimated to be about 9,000 gal.

Two pumps are planned to be used to remove acid-dissolved waste. The first unit is presently in-place. Although designed and built for normal caustic-waste pumping, the present Flygt pump may function for a limited but useful time, for pumping out an oxalic acid-dissolved solid combination. It is planned to be run-to-completion or failure, whichever occurs first. A second Stancor pump assembly has been designed by ARES Corporation, for oxalic acid service.

This memo presents the results of a compatibility assessment. Its intent is to estimate the chemical resistance (or compatibility) of the various pump materials to oxalic acid, as a basis for minimizing service-induced degradation. In addition, a maximum operating temperature is recommended.

SUMMARY and CONCLUSIONS

The new Stancor pump assembly is expected to operate satisfactorily provided the operation temperature is restricted to < 120° F (~50° C). Operation at a temperature as high as 175° F (~80° C) is possible however, for shorter operation times estimated at 500 to 1,000 hr.

For waste-wet components, the stainless steels are the corrosion-limiting metals. Aramid fibers in a waste-wet gasket appears to be the temperature-limiting (about 210° F, 99° C, max.) nonmetal component. Premature failure of a tefzel liner, in a flowmeter, might lead to a premature pitting corrosion failure of its carbon-steel body.

DISCUSSION

The attached table (Table 1) is a compilation of corrosion or degradation effects of the materials of construction of a range of pump materials whose internals are wet by oxalic acid-water solutions (generally 4 and 8 wt. %). For pump materials in the pump pit, the general environment (termed vapor space) is expected to be high-humidity air. However, if some spray-leakage of oxalic acid-dissolved waste occurs, it could degrade pump component external surfaces. Estimated degradation behavior is presented for both of these environmental conditions.

Corrosion resistance data for metals, as well as degradation data for nonmetals, are generally obtained by experimental testing the material in a solution of a single chemical dissolved in water. Occasionally, some corrosion tests are conducted in a mix of chemicals in order to develop more prototypic data. In fact, most of the Hanford waste tank carbon-steel corrosion test data were developed with prototypic mixes of non-radioactive chemical species. In contrast, most of the relevant oxalic acid-corrosion test data available are based on single component tests. Thus, it is possible that oxalic acid-bearing waste solutions could be either less or more aggressive than the oxalic acid-water-only solutions that are considered.

The following table compares pump component materials with expected degradation rates caused by 4 and 8 wt. % oxalic acid in water. These two levels are expected to bracket in-tank acid concentrations. Concentrations less than 4% will generally produce lesser rates of degradation. The 8% concentration is lightly less than saturation at room temperature (RT).

Some corrosion-rate data can differ nominally between different data references and is noted, where applicable. In general, worst-case data are used to estimate environmental effects on materials. Further, if it is not clear exactly what environment a given element of a component is exposed to, it is assumed that it is the worst-case (viz., oxalic acid), until otherwise known.

Reference data was obtained from Hanford Library text and reference books, corrosion/material degradation literature, Hanford and Savannah River Site documents, Russian Scientific Technology Center Mining and Chemical Combine (with Sandia National Laboratories) documents, and material supplier company websites. A number of these documents are cited elsewhere for other components such as compatibility assessments for a leak detector (Ref. 1), a pressure transmitter (Ref. 2) and a review of American and Russian corrosion documents (Ref. 3). Specific references that were used to construct Table 1 are listed on that table.

PUMP MATERIALS BEHAVIOR IN OXALIC ACID AND TANK VAPOR SPACE

Table 1, Corrosion Effects of Oxalic Acid on Pump Components and Materials for C-106 Waste Dissolution, covers 14 manufacturing companies and comprises 23 different components. An explanation of the table follows.

The vendor name, part description, part number, and part breakdown are presented in the first four columns. Three columns detailing the part's material(s) of construction, its material condition (e.g., heat treatment), and the environment of operation follow this. For example, during normal operation of the upper portion of the pump, it is expected to be exposed mainly to humid-air. Should a waste leak occur in the pump pit, this is termed "an oxalic acid leak-spray." The corroding effect of the leak-spray is considered to be equivalent to immersion, which is likely a worst-case condition compared to a short-term spray exposure. The pump pit drain would have to be plugged and the leak-spray severe and sustained, in order to immerse the pump. The pump internals, of course, will be exposed to oxalic acid-waste.

The eighth column describes the expected "Uniform (or General) Corrosion-Rate" for metals. For nonmetals the term, "Degradation Condition" is presented. Nonmetals often degrade by water absorption (swelling) and/or cracking. Generally very little information exists for stress-cracking of either metals or nonmetals. None was found for the effect oxalic acid on the noted materials, but that doesn't mean that such a failure won't occur. In addition, this column in the Table contains a significant amount of corrosion shorthand. For example, the term "mpy" stands for the rate-of-thickness loss of metal, in mils (or thousandths-of-an-inch) per year. It is often reported in other forms (in/day, microns/hr, etc.) but they were normalized here to the single unit, mpy.

The last two columns contain salient "Comment/Questions," and the term "Acceptability" level for operation of the given component in its noted environment(s).

For brevity, materials corrosion or degradation behavior is discussed in the following narrative, based on categories of materials, as opposed to individual components. The effect of environment, on individual component materials, is detailed in Table 1. For discussion, the metals and nonmetals evaluated are broken down as follows:

METALS

Carbon-steel. This term generally means mild steel (i.e., with a carbon content that is low enough such that the metal is not hardenable by heat treatment). One low-alloy, heat-treatable steel used, was AISI 4140. In general, both mild steels and the 4140 low-alloy steel, will experience about the same corrosion-rate in humid air and in oxalic acid, respectively.

Stainless steel. The stainless steels (SS) used are type 316, CF8M (a cast-equivalent of type 316), and two, nearly-the-same precipitation hardenable (PH) alloys referred to as PH 17-4 and PH 15-5. For the purpose of this memo, they are similar in their corrosion behavior to oxalic acid. Type 316 is referred to as an austenitic SS and is normally used in an annealed or cold-worked condition.

NONMETALS

Nonmetals are broken down into two categories: Plastics and Elastomers and Linings.

Plastics. Plastics used are: ultrahigh molecular weight polyethylene (UHMWPE), glass fiber, polytetrafluoroerthylene (PTFE, also called teflon), polyamide (aramid fiber, termed Nomex), tefzel (ETFE), and fluoropolymer (FEP). The terms of nomenclature noted here for nonmetals were taken from Ref. 4.

Elastomers and Linings. These include neoprene GR-M (GRS), ethylene propylene diene monomer (EPDM), epoxy, and silicone rubber.

