Prevention for Possible Microbiologically Influenced Corrosion (MIC) in RHLWE Flush Water System (U)

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HIGH LEVEL WASTE ENGINEERING SUPPORT

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P. D. d'Entremont
ADC/RO

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CORROSION (MIC) IN RHLWE FLUSH WATER SYSTEM (U)

By

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PREVENTION FOR POSSIBLE MICROBIOLOGICALLY INFLUENCED CORROSION (MIC) IN RHLWE FLUSH WATER SYSTEM (U)

INTRODUCTION AND SUMMARY:

This report is in response to the request [1] to provide a recommendation for the prevention of possible microbiologically influenced corrosion (MIC) for the RHLWE (Replacement High-Level Waste Evaporator) flush water (FW) system. The recent occurrences of MIC at DWPF [2,3] prompted HLWE to evaluate the possibility of MIC occurring in this 304L stainless steel RHLWE flush water system. Concern was heightened by the fact that the well water used and the other conditions at H-Tank Farm are similar to those at DWPF. However, only one known leak has occurred in the existing 304L evaporator flush water systems in either tank farm (in 1H system), and no MIC corrosion has been confirmed in the tank farm area. The design of the RHLWE flush water system (completed long before the occurrence of MIC at DWPF) was modeled after the existing evaporator flush water systems and did not specifically include MIC prevention considerations. Therefore, MIC prevention was not specifically considered during the design phase of this flush water system. The system is presently being installed.

Realistically, the best and most sensible engineering approach would be to operate the system as designed. If a failure should occur, the failed pipe section could be repaired or replaced and an investigation initiated to determine the cause of corrosion failure and to seek the appropriate solution. Because most of the system is above ground and located in a non-radiation zone, maintenance and repair can be readily accomplished, as needed. The few inaccessible portions of the system are located inside the evaporator cell where a high radiation field exists. Though not specifically verified, the consensus is that the high radiation field will be an effective biocide and deterrent to the growth of MIC bacteria.

After an extensive evaluation, a task team concluded that the best biocide to prevent the occurrence of MIC would be NaOH at fairly low concentration [4,5]. Sodium hydroxide (NaOH) is optimal in this application, because of its effectiveness, low cost, and familiarity to the Operations personnel (see Appendix A). However, it is the opinion of the task group that application should be withheld until MIC corrosion is demonstrated in the system.

RECOMMENDATIONS:

1. It is recommended that the new RHLWE flush water system be operated as designed, i.e., without inhibitor, just as the other existing FW systems have been and are operated in both tank farms. Should a failure occur in the future, repair can be made and an investigation initiated to determine the cause and to seek the appropriate solutions.
2. If and when MIC corrosion is discovered and confirmed in HLW tank farms, it is recommended that the flush water system be protected by adding sufficient NaOH to maintain a minimum pH of 10.7 (or 0.0005 M [OH-]) as inhibitor / biocide to mitigate the possibility of MIC corrosion.

DISCUSSION:

Historical Experience in 304L Evaporator Flush Water Systems

The 1H evaporator flush water (FW) system has been in use since 1963; the 2H and 2F, since 1982 and 1980, respectively [6]. Of these three FW systems, only 1H has a confirmed underground leak of about 6 gallons per day [7]. Under pressure, the leak may increase three to fourfold to a maximum of about 24 gallons / day or 0.017 gpm. These are rather low volumetric flowrates and probably will not cause any serious soil erosion. The exact location of this leak is still not known. There are no known leaks in either of the other FW systems [8,9]. The evaporator flush water mass balances are recorded daily in the High Level Waste Operations Morning Reports [10].

Description of RHLWE Flush Water System and MIC Prevention:

The flush water system for the RHLWE uses sufficiently high pressure to flush potentially contaminated process lines and equipment. The system consists of a flush water tank, flush water pumps, and a means of heating the flush water by use of a steam injection system downstream from the pump. The design provides the means for automatic refilling of the flush water tank and a manual bypass for maintenance. Well water will be used for the process flush water supply.