GENERAL DEGRADATION BEHAVIOR OF METALS AND NONMETALS

Those component materials that are pump service-limiting, are selected metals (viz., the stainless steels, type 316 and the PH alloys). Recommended pump operation temperature levels are more restricted because of the behavior of these metals than most of the nonmetals. It will be argued that maintaining pump-internal temperatures to $< 120^\circ$ F ($\sim 50^\circ$ C), should ensure a relatively long service life. Short-term higher temperatures, say up to about 175° F ($\sim 80^\circ$ C) are feasible. At the latter temperature, the service-limiting material transfers to Aramid fibers in an EPDM gasket. Very limited data suggest that pump operation for 500 to 1,000 hr may be satisfactory.

Metals. As noted above, the assumed corrosion-environmental conditions are humid air (pump pit vapor space) and oxalic acid (4 & 8 wt. %). A leak-spray in the pit is considered to be equivalent to the worst-case condition of immersion. The reader will note that in Table 1, some manufacturers rate stainless steels ranging from "satisfactory" to "not resistant," and even "unsatisfactory," for oxalic acid service. Such a wide range of callouts often reflects engineering differences regarding their rating systems and sometimes represents experience where some dissolved impurities (in the solutions or in actual fluid feeds) can cause a greater metal loss. Further, for some components, a relatively small loss of metal can have a more damaging effect (e.g., leakage around seals or gaskets, or loss of close tolerances in closer-contacting metal parts) than a larger loss in other, less dimension-restricted components.

Corrosion of type 316 (including its partner alloy 304) and PH 17-4 SS are temperature-limited primarily because their corrosion-rates increase rapidly with increasing temperature and could be more aggressive due to other dissolved chemical species in the waste. Savannah River staff (Ref. 5) found that corrosion rates as high as 80 to 600 mpy occurred at boiling, and 60 to 100 mpy at 176° F (~ 80° C) for type 304 SS for oxalic acid alone. They also found that PH 17-4 started out with a corrosion rate > 500 mpy (4-hr exposure) at 195° F (~90° C), but slowed to about 16 mpy after about 167-hr exposure. Because other chemical components in Hanford waste will be dissolved by the oxalic acid, a reduced operation temperature appears justified.

A thrust bearing (in a Flow-Tek ball valve), composed of 50% teflon and 50% 316 SS, might suffer some long-term disintegration in oxalic acid. It is assumed that its structure is a sintered, porous metal with teflon that was pressure-fed into the porous metals' interstices. In addition, such porous metals tend to be more brittle than their base metal parent due to oxidation during sintering. Thus, a small corrosion loss of the metal might lead to some structural failure under load, leading to extrusion and loss of the teflon.

Carbon-steel components are located in the pump pit vapor space and will generally be exposed only to humid air. A leak-spray of oxalic acid could produce a worst-case steel immersion corrosion-rate possibly as high as 200 mpy (see Table 1 for details). Because such a condition would exist only for relatively short time periods, most carbon-steel components will not suffer significantly. One exception could be the ABB flowmeter, which has a carbon-steel body with a tefzel liner. Should the liner fail early in the life of the pump, some corrosion-induced body leakage by pitting corrosion might occur.

Nonmetals. All of the normally waste-wet nonmetals (UHMWPE, EDPM, PTFE and Tefzel) are highly resistant to oxalic acid at temperatures generally exceeding 212° F (~ 100° C). Some non waste-wet components such neoprene and silicon rubber are limited to about 70 to 80° F (21 to 26° C) but in oxalic acid. Since humid air is the dominant vapor space environment, they are unlikely to be significantly affected. FEP is oxalic acid-resistant to about 390° F (~ 280° C) and is of no concern.

A gasket composed of aramid fibers (namely Nomex) in an EPDM binder appears to be the most temperature-limiting, waste-wet nonmetal component. Nomex fiber loses 41 to 80% of its strength at 210° F (~ 99° C). after a 1,000 hr exposure in oxalic acid (See Table 1 for reference). The fiber appears to be a strengthening element for the EPDM. A strength loss in the fiber might lead to premature extrusion or failure of the gasket at about 212° F (~ 100° C).

List of References

1) Memo, Schwenk, E. B. to M. White, March 19, 2003, "Materials Compatibility Listing – Leak Detector," ARES Corporation, Richland, Washington. (Appendix C)

2) Memo, Schwenk, E. B. to M. White, April 1, 2003, "Materials Compatibility Listing – Pressure Transmitter," ARES Corporation, Richland, Washington. (Appendix B)

3) Schwenk, E. B. to M. White, March 26, 2003, "Review of Russian Oxalic-Citric Acid Corrosion Publications & American Oxalic Acid Corrosion Publications," ARES Corporation, Richland, Washington.

4) Schweitzer, P. E., 1995, Corrosion Resistance Tables (Metals, Nonmetals, Coatings, Mortars, Plastics, Elastomers and Linings, and Fabrics), Marcel Dekker, New York.

5) Memo, F.T. Wyman to Pl. J. Moroz, et al, May 1980, "Handling of Oxalic Acid," Savannah river Site, Aiken SC.

Table 1. Corrosion Effects of Oxalic Acid on Pump Components and Materials for C-106 Waste Dissolution

Vendor	Part Description	Vendor Part No.	Part Breakdown	Material	Material Condition	Environment	Uniform Corros-rate or Degradation Cond'n[i]	Comment/Question	Acceptability
ACTEK	Hoist Ring	46010	--	4140 CS[a]	--	Pump pit vapor space (VS)	Low in VS: likely < 5 mpy; temporary oxalic acid spray leak , < 200 mpy[12] for immersion.	--	Satisfactory = S
SENSOTEC	Pressure Transmitter	AP121CP, 8A	--	PH[b] 17-4 or 15-5 SS[c]	Ht Trt: likely solution treated and aged.	External: pump pit VS.	External surface: Low (< 5 mpy), comparable to 316 SS[13].	Component should never contact Acid, see component by Red Valve	S for external (Ext.)[m] surface. Part is considered acceptable due to the wetted portion of the transmitter being the internal EPDM liner of the Red Valve Series 48 flanged pressure isolator
SENSOTEC	Cable w Mating Connector	AA114-20	--	PH 17-4 SS	Ht Trt: likely solution treated and aged.	Pump Pit VS	Ext. surface: Low (< 5 mpy), comp. to 316 SS[13]	--	S
FLOW-TEK	2" Ball Valve w butt weld	140200-11002SDFG-NN	Same as 140200-11002SDFG-NB, below.						
FLOW-TEK	2" Ball Valve w butt weld	140200-11002SDFG-NB	Valve Body, A351	CF8M SS (Casting equiv. to Type 316 SS)	Likely Ann[e]	External: pump pit VS. Internal: Oxalic Acid + waste	Ext. surface: < 20 mpy [2] (based on non-cast 316 data). Int. surface: See also info on stem below.	Int. surface: CR > 50 mpy [9, 10] at T > 60°F. CR increases as Temperature elevates	S for ext. surface. Int. surface: S a@ RT and expected operating time, time-limited at higher T's.
			Seat, Cavity Filler	UHMWPE[d]	--		Acceptable[4]; Excellent[5].	Int. surfaces: Keep T < 130° F [2]	S
			Stem	316 SS	Likely Ann.		Ext. surface: < 20 mpy [2 Int. surface:< 20 mpy[2]; Not resistant for long term use[6]; Unsatisfactory for long term use[2,7]. >50 mpy [10]. 10% = 30 mpy @ 122° F; 60-100 mpy @ 176° F; 80-600 mpy @ boiling [9].	Int. surface: CR > 50 mpy [9, 10] at T > 60°F. CR increases as Temperature elevates.[9, 10]	S for ext. surface. Int. surface: S @ RT and expected operating time, time-limited at higher T's.
			Thrust washer	15% glass fiber + 85% PTFE	--		Epoxy fiberglass –recommended[8]; Teflon-recommended[8]	--	S for both ext. & int. surfaces.
			Thrust bearing	50% 316 SS + 50% PTFE	Likely sintered metal w teflon in interstices.		PTFE satisf. Type 316 SS > 50 mpy [10], < 20 mpy[7] 30 mpy @ 122° F[9], etc.	Maintain T < 122° F to control CR < 50 to 100 mpy.[9, 10]	S for both Int. & Ext. surfaces @ RT and expected operating time. Time-limited for Int. surface at T> RT.

(a) CS = carbon-steel (b) PH = precipitation hardenable (c) SS = stainless steel (d) UHMWPE = ultra-high molecular weight polyethylene (e) Ann = annealed (f) Ht Trt = heat treatment (g)PTFE = polytetrafluoroethylene (teflon) (h) SCC = stress-corrosion cracking. (i). Comment: Designation of chemical concentration by authors can be misleading; present author has assumed that the term "saturated" (at least for oxalic acid) really means about 10 wt. % at RT. (j) CR = corrosion-rate in mils/year (mpy). (k) VS = vapor space (l) Int. = internal. (m) Ext. = external.

(1) www.howellpipe.com (2) Schweitzer, P. A., 1995, Corrosion Resistance Tables, pp. 2085-2097, Marcel Dekker, Inc., New York. (3) www.setra.com/ (4)www.flowserve.com (5) www.graco.com
(6) www.rosemount.com (7) www.graco.com (8) Hamner, N. E., 1975, Corrosion Data Survey, Nonmetals Section, 5th Edition, National Association of Corrosion Engineers, Houston Texas (9) Wyman, F. T. to P. J. Moroz et al., May 28, 1980, "Petrochemical Department – Savannah River – 200 Areas Materials Engineering Handling of Oxalic Acid," Savannah river Site, Aiken SC. (10) Graver, D. L., 1985, NACE Corrosion Data Survey Metals Section, 6th Edition, Houston Texas.

Table 1. (Continued)

Vendor	Part Description	Vendor Part No.	Part Breakdown	Material	Material Condition	Environment	Uniform Corros-rate or Degradation Cond'n	Comment/Question	Acceptability
RED VALVE CO. INC.	Flanged Pressure Isolator (sensor for 2" pipe body)	Series 48	--	Type 316 SS	Likely Ann.	Ext: Pump pit VS Int: oxalic acid + waste	< 20 mpy[2]; > 50 mpy[10]. Not resistant for long term use[6]; Unsatisfactory for long term use[2,7]. 10% = 30 mpy @ 122° F; 60-100 mpy @ 176° F; 80-600 mpy @ boiling[9].	Int. surface: CR > 50 mpy[9, 10] at T > 60°F. CR increases as Temperature elevates.[9, 10]	S for ext. surface. S for int. surface @ RT and expected operating time; Time-limited for T >RT
				EPDM	--	Oxalic acid + waste	Resistant to 280° F (~140° C)[2]	Recom. T < 122° F in keeping with limitations of other materials Wetted Portion of Pressure Transmitter Assembly (w/Sensotec AP121CP) is the EPDM sleeve	S for both Int. & Ext. surfaces
HART IND, INTL. INC.	Pipe union	3535-8-B-316	--	316 SS	Likely Ann.	Ext: Pump pit VS. Int: oxalic acid + waste	Ext. surface: < 20 mpy[2]; Int. surface: Not resistant for long term use[6]; unsatisfactory for long term use[2,7]. 10% = 30 mpy @ 122° F; 60-100 mpy @ 176° F; 80-600 mpy @ boiling[9].	Int. surface: CR > 50 mpy[9, 10] at T > 60°F. CR increases as Temperature elevates.[9, 10]	S for ext. surface. S for int. surface @ RT and expected operating time; time-limited for T > RT.
	O-Ring		--	EPDM	--		Resistant to 280° F (~140° C)[2]	Recom. T < 122° F in keeping with limitations of other materials	S for ext. and int. surfaces.
GARLOCK	Gasket 3" CL 150 RF Flange 1/8" thick, Compressed fiber	BLUEGARD Style 3700	-	Aramid Fiber w EPDM binder	--	Ext: Pump pit VS. Int: oxalic acid (4%) + waste	Aramid fiber loses 41 to 80% of its strength at 210° F in 1,000 hr.[11] EPDM-resistant (see RED VALVE above)	Aramid fiber strength loss around 122° F (or less), Recom. T < 122° F in keeping with limitations of other materials	Satisfactory at expected operating temperature and limited operating time.
ABB INC	Flowmeter with 30 ft. cable	10D1475-JN12QD28KY12A11 22C1	Body	Welded CS	w epoxy finish	Ext: Pump pit VS.	Ext. surface: C-steel CR likely < 5 mpy; temporary ox. acid leak spray, < 200 mpy[12] immersed. Epoxy coatings unsatisfactory in oxalic acid[2] but S in humid air.	Recom. T < 122° F in keeping with limitations of other materials	S for ext. surface.
				Tefzel liner	--	Int: oxalic acid + waste	Int. surface: Resistant to 220° F (~104° C)[2]	Recom. T < 122° F in keeping with limitations of other materials	S for int. (Tefzel) surface.
				Elec. cable	--	Pump pit VS.	Sat. in VS. May not be resistant to ox. acid immersion.	--	Likely S
BAND-IT	SST Cable Tie	Self-Lok K014	--	316 SS	Likely Ann.	Pump pit VS.	Ext. surface: < 20 mpy[2];	--	S for ext. surface.

(11) www.Dupont.ca, also in Tech Info Bulletin H-52720, April 1999. (12) Memo E. B. Schwenk to File, March 26, 2003, "Review of Russian Oxalic-Citric Acid Corrosion Publications & American Oxalic Acid Corrosion Publications," ARES Corporation Richland, WA. (13) ASM 1987, Metals Handbook, Ninth Edition, Vol. 13, Corrosion, p. 550, ASM International, Metals Park, Ohio.