Microbiologically influenced corrosion (MIC) can occur as a result of colonization of microorganisms from the environment (often natural waters). A colony thrives on nutrients from the same environment, such that a huge population generation may occur at a localized site defined by the colony. The existence of organisms in the water does not necessarily guarantee problems. Other factors are also important: water velocity, temperature, chemical additions, etc. Usually water moving at a sufficiently fast rate will effectively scrub the pipe surfaces and prevent establishment of colonies and build-up of tubercles. A stagnant situation removes the scrub advantage. In fact, the worst situation occurs under stand-by or idle conditions in untreated water systems, because all the ingredients for MIC development are usually present. Recirculation (i.e. keeping the water moving) is an alternative to biocide treatment for mitigating the tubercle growth. A velocity of 5 fps is usually suggested as adequate to prevent anchoring of microorganisms and development of tubercles and colonies, though even this is not a guarantee [11,12].

In terms of bacterial control, a pH range of 10 to 10.5 has been variously recommended [11,12] as the minimum level for preventing MIC in a recirculating cooling water system. This occurs by reducing bacterial reproductive capability [13,14]. Therefore, with sufficient NaOH, the system would be protected during the non-use periods.

From the list of identified areas [1] and the sketches of pipelines [15] that could impact the MIC potential in the RHLWE flush water system, the following negative and positive attributes were noted and identified. References [1] and [15] are attached as Appendices B and C, respectively.

Negative Attributes:

1. Low points with no drain.
2. Long straight horizontal pipe runs without any slope (no drain).

3. Vertical pipe sections with standing water located between main horizontal lines and isolation valves.
4. Not every line is designed to be able to be blown down (emptied and dried).
5. System designed to use well water without biocide treatment.
6. Unknown details of components and their tie-ins. Components include valves, filters, strainers, etc. These, having numerous locations capable of trapping water, may be most vulnerable in cultivating bacterial growth and MIC.

Positive Attributes:

1. Accessibility - most of the pipe system is above ground (not buried) and outside of the evaporator cell.
2. Non-radiation zone - minimal contamination and radiation concerns exist for most of the system. Exposure for maintenance workers is not an issue.

This set of advantages offers the opportunity for hands-on maintenance, repair and/or replacement of corroded pipe sections or components for the major portion of the system. Normal efforts and expenses and minimal exposure to maintenance workers will occur.

REFERENCES:

- [1] D.J. Martin, Memo to H.A. Abodishish, "Microbiological Corrosion Potential For RHLWE Flush Water System," HLW-HLE-940193, 6/23/94. Attached as Appendix B in this memo.
- [2] C.F. Jenkins, Memo to B.D. Amerine and J.F. Ortaldo, "Parallel Plate Heat Exchanger Failure (U)," EES920191, 6/23/92.
- [3] C.F. Jenkins, Memo to J.F. Ortaldo and B.D. Amerine, "MIC-Corrosion in DWPF Melter Cooling Water System Piping (U)," EES-920043, 2/7/92.
- [4] L.A. Galazka, "Project S4062, RHLWE MIC MEETING MINUTES," E-mail, 12/9/94.
- [5] T.C. Hsu, Memo to D.J. Martin and L. Galazka, "Preventive Biocide For Potential Micro-biologically Influenced Corrosion (MIC) In RHLWE Flush Water System (U)," HLW-HLE-94-0630, Rev. 1, 1/11/95.
- [6] DPSTSA-200-10, Sup 18, "Safety Analysis - 200 Area Savannah River Plant Separations Area Operations, Liquid Radioactive Waste Handling Facilities," 1988, pp. 3-51.
- [7] P.W. Norris, Personal Communication With T.C. Hsu, 4/18/95.
- [8] M.J. Rea, Personal Communication With T.C. Hsu, 4/18/95.
- [9] J.E. Griffiths, Personal Communication With T.C. Hsu, 4/18/95.
- [10] High Level Waste Operations Morning Reports.
- [11] G. Kobrin, "MIC Causes Stainless Steel Tube Failures - Despite High Velocity Water," Material Performance, V.33, No.4, April 1994, p.62.
- [12] G.G. Geesey, "Biofilm Formation," A Practical Manual on Microbiologically Influenced Corrosion, G. Kobrin, ed. NACE, Houston, 1993.
- [13] D.H. Pope, D.J. Duquette, A.H. Johannes and P.C. Wayner, "Microbiologically Influenced Corrosion of Industrial Alloys," Material Performance, Vol. 24, No. 4, p.14, 1984.
- [14] G. Kobrin, editor, Practical Manual on Microbiologically Influenced Corrosion, NACE International, 1993, pp.106, 120.
- [15] J.W. Norris, "Hand Sketches of Pipelines in the RHLWE Flush Water System," received 6/27/94. Attached as Appendix C in this memo.