Table 1. (Continued)

Vendor	Part Description	Vendor Part No.	Part Breakdown	Material	Material Condition	Environment	Uniform Corros-rate or Degradation Cond'n	Comment/Question	Acceptability
CROUSE-HINDS	Strain Relief Cord connector	CGB-194	Bushing	CS w Zn electroplate	--	Pump pit VS.	Ext. surface: C-steel CR likely < 5 mpy; temporary ox. acid leak spray, < 200 mpy(12) immersed. .	Zn electroplate not resistant to ox. acid spray-leak.	S in VS
			Gland nut	Neoprene	--		OK in VS. Resistant @ RT to 50% oxalic acid leak spray; unsat. for immersion at T > RT.	--	S in VS
	Cable Strain Relief Grip	RPE 417-115	Nut	Aluminum	--	Pump pit VS.	Likely < 5 mpy for VS. Temporary spray-leak of oxalic acid @ RT < 20 mpy(8) immersed. @ 100° F 20-50 mpy(8).	--	S in VS
			Mesh	316 SS	Likely Ann.		Ext. surface: < 20 mpy(2);	--	S in VS
	Cable fitting, 1" C-Form C	CGB-397	Bushing	CS w Zn electroplate	--	Pump pit VS.	Likely < 5 mpy for VS. Temporary ox. acid leak-spray < 200 mpy (12).	--	S in VS
			Gland nut	Neoprene	--		OK in VS. Resistant @ RT to 50% oxalic acid leak spray; unsat. for immersion at T > RT.		
	1" Plug	PLG-3	--	Neoprene	--	Pump pit VS.	OK in VS. Resistant @ RT to 50% oxalic acid leak spray; unsat. for immersion at T > RT.	--	S in VS
THERMON	Connection Power Kit, Heat Trace	ECA-1-SR	--	Cast Al	--	Pump pit VS	Likely < 5 mpy for VS. Temporary spray-leak of oxalic acid @ RT < 20 mpy(8) immersed. @ 100° F 20-50 mpy(8).	--	S in VS
	Termination Kit, End of Circuit	ET-6C	--	Silicone	--	Pump pit VS	OK in Vapor space. Resistant to 80°F in oxalic acid leak-spray; unsat. at T > 80°F(2) for immersion.	--	S in VS
	Cable heat Trace, 12 W/FT W Over Jacket	TSX-12-1-BNOJ	Ni-plated Cu bus wires	Ni	--	Pump pit VS	Likely < 5 mpy in VS. 20-50 mpy for Ni immersed in oxalic acid(8) leak-spray.	Assumption: both jacket and wire insulation breached.	S in VS
			Wire Insulation	Fluoropolymer Insulation (FEP)	--	Pump pit VS	Resistant in VS. Resistant to acid leak-spray immersion at 390° F(2).	Assumption: jacket breached.	S in VS
			Jacket	Fluoropolymer Insulation (FEP)	--	Pump pit VS	Resistant in VS. Resistant to acid leak-spray immersion at 390° F(2).	--	S in VS

Table 1. (Continued)

Vendor	Part Description	Vendor Part No.	Part Breakdown	Material	Material Condition	Environment	Uniform Corros-rate or Degradation Cond'n	Comment/Question	Acceptability
OMEGA	Thermocouple Type "T"	TJ600-SCPSS-125-G6 or TJ600-CPSS-116C-6	Sheath	CS	--	Pump pit VS	Likely < 5 mpy for VS. Temporary ox. acid leak-spray immersion < 200 mpy [12].	--	S in VS
			J type Thermocouple material	Steel surrounds thermocouple matl	--	Pump pit VS	Likely < 200 mpy for ox. acid leak-spray immersion.	--	S in VS
GEDNEY	Reducer, 1" x ½"	RB323S	--	CS w electroplate Zn	--	Pump pit VS	Likely < 5 mpy for VS. Temporary ox. acid leak-spray immersion < 200 mpy [12].	--	S in VS
3M INC.	Glass Cloth Tape, ¾" Width	27	--	Woven glass cloth w adhesive.	--	Pump pit VS	Satisfactory for VS. Adhesive likely degraded by ox. acid leak-spray.	--	S for VS.
Flygt Pump	Rotor	Unk.	Unk.	Unk.		Oxalic acid + waste	Unk.	Flygt Pumps are being operated with "run to failure" operating principle. Therefore, material compatibility was not considered.	Unk.
	Stator	Unk.	Unk.	Unk.		Oxalic acid + waste	Unk.		Unk.

Attachment B

Materials Compatibility – Pressure Transmitter

Date: April 1, 2003

To: M. White cc. M. Feldmann

From: E. B. Schwenk

Subject: **MATERIALS COMPATIBILITY LISTING – PRESSURE TRANSMITTER**

Introduction

Single-shell tank (SST) 241-C-106 has had its liquid waste pumped out with the plan that the remaining waste solids will be removed by in-tank oxalic acid-dissolution and pump-out. The 530 kgal tank retains a residual sludge waste that is estimated to be about 9,000 gal.

Continuous monitoring for waste fluid pressure, using pressure transmitter, PE 101, is required to ensure that the transfer line flush connection is PHYSICALLY DISCONNECTED from the active C-106 waste transfer pump.

Pressure Transmitter Behavior in Oxalic Acid Waste

The following table is a compilation of corrosion or degradation effects of the materials of construction of the pressure transmitter. The pressure transmitter is constructed of three different components. The components are: Sensotec pressure transmitter and electrical cable and a Red Valve Series 48 pressure isolator. The Sensotec pressure transmitter is isolated from the process fluid by the Red Valve series 48 isolator. The internal portion of the Red Valve isolator is a EPDM sleeve wetted by oxalic acid solutions (viz., 4 and 8 wt. %). The environment around the external surface of the transmitter is assumed to be high-humidity air. Should a spray-leak occur in the pump pit, the external surface of the transmitter could be exposed to oxalic acid-dissolved waste. Thus, estimated corrosion-rate conditions are presented for both conditions (humid air and acid).

Corrosion resistance data for metals, as well as degradation data for nonmetals, are generally obtained by testing the material in a solution of a single chemical dissolved in water. Occasionally, some corrosion tests are conducted in a mix of chemicals in order to develop more prototypic data. In fact, most of the Hanford waste tank carbon-steel corrosion test data were developed with a prototypic mix of non-radioactive chemical species. In contrast, most of the relevant oxalic acid-corrosion test data available are based on single component tests. Thus, it is possible that oxalic acid-bearing waste solutions could be either less or more aggressive than the oxalic acid-water-only solutions that are cited below.

Table 1. Effect of Oxalic Acid on Pressure Transmitter Materials

Vendor	Component	Material	Environment	Corrosion-Rate (or Degradation)	Acceptability
SENSOTEC	Pressure Transmitter	PH [a] 17-4 or 15-5 SS[b]	Pump pit vapor space (VS).	Ext. surface: Likely < 5 mpy[d] for humid air. Ox. acid spray-leak, < 20 mpy[3] for immersion.	Satisfactory (S) for ext. surface. S for int.surface. Recom. maintain T < 120° F to control CR < 100 mpy[4]. Part is considered acceptable due to the wetted portion of the transmitter being the internal EPDM liner of the Red Valve Series 48 flanged pressure isolator
SENSOTEC	Electrical Cable w mating connector	PH 17-4 SS Sheathing	Pump pit VS.	Ext. surface: Likely < 5 mpy for humid air. Ox acid leak-spray < 20 mpy[3] for immersion.	S for ext. surface.
RED VALVE CO. INC.	Flanged Pressure Isolator (sensor for 2" pipe body)	Type 316 SS EPDM	Pump pit vapor space (VS). Internal (Int.) surface: oxalic acid[c] + waste.	< 20 mpy[2]; > 50 mpy[10]. Not resistant for long term use [6]; Unsatisfactory for long term use [2,7]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling . Resistant to 280° F (~140° C)	S for ext. surface. S for int. surface @ RT and expected operating time; Time-limited for T >RT S for both Int. & Ext. surfaces

(a) PH = precipitation hardenable alloy.
(b) SS = stainless steel.
(c) Solution of oxalic acid (4-8% in water) plus remaining waste components (possibly some Na-salts, etc.).
(d) Mpy = mils per year.

Discussion

For a normal humid-air environment in the pump pit, no significant corrosion would occur to the external of PH 17-4 or 15-5 stainless steel surfaces of the pressure transmitter. Even if an oxalic acid-waste spray or leak were to occur, total immersion would have to occur to produce a corrosion-rate of < 20 mpy 70° F (~ 21° C) acid temperature level. To ensure that the transmitter corrosion-rate does not exceed 100 mpy, it is recommended that acid temperature level be maintained < 120° F (~ 50° C) during operation. Even assuming an accelerated corrosion rate due to other dissolved waste components, the level would not be significant to a 6-month operation. The wall of the pressure transmitter in direct contact with the acid/waste mixture is an EPDM flexible sleeve that covers the entire 360°internal circumference of the pipe. EPDM is considered a satisfactory material in the acid/waste mixture at the operating conditions (temperature, pressure, etc.).

Conclusion

The pressure transmitter, and its attendant sheathed cable should operate satisfactorily for the anticipated life of the pumping system

References:

1) www.howellpipe.com

2) www.setra.com

3) Schweitzer, Philip A., 1995, Corrosion Resistance Tables, pp. 2085-2100), Marcel Dekker, New York.

4) Memo, Wyman F. T to P. J. Moroz, et al., May 28, 1978, "Petro-chemicals Department – Savannah River – 200 Areas, Materials Engineering, Handling of Oxalic Acid," Aiken South Carolina.

Attachment C

Materials Compatibility – Leak Detector

Date: March 19, 2003

To: M. White cc. M. Feldmann

From: E. B. Schwenk

Subject: **MATERIALS COMPATIBILITY LISTING – LEAK DETECTOR**

Introduction

Single-shell tank (SST) 241-C-106 has had its liquid waste pumped out with the plan that the remaining waste solids will be removed by in-tank oxalic acid-dissolution and pump-out. The 530 kgal tank retains a residual sludge waste that is estimated to be about 9,000 gal.

Continuous monitoring for any leakage within the three transfer pits (viz., heel pit 241-C-06B and central pump pit 241-AN-06A) is planned to be done, using in-place electrical conductivity leak detection probes. These probes sit on the floor of each pit and will annunciate any leakage to the pit bottom that exceeds about 1-in. in depth. The leak detectors are made primarily of stainless steel (SS). To ensure safe and controlled operation, the leak detector probes must be able to operate in the presence of leaked, acidified (oxalic acid) waste containing typical Hanford waste components. The probes operate based on completion of an electric circuit due to ionic current flow between the two SS electrodes.

Leak Detector Behavior in Oxalic Acid Waste

The following table is a compilation of corrosion or degradation effects of the materials of construction of typical leak detectors in an oxalic acid solution (viz., 4 and 8 wt. %) in water. The vapor space above any leaked waste is assumed to be high-humidity air with low concentrations of any of the dissolved waste species. For high-rate leaks some splashing of waste onto other components could occur.

Corrosion data for metals, as well as degradation data for nonmetals, are generally developed for a single chemical species dissolved in water. Occasionally, some corrosion tests are conducted in a mix of chemicals in order to develop more prototypic data. In fact, most of the Hanford waste tank carbon-steel corrosion test data were developed with a prototypic mix of non-radioactive chemical species. In contrast, most of the relevant oxalic acid corrosion test data available are based on single component tests. Thus, it is possible that oxalic acid-bearing waste solutions could be either less or more aggressive than the oxalic acid-water-only solutions that are cited below.

The following table compares leak detector component materials with expected degradation rates caused by 4 to 8 wt. % oxalic acid in water. Corrosion-rates can and do vary nominally between different references, as noted for the SS leak detector frame.

Table 1. Effect of Oxalic Acid on Leak Detector Component Materials

Component	**Material**	**Environment**	**Corros-Rate** (or equiv.)	**Comment**
Leak Detector Frame	SS[(a)]	Oxalic acid[(b)]	< 20 to 20-50 mpy[(c)] for immersion (Ref. 2); > 50 mpy (Ref. 3). Likely much lower for short-term corrosion in vapor space (VS).	Normal dissolved waste components could increase or decrease immersion c-rate of SS frame.
Lk Det. Electrical cable	Soft rubber ('SO')	Oxalic acid[(b)]	For soft rubber or Nitrile Buna N, both are rated U (unsatisfactory) for immersion at T > 80°F, per Ref. 3. Likely ok for short-term exposure in VS.	Soft rubber will swell and/or crack, if immersed in acidic waste. Likely ok for short-term exposure in VS.
Elec. Cable	Cu	Oxalic acid[(b)]	Cu C-rate < 20 mpy (Ref. 2 & 3) for immersion. Likely much less for short-term exposure in VS.	Normal dissolved waste components could increase or decrease immersion c-rate.
Elec. Cable 'CGB' connector	Soft rubber and C-steel[(d)]	Oxalic acid[(b)]	For soft rubber or Nitrile Buna N, both are rated U (unsatisfactory) for immersion at T > 80°F, per Ref. 3. Likely ok for short-term exposure in VS. For C-steel[(d)] c-rate could be 100 to 200 mpy (Ref. 4 and 5), possibly higher. Crevice corrosion and accelerated pitting corrosion also likely.	Soft rubber will probably swell and/or crack if immersed. Likely ok for short-term exposure in VS. Corrosion-rate for C-steel could be increased or decreased by normal diss. waste components. Likely ok for short-term exposure in VS.
Elec. cable	TC	Oxalic acid[(b)]	Cu C-rate < 20 mpy (Ref. 2 & 3) for immersion. Likely much less for short-term exposure in VS.	Soft rubber will swell and/or crack, if immersed in acidic waste. Likely ok for short-term exposure in VS.