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APPENDIX A

**EXHAUSTIVE EVALUATION OF OPTIONS FOR MIC PREVENTION IN
THE RHLWE FLUSH WATER SYSTEM (U)**

In September 1994, a task team was assembled to evaluate the RHLWE flush water system (304L). Design of the system was complete, and it was fabricated and partially installed. The main purpose was to exhaustively search and evaluate viable options to prevent possible occurrence of MIC corrosion in the flush water system. A specific goal was to define a biocide or some other means to prevent MIC in the partially installed system. The range of options considered was rather complete and thorough [1]. The conclusion is that dilute NaOH additions for pH-control is the best solution from all aspects [1,2].

DISCUSSION:

The list of options considered follows. The advantages and disadvantages of the options are indicated.

TABLE 1. REMEDIAL OPTIONS CONSIDERED

<u>Option Considered</u>	<u>Advantages</u>	<u>Disadvantages</u>
Construction material change	Depending on material, may reduce/prevent MIC	New design & fabrication needed; costly, impractical.
Administratively controlled blowdown with periodic draining	Will prevent MIC, if done often enough	Major redesign needed - costly, impractical; procedure not acceptable to operations.
Administratively controlled periodic flush	Will prevent MIC, if done often enough	Some redesign needed; procedure not acceptable to WM Operations.
Heat treatment of FW system (165 deg F for 2 minutes)	Will kill off MIC bacteria, if done often enough	Some redesign and new equipment needed; impractical.
Take no action; repair and/or replace as needed	Applicable to most of the system	Not applicable to few portions of system being inaccessible (in evap cell).
Use steam condensate as supply for flush water	Bacteria would be absent	Large condensate volume not always available when needed.
Recirculation of flush water	The scrub action prevents MIC site formation	Major redesign needed - costly, impractical.
Chemical biocides (to be separately tabulated)	Appropriate chemicals can prevent bacterial growth	Only a few meet min req't, with their own limitations.

TABLE 2.
CHEMICAL BIOCIDES CONSIDERED

<u>Chemical Biocides</u>	<u>Conc</u>	<u>Tank Chem</u>	<u>Environmental</u>	<u>Safety</u>	<u>Ind Hygiene</u>	<u>Remarks</u>
1. NaOH (caustic)	pH= 10.7	Acceptable	Acceptable	Acceptable	Acceptable pH < 9	Protective equip'mt
2. NaOCl (Na-hypochlorite)	5 - 7 ppm residual	Accept.	Accept.	Accept.	Accept.	Short life, need wkly replenish
3. HOBr (Towerbrom)	6 - 9 ppm	Req Eval	Req Eval	Req Eval	Req Eval	New permit req'd ?
4. AmCide 5712 (polyoxyethylene)	1.5 - 14 oz/kgm	Req Eval	Req Eval	Req Eval	Req Eval	New permit req'd ?
5. Nalco 7320 (2,2 dibromo-3- nitrilopropionamide)		Req Eval	Req Eval	Req Eval	Req Eval	New permit req'd ?
6. Nalco 7330 (5-chloro-2-methyl-4- isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one)		Req Eval	Req Eval	Req Eval	Req Eval	New permit req'd ?
7. Nalco 7338 (Glutaraldehyde)		Req Eval	Req Eval	Req Eval	Req Eval	New permit req'd ?