(a) SS =Type 304L, 316 or 18-8. [18-8 = 300 series SS, e.g., 304, 316, etc.]
(b) Solution of oxalic acid (4-8% in water) plus remaining waste components (possibly some Na-salts, etc.).
(c) Mpy = mils per year.
(d) C-steel = carbon steel

Discussion

The leak detectors are made mainly of SS. Their lifting bails and electric wire connector fittings are C-steel. Electrical leads to the leak detectors are covered with non-chemically resistant soft rubber. It is assumed that that the individual copper (Cu) wires are further encapsulated by some thermoplastic-type of insulating material. Two types of electrical wire were noted in the Ref. Drawings: SO and TC. The SO leads have a soft rubber outer cover while the term TC is a designation for a "tray cable." The TC is assumed to also have a soft rubber outer layer. Leak-proof carbon-steel fittings are used at the point of entry of the electrical leads into their respective leak detectors.

For a short-term exposure (say less than 5-days) of the leak detectors to waste, some attack of the SS electrode-bolts would be expected, but would not destroy their effectiveness. Some corrosion products might develop on the SS electrode-bolts. If the corrosion products were electrically non-conductive, the detectors might slowly degrade and fail due to non-conductance through the product layer. This however, is unlikely in relatively short exposure times. Further, even assuming an accelerated SS corrosion-rate (say to 200 mpy) the leak detector bodies will still remain intact. Their wall thickness is estimated to be about 1/16-in, or more.

For waste levels that would cover the detector, degradation of the lead's insulation would occur. Eventually some leakage of waste to the internals of the detector would occur, but only after the detector annunciated. Consequently, if a small or large leak occurred, the detector would act as designed. After the leak is acted on, the detector should be replaced.

Conclusion

The pump pit and heel pit leak detectors should operate effectively for short-term exposures (say, up to 5-days). After any leak is resolved, the detector should be replaced to ensure consistent operation. It is possible that the detector could operate for nominally longer times, if required, until in-leakage around the wire entry occurred.

References:

1) Dwg H-2-34965, Shts 1 through 8, dated 1972, 1975, 1993, 1997, 2001, and 2002. Bldg. No: 200G, 241G.
2) NACE (National Association of Corrosion Engineers), 1974, Corrosion Data Survey, Metals Section, 5th Edition, compiled by N. E. Hamner, Houston TX.
3) Schweitzer, Philip A., 1995, Corrosion Resistance Tables, pp. 2085-2100), Marcel Dekker, New York.
4) Elmore, M. R., 1996, "Corrosion of Mild Steel in Simulated Cesium Elution Process Solutions," PNNL-11284, UC-2030, Pacific Northwest National Laboratory, Richland, WA.
5) Sills, J. K., et al., 1996, "Fiscal Year 1995 Laboratory Scale Studies of Cs Elution in Tank 8D-1 and Sludge Dissolution in Tank 8D-2," PNNL-10945, UC-2000, Pacific Northwest National Laboratory, Richland, WA.

Attachment D

Materials Compatibility – Ventilation System

MATERIAL COMPATIBILITY OF VENTILATION SYSTEM

Ventilation System Components

The assessment of the ventilation system for compatibility with anticipated oxalic acid vapors and aerosols assumes there will be negligible oxalic acid vapor that enters the ventilation system. *Using Henry's Law, the molar concentration (or molar fraction)* of oxalic acid in the vapor space was determined to be 2.096×10^{-9}, confirming that the oxalic acid vapors are negligible.

It was also assumed that due to the design of the in-tank chemical mixing assembly and acid addition system, few aerosols will be created during waste retrieval using the acid dissolution process. The drop leg that will be utilized for oxalic acid additions discharges into a 10-inch schedule 40 pipe which projects the acid into the tank within a few inches of the tank bottom. Oxalic acid may also be introduced to the tank through the eductor, which is located at the bottom of the tank, minimizing aerosols. During acid mixing, the eductor is submerged in the acid-waste mixture, also minimizing aerosols.

All components in the ventilation system and its condensate return system are expected to operate satisfactorily for the duration of the acid dissolution campaign. The majority of the components of the ventilation system are stainless steel with a few items being carbon steel. The stainless steel components have been determined to be acceptable for the life of the project. Stainless steels, both 304 and 316, are expected to have similar corrosion rates. Stainless steels and carbon steels are generally rated unsatisfactory for oxalic acid for long-term use due to corrosion rates greater than 50 mils per year and 200 mils per year at 60°F, respectively, with greater corrosion rates at elevated temperatures. However, due to the shortened life of this project (approximately 3 months), and low operating temperature (70 to 90°F) stainless and carbon steel components are not expected to suffer significantly. Additionally, these corrosion rates are given for materials immersed in oxalic acid. Components in the ventilation system will not be immersed in oxalic acid and will only be exposed to minimal/negligible oxalic acid vapors and aerosols. Other components consist of neoprene, Cilran, Teflon, polyester and Buna-N. These components are not expected to be significantly affected by the oxalic acid.

Some components that were initially of concern were the pre-filter, HEPA filter, gel seal and Garlock 3000 gasket. The Garlock 3000 gasket is composed of aramid fibers with a nitrile binder. The aramid fibers will degrade quickly at elevated temperatures ($T \geq$ 210°F or 99 °C) in oxalic acid. However, *with the expected operating temperature* ($T \approx$ 70-80°F or 20-25 °C), *short project life* and inclusion of nitrile binder, the gasket is unlikely to be significantly affected. Refer to Attachment D for additional details regarding each components compatibility assessment. The filters are discussed in the next section, Ventilation System Safety Related Components.

The heater coil and fins are constructed of stainless steel. Stainless steel is not recommended for long term use, with corrosion rates of 50 mils per year, increasing with temperature. If aqueous oxalic acid droplets come into contact with these components, there may be some pitting. Eventually, the aqueous oxalic acid droplets will evaporate leaving behind the powder form of oxalic acid, which is not a corrosion concern.

Methods to evaluate the impact of the oxalic acid on the portable exhauster will be developed to determine the future usability of the unit.

Ventilation System Safety-Related Components

Approximately 99 percent of the oxalic acid aerosols will be removed by the demister, protecting the pre-filter and HEPA filter. In addition, the heater upstream of the filters is expected to raise the temperature of the air stream 10+ °F, which will minimize condensation of oxalic acid on the filter media. The demisters, heater and HEPA filters will protect the continuous air monitor (CAM) and subsequent equipment down stream of the HEPA filters from contact with the acid aerosols.

The sample tubing and internal components of the CAM sample head have have been evaluated and will maintain operability for the minimum required 10 minutes (as required by HNF-SD-WM-SAR-067 Rev. 3) in the event that the HEPA filters breach. Refer to Attachment G for the record of conversation detailing the AMS-4 CAM resistance to oxalic acid.