REFERENCES:

- [1] L.A. Galazka, "Project S4062, RHLWE MIC MEETING MINUTES," E-mail, 12/9/94.
- [2] T.C. Hsu, Memo to D.J. Martin and L. Galazka, "Preventive Biocide For Potential Microbiologically Influenced Corrosion (MIC) In RHLWE Flush Water System (U)," HLW-HLE-94-0630, Rev. 1, 12/9/94, 1/11/95.

APPENDICES B & C TO FOLLOW

WESTINGHOUSE SAVANNAH RIVER COMPANY
INTER-OFFICE MEMORANDUM

HLW-HLE-940193

June 23, 1994

TO: H. A. ABODISHISH, 703-H, HLWE

FROM: D. J. MARTIN, 707-2H, HLWE/RHLWE

*Jeff Lauth for
DJM***MICROBIOLOGICAL CORROSION POTENTIAL FOR RHLWE FLUSH WATER SYSTEM (U)**

The Flush Water system for RHLWE has been evaluated to identify potential areas where MIC (Microbiologically Influenced Corrosion) might occur. In light of recent MIC events at DWPF, a heightened awareness to the problem now exists at HLWM. Mr. Thomas Hsu of WMT has requested a summary of key areas of concern in order to determine a path for MIC-prevention in the RHLWE Flush Water System. The attached table identifies these areas based upon review of piping arrangement as currently designed. Mr. J. W. Norris of RHLWE will be available to provide further assistance as necessary.

Questions or comments may be brought to me at 7-1986 or 7-1442.

JWN:jwn

cc: M. S. Peters, 707-2H
J. E. Marra, 703-H
H. A. Abodishish, 703-H
T. C. Hsu, 703-H
D. C. Bumgardner, 707-2H
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J. W. Norris, 707-2H

**IDENTIFICATION OF AREAS POTENTIALLY AFFECTED BY MIC
IN RHLWE FLUSH WATER SYSTEM.**

LINE #	DRAWING #	LOCATION	COMMENT
FW 287 to evap. seal pot	SE5-2-2005623 SE5-2-2005624 W833907 SE5-2-2007013	2ND & 3RD LEVEL	low points exist at sect. A17- A17 and A18-A18 of SE5-2-2005624 & SE5-2-2005623
FW 252 to evap. feed	SE5-2-2005623 W833907	2ND LEVEL	low point exists at sect. A-18 A-18. no drain
FW 253 to lower evap. spray	SE5-2-2005623 W833907	2ND LEVEL	low point exists at sect. A-18 A-18 no drain
FW 263 to demister spray	SE5-2-2005623 W833907	2ND LEVEL	low point at sect A-18 A-18. no drain
FW 264 to upper evap. spray	SE5-2-2005623 W833907	2ND LEVEL	low point at sect A-18 A-18. no drain
FW 265 Demister spray	SE5-2-2005623 W833907	2ND LEVEL	low point at sect A-18 A-18. no drain
FW 266 Evap nozzle decon spray	SE5-2-2005623 W833907	2ND LEVEL	low point at sect A-18 A-18. no drain
FW 299 Condenser cell	SE5-2-2005623 W833917 W2010502 W2005767	el. 335'-6" to cond. cell	Low points at sect. A-17 A-17 of SE5-2005623 and sect. J-J of W2005767. Straight run at el. 335'-6" not sloped
FW 288 Evap. dip tubes	SE5-2-2005623 SE5-2-2005624 (loc.J-15) W833908 W2010502	3rd level el. 347'-6"	Drains at tie-ins FW 296 FW 297 , straight run not sloped.
FW 281 Anti-foam tank	SE5-2-2005623 SE5-2-2005624 W833908 W2010502	2nd and 3rd level el. 345'-9"	No slope on straight run at 345'-9". low point drain exists on SE5-2-2005624 sect. A17-A-17
FW 283 Mercury removal tank	SE5-2-2005623 SE5-2-2005624 W833908 W2010384 (loc.R-21)	el. 316'-6"	Straight runs have no slope. low point drain exists on SE5-2-2005624 sect. A17-A-17
FW 295 Flash Tank	SE5-2-2005623 (loc. J-12) W833910	el. 333'-3"	Low point drain on FW 281 dwg. SE5-2-2005623 section A17- A17

ATTACHMENT 1

LINE #	DRAWING #	LOCATION	COMMENT
FW 291 to Sump Jets, Steam Lances, Steam Lifts, Level Insts.	SE5-2-2005624 (loc.P-12)	3rd level	low point drain on FW 281. (section A17- A17) no slope on straight runs
FW 541 Sump Jet	W2010502 SE5-2-2005624 (loc.P-12)	3rd level	stagnation point above iso. viv. see sect. y-y dwg 2010502
FW 293 Steam Lances	W2010502 SE5-2-2005624 (loc.P-12)	3rd level	stagnation point above iso. viv. see sect. A-A dwg 2010502
FW 292 Steam Lifts	W2010502 SE5-2-2005624 (loc.P-12)	3rd level	stagnation point above iso. viv. see sect. C-C dwg 2010502
FW 530 Sump Level Insts.	W2010502 SE5-2-2005624 (loc.P-12)	3rd level	stagnation point above iso. viv. see sect. y2-y2 dwg 2010502

Line 281

1. Low point - elevation $323'-1.0''$ ~~section A16-A16~~ DWG W2010502
~~section A17-A17~~

* drain to low point added in Rev. 2 of dwg.

FLW - V-1082

~~NOTE P-120 SHOULD DRAIN VALVE IN DIFFERENT LOCATION.~~

2. section T-T DWG SES-2-2005624 line 281 ends at nozzle to antiFoam tank / no drains exist here therefore piping should slope to drain to low point / or to antifoam tank. there is no capability to blow line dry without draining system.

LINE 287

DWG'S SE-S-2-2007013

SE-S-2-2001934 evap. bldg.

SES-2-2005624 section A17-A17

SES-2-2005623 section A18-A18

Line 287 (multiple tie in points) serves Evap. through seal pot.

S-14.94

LINE 291 EVAP. SUMP TET.

also lines

DWG 5-2-2005623
1005624

LANCES
LIFTS
INSTANTS.

541
293
292
530

W 2010502
W 833918 W 833913
W 833914

possible stagnation points at 339' level for steam lance, sumpjet, lifts
no drain at low point would have to use plant
air to blow clean through MV 525 and MS 128, etc.
also FW 530 feeds instants for EV. sump.

347'-6" FW 590
CAVIT FROM ABOVE
346'-6" 291
342'-9" EX LINES
TO LEVEL INST. INSIDE EV.

SECTION
Y2-Y2
W 2010502.

SECTION
C-C
W 2010502

TO EVAPORATOR DIP TUBES

W 2010502

SES-2-2005624

SES-1-2005633

FW 461-467

common DRAIN at 100 ft on line 281
no loop seals

LINE 295 FLASH TANK

SES-2-200 5623

W 833910

FW 34D

Common low point
one tie in 34D
DRAINS TO SUMP.

section A13-A13
SES-2-200 5623

LINE 283

DWG's

SES-2-2005623

2005624

2005622

W2010384 *

line 283 serves mercury removal tank

one common low point w/drain - Other points of stagnation
will drain into tie in points 269, 257, 260 and mercury removal tk.

line ^{FW}251 drains into Chem Add tank

line

Line 299
EVAP. CELL CONDENSER.

Common DRAIN PRIOR TO FW SOH
NO LOOP SEALS