Table 1
MATERIAL COMPATIBILITY OF VENTILATION COMPONENTS
(Equipment Up to and Including HEPA Filters)

COMPONENT	MATERIAL	MAT'L REF.	CORROSION/ DEGRADATION	COMPATIBILITY
Exhauster Connection				
Connecting Ductwork	ASTM A312 304L Piping, ASTM A240 304L Flanges, ASTM A403 WP 304L	ECN-720070-R0	Rated similar to that of 316 SST[8]. Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
	Fittings, Neoprene gasket for flanged joints.		"Good" in concentrated acid[13, 2].	Satisfactory
Expansion Joint (-EJ-101) (-EJ-102)	Chlorobutyl/Polyester, Garlock Style 9394 Flex joint.	ECN-720070-R0	"Good" in concentrated acid[5]	Satisfactory
	ASTM A240 304L Mounting Flanges.		Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
	Neoprene gaskets.		"Good" in concentrated acid[2].	Satisfactory

COMPONENT	MATERIAL	MAT'L REF.	CORROSION/ DEGRADATION	COMPATIBILITY
Transition	ASTM A240 304L 11 ga. Sheet Metal, 0.125 inches thick.	ECN-720070-R0	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
	ASTM A240 304L Flanges.		Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
	Neoprene gaskets.		"Good" in concentrated acid[2].	Satisfactory
Exhauster Unit				
Inlet Duct	304L Stainless steel.	H-14-102577	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Isolation Dampers (-V-135) (-V-136)	Keystone, 316 SST body, disc and stem.	H-14-102577 and ECN-720070-R0	Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
	Teflon stem packing.		"Outstanding/excellent" in concentrated acid[2]	Satisfactory
	Buna-N (NBR/Nitrile) seat.		"Good" *in concentrated acid*[2]	*Satisfactory*
	Neoprene gaskets for flange mounting.		"Good" in concentrated acid[2].	Satisfactory
Demister	Koch-Otto York Demister, Model 299 Type 3G, 304 SST wire mesh.	H-14-102578	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Heater Coil	SST.	VI96675-227	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Pre-Filter Housing (-FLT-001)	Flanders Filter Housing, Stainless Steel.	H-14-102578	Minimal exposure to oxalic acid due to demister and the heater upstream of the filters, which will	Satisfactory

COMPONENT	MATERIAL	MAT'L REF.	CORROSION/ DEGRADATION	COMPATIBILITY
	Door seals are neoprene.		minimize condensation of oxalic acid on the filter media and associated equipment.	Satisfactory
Pre-Filter (-FLT-001)	FARR Pre-filter. Filter media is microfiber glass. Frame is high wet-strength beverage board.	H-14-102578	Minimal exposure to oxalic acid due to demister and the heater upstream of the filters, which will minimize condensation of oxalic acid on the filter media and associated equipment.	Satisfactory
HEPA Filter Housings (-FLT-002 & 003)	Flanders Filter Housing. Stainless Steel. Door seals are neoprene.	H-14-102578	Minimal exposure to oxalic acid due to demister and the heater upstream of the filters, which will minimize condensation of oxalic acid on the filter media and associated equipment.	Satisfactory
HEPA Filters (-FLT-002 & 003)	Flanders Nuclear Grade HEPA filter with fluid seal. Filter media is non-woven glass paper (boron silicate microfiber) with aluminum separators. Frame is 304 Stainless Steel. Frame-to-media sealant is urethane. Fluid Seal is Flanders Blu-Jel Seal. Faceguard is 18 ga. Stainless steel.	H-14-102578	Minimal exposure to oxalic acid due to demister and the heater upstream of the filters, which will minimize condensation of oxalic acid on the filter media and associated equipment.	Satisfactory
HEPA Filter Change-out Bag	8 mil PVC.	H-14-102578	Minimal exposure to oxalic acid due to demister and the heater upstream of the filters, which will minimize condensation of oxalic acid on the filter media and associated equipment.	Satisfactory
Test Sections	Stainless steel.	H-14-102578	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Vacuum Pumps	Stainless steel.	H-14-105208	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
CAM tubing	Stainless steel.	H-14-105280	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.

COMPONENT	MATERIAL	MAT'L REF.	CORROSION/ DEGRADATION	COMPATIBILITY
Condensate System				
Condensate Lines	Stainless Steel.	H-14-102578	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Isolation Valves (-V-160) (-V-161) (-V-162) (-V-163) (-V-164) (-V-165) (-V-166)	304L Stainless Steel.	H-14-102578	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Seal Pot (SP-001)	Stainless Steel.	H-14-102578	Rated similar to that of 316 SST[8] Not Resistant for long term use[6]; unsatisfactory for long term use[1,2]. 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling [7].	Satisfactory at expected operating temperature and limited operating time.
Liquid Level Sensor	Drexel Brook 508-45-709 probe, Teflon.	H-14-102578	Recommended at T ≤ 860° F (460° C)	Satisfactory
Seal Pot Pump (P-004)	Pump is a Randolph Austin 610-100 peristalic (only tubing is in contact with acid). Tubing is Cilran, a thermoplastic rubber.	H-14-102578	Manufacture rated Cilran tubing as "good"[3].	Satisfactory
Condensate Return Line	ASTM A106 piping, ASTM A105 Carbon Steel fittings, ASTM A234 B16.9 reducer, ASTM A193 flange.	ECN-720070-R0	Components of carbon steels, generally mild steels, will all experience about the same corrosion rate[8]. Immersion < 200 mpy [9].	Satisfactory at expected operating temperature and limited operating time.
	Garlock 3000 gasket, aramid fiber with nitrile binder.		Aramid fiber loses 41 to 80% of its strength at 210 °F (99° C) in 1,000 hr.[4] Nitrile is resistant[1].	Satisfactory at expected operating temperature and limited operating time.

mpy = mils (thousands of an inch) per year

References:

(1) Schweitzer, P. A., 1995, Corrosion Resistance Tables, pp. 2085-2097, Marcel Dekker, Inc., New York.
(2) www.graco.com
(3) Email from Bob Finger [bfinger@randolphaustin.com] Subject: Re: Compatibility of Cilran tubing, April 4, 2003
(4) www.Dupont.ca, also in Tech Info Bulletin H-52720, April 1999.
(5) Garlock Sealing Technologies, Garlock Inc., 2002, Expansion Joint Technologies Guidelines, Palmyra NY.
(6) www.rosemount.com
(7) Wyman, F. T. to P. J. Moroz et al., May 28, 1980, "Petrochemical Department – Savannah River – 200 Areas Materials Engineering Handling of Oxalic Acid," Savannah river Site, Aiken SC.

(8) Schwenk, E.B. Memo: *Materials Compatibility – Pump Components and Materials.* April 2, 2003.
(9) Schwenk, E.B. Memo:, *Review of Russian Oxalic-Citric Acid Corrosion Publications & American Oxalic Acid Corrosion Publications*, March 26, 2003.

Attachment E

Materials Compatibility – Flush System

Materials Compatibility – Flush System

The flush system is designed to carry water to the Flygt pump for the purpose of flushing waste lines and will be used to introduce acid into the tank for the dissolution process. Therefore, the flush system was investigated for material compatibility. The majority of the system is constructed of 316 stainless steel with some brass and carbon steel components. Non-metallic components are Ethylene Propylene Diene Terpolymer (EPDM). These components would be a concern in a long-term design life (>1 year) or at temperatures >300°F (150 °C), but are adequate for short-term use at the expected operating temperature (T = 70-80° F or 20-25 °C). The following table provides a component-by-component assessment of the ability of the flush system to function in oxalic acid.

Component	Material	Material Ref	Compatibility with Oxalic Acid
Tee 2" Class 150, THD, GALV	ASTM A197	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Elbow 45, 2" Class 150, THD, GALV	ASTM A197	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Bushing, RDCG, 2x1 THD	ASTM A197	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
PIPE, 2" Sch 40 TBE Length AR, SMLS OA WELED CS	ASTM A53, TYPE E GR B or ASTM A106	ECN-720276 R0	Carbon Steel, will corrode at a rate of greater than 50 Mils/ year
PIPE, 2" Sch 40 TBE Length AR	ASTM A312 GR TP 304L	H-14-105661 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
DURABLA-Check Valve PART NUMBER 8374SW	316 SST w/Inconel spring	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Hart Industries Union Female with EPDM O-Ring--3531-8-E316L	O-Ring EPDM Union----316L SST	ECN-720276 R0	EPDM is fine 10% Oxalic Acid, The Stainless Steel will corrode at a rate of greater than 50 mils/year [1]
Hansen Coupling Quick Disconnect, 1" socket end B8-HP36	Brass	H-14-105661 R0	Will corrode at a rate of less than 50 mils/year—Will be fine with the 10-week job durations
Ashcroft—Pressure gauge 251009SWL021	316 Stainless	H-14-105661 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Coupler---200DWBPSTSS	Stainless Steel	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job

Component	Material	Material Ref	Compatibility with Oxalic Acid
			duration
Dixon 200-A-SS	Stainless Steel	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Female Hose Nipple	Service Brass or equal	ECN-720276 R0	Will corrode at a rate of less than 50 mils/year—Will be fine for the short-term job duration
Concentric Reducer	ASTM A197	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration
Pipe 1" schedule 40 THD, Length AR	ASTM A53, TYPE E GR B or ASTM A106	ECN-720276 R0	Carbon Steel, will corrode at a rate of greater than 50 Mils/ year
Bushing RDGD 1" x ¼" THD	ASTM A197	ECN-720276 R0	Stainless Steel will corrode at a rate of greater than 50 mils/year[1] Will be fine for the short-term job duration

1. Schweitzer, Philip A., 1995, *Corrosion Resistance Tables,* pp. 2085-2100, Marcel Dekker, New York

Attachment F

Materials Compatibility – Miscellaneous Equipment

MATERIAL COMPATIBILITY OF MISCELLANEOUS EQUIPMENT

The Enraf assembly will be used to detect liquid levels within the tank. Accordingly, components of the Enraf assembly were evaluated for compatibility with oxalic acid The displacer body, or plummet, for this assembly is constructed of ultra-high molecular weight polyethylene (UHMWPE). UHMWPE is rated acceptable for use with oxalic acid. Other components that were addressed consist of the snap wire and the level gage wire. The snap wire is comprised of 300 series SST and is rated satifactory, as it is not expected to be immersed in oxalic acid. The level gauge measuring wire material is comprised of platinum –20 percent iridium. There is no reference data readily available to provide a corrosion rate for this material. Platinum in general is resistant to acid attack and data for platinum –10 percent iridium is rated as resistant. However, it is recommended that the Enraf assembly be used for periodic manual level detection, providing additional protection to the associated wires.

Table 1
Material Compatibility of Miscellaneous Equipment

COMPONENT	MATERIAL	MAT'L REF.	CORROSION/DEGRADATION	COMPATIBILITY
Enraf Displacer Body	Ultra-High Molecular Weight Polyethylene (UHMWPE)	H-2-817634	Acceptable(1); Excellent(2). Int. surfaces: Keep T < 130° F (2)	Satisfactory
Snap, 0.094 Wire	300 Series SST	H-2-817634	Rated similar to that of 316 SST(3). Not Resistant for long term use(4); unsatisfactory for long term use(5,6). 10% = 30 mpy @ 120° F; 60-100 mpy @ 175° F; 80-600 mpy @ boiling (7).	Satisfactory at expected operating temperature and limited operating time.
Level Gauge measuring wire (PN9954.962)	Platinum 20% iridium	H-2-817634 (VI-31560)	Data not readily available for platinum-20% iridium. Data for platinum-10% iridium rated as resistant.(4)	Component expected to perform satisfactory.

(1)www.flowserve.com (2) www.graco.com (3) Schwenk, E.B. Memo: *Materials Compatibility – Pump Components and Materials*. April 2, 2003. (4) www.rosemount.com (5) Schweitzer, P. A., 1995, Corrosion Resistance Tables, pp. 2085-2097, Marcel Dekker, Inc., New York. (6) www.graco.com

Attachment G

ARES RECORD OF CONVERSATION WITH EBERLINE SALES ENGINEER REGARDING THE AMS-4 CONTINUOUS AIR MONITOR OXALIC ACID COMPATABILITY

ARES
CORPORATION

RECORD OF CONVERSATION

DATE:	May 29, 2003	**TIME:**	12:50 pm	**FILE:**	03RL05104
MEETING		**T-CON**	X	**PHONE NO.**	505-471-3232

SUBJECT: **AMS-4 CAM UNIT LOCATED IN THE PORTABLE EXHAUSTER AT WASTE TANK 241-C-106.**

LOCATION: ARES Office 1100 Jadwin

PARTICIPANTS
- Jeff Sawyer
- Alan Hagensen

COPIES:
Alan Hagensen
Tom Salzano
0193101.07 Job File (BG & RL)
RLF-File/LB

PREPARED BY: ____________________ (Signature)   **DATE PREPARED:** May 29, 2003

Talked with Jeff Sawyer from Thermo Electron Corporation regarding the AMS-4 CAM unit located in the portable exhauster at waste tank 241-C-106.

Explained to Mr. Sawyer that oxalic acid was to be used to mobilize the waste in the tank, and that there was the possibility that oxalic acid vapor/aerosols may enter the AMS-4 unit, should there be a breach in the HEPA filters of the exhauster. Explained that there was a requirement that should this event occur, the CAM was required to continue to operate for a period of 10 minutes. Asked Mr. Sawyer if there were any materials used in the CAM that would cause a failure before the 10-minute period due to the oxalic acid.

Mr. Sawyer said that there was nothing in the unit that should be a problem except for the mass flow sensor, of which he did not know the materials it was made of, and thus might pose a problem. He went on to say that there were two different AMS-4 units that were made and used at the Hanford site, some with an external flow sensor. Mr. Sawyer said that if the unit that was in place was one that had the external flow sensor, then there should be no problem and the unit should continue to operate for the 10-minute period required.

Upon checking the drawing, H-14-105280, the CAM installed does have the external flow element option, therefore there should be no issue with the oxalic acid.