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1	1	Cog.Eng. RP Anantatmula	<i>R.P. Anantatmula</i>	11-10-94	R1-30						
1	1	Cog. Mgr. PC Ohl	<i>P.C. Ohl</i>	11-10-94	R1-30						
1	1	QA DC Board	<i>Don Board</i>	11-10-94	S1-57						
		Safety									
		Env.									
1	1	SH Rifaey	<i>Sh. Rifaey</i>	11-14-94	S1-55						

18. RP Anantatmula <i>R.P. Anantatmula</i> 11/10/94 Signature of EDT Originator		19. Authorized Representative Date for Receiving Organization		20. PC Ohl <i>P.C. Ohl</i> 11/11/94 Cognizant Manager Date		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-TP-283, Rev. 0

Document Title: Test Plan for the Selection of the ENRAF Gauge Wire Material

Release Date: 11/15/94

**This document was reviewed following the
procedures described in WHC-CM-3-4 and is:**

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

V. L. Birkland
V. L. Birkland

11/15/94

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WHC-SD-WM-TP-283

Rev. 0

TEST PLAN FOR THE SELECTION OF THE ENRAF GAUGE WIRE MATERIAL

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Approval Designator Q

R. P. Anantatmula
October 1994

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TEST PLAN FOR THE SELECTION OF THE ENRAF GAUGE WIRE MATERIAL

1.0 INTRODUCTION

The measurement of liquid levels is the primary method of early leak detection in some underground waste storage tanks at Hanford. The same method is also used for the detection of intrusion of liquids into the tanks. The age of the tanks and the history of the single-shell tanks developing leaks resulted in a high priority being placed on early leak detection. The Food Industry Corporation (FIC) gauges used for many years for this purpose are no longer available and are rapidly failing. As a result, continued and uninterrupted level detection is a critical activity for monitoring the status of the waste being stored in underground tanks.

After extensive evaluation and testing, the ENRAF¹ Series 854 level gauge was selected to replace FIC gauges as the primary instrument for monitoring waste surface levels in waste storage tanks at Hanford. The material for the wire from which the displacer of the gauge is suspended was selected to be type 316 stainless steel (316) based upon its excellent corrosion resistance in Hanford tank wastes. Installation of the 316 wire gauges began early in fiscal year (FY) 1994 with a total of 18 gauges scheduled for installation during the fiscal year.

After approximately 10 weeks of service, the displacer attached to the gauge installed in tank 241-S-106 separated from the wire, resulting in an error message on the gauge readout which indicated that the displacer was missing. A task team was assembled which identified the need for short-term actions to re-establish tank waste level monitoring. The failed wire was removed and sent to Pacific Northwest Laboratory (PNL) for analysis. It was determined that the wire failure was due to chloride ion stress corrosion cracking of the 316 wire. Radiation induced breakdown of the polyvinyl chloride (PVC) riser liners is suspected to be the source of the chloride ions.

As a result of this 316 wire failure, the task team proposed short-term and long-term actions. The short-term actions included evaluating the source of the chloride ions, while continuing to monitor liquid levels. One of the long-term actions is the selection of a wire material that is compatible with the PVC liner and the tank waste environment. This document describes the test plan for the selection of one material, from the list of candidate materials, that is the most suitable material for use in the combined environment of the PVC liner and the tank waste.

2.0 OBJECTIVE

The objective of this test plan is to test the candidate wire materials in environments simulating the PVC liner and the tank waste environment. The

¹ENRAF, Inc.

candidate wire materials were selected on the basis of literature search. A preferred wire material has been selected based upon literature search, consultation with technical experts in Materials and Corrosion Engineering, and vendor information. The selected material is Pt-20%Ir alloy. The tests performed under this test plan will be used to confirm and validate the expected performance of the selected material and will be done in parallel with continued installation of ENRAF gauges using the recommended material. At the end of test, the corrosion experienced by the materials will be evaluated. The corrosion data will then be used as a basis for verifying that the recommended material is compatible for long-term use in all the waste tanks, i.e., tanks with and without PVC liners. It is fully expected that the material selected by literature search, consultation with technical experts, and vendor information will be acceptable, however, if test results do not confirm the expected performance of the recommended material additional evaluation will be required.

3.0 SCOPE

The testing will be performed on at least four candidate materials, viz, Hastelloy² C-22, Pt-10%Rh, Pt-20%Rh, and Pt-20%Ir. The materials will be procured as 8 mil diameter wire to be prototypic of the wire used in the ENRAF level gauges. Two test environments will be used. One of the environments will simulate the hydrochloric acid (HCl) environment created by the radiation induced decomposition of the PVC liner, while the other will simulate the caustic environment of the tank wastes. The candidate specimen wires will be exposed to the HCl and the caustic environments in separate vessels. The test vessels containing the test solutions and specimens will be placed in a gamma pit to simulate the radiation exposure (~200 R/hr) experienced by the ENRAF gauges in service.

The laboratory experiments will be performed by PNL with technical coordination provided by Westinghouse Hanford Company (WHC).

4.0 DESCRIPTION OF TEST

Testing will be performed in vessels that are compatible with the environments. Test temperature for the test will be the maximum temperature observed in the dome space in the tank farms from the latest available records. As mentioned before, the test solutions will be HCl and a caustic environment (similar to the waste environment in the tank farms). In both cases, worst-case environments will be used. A PNL plastics expert will be consulted to determine the worst-case HCl environment created by the radiolytic degradation of the PVC and condensation on the wire. The worst-case caustic environment will be obtained from the tank farm waste characterization records.

The test will be conducted in a gamma pit at ~1,000 R/hr for three months. Although such high radiation fields are not encountered in the

²Hastelloy is a trademark of Haynes International.

dome space of the Hanford waste tanks, the objective of these tests is to accelerate the radiation effect to see if there is an observable effect of radiation on corrosion during the test period. The three-month test period is chosen because measurable weight loss should occur in those materials susceptible to corrosion. In addition, this time period allows valid extrapolation of life expectancy to more than one year. It is anticipated that the wires will be placed in a polyethylene vessel and will be electrically isolated from each other. The experiments with HCl and the caustic environment will be performed in separate vessels. The vessels will be placed into a larger autoclave vessel and the annulus filled with deionized water. This will allow transfer of heat from the autoclave to the specimen vessels. The autoclave temperature will be controlled using electronic controllers and thermocouples, with one thermocouple measuring the temperature of the deionized water. The test temperature will be controlled to within $\pm 1^\circ\text{C}$. At the end of the three-month period, the test will be terminated and the candidate material specimens will be removed from the test vessels for post-test evaluation. Another test will be performed in parallel, with the Pt-20%Ir alloy wire (exposed to the HCl and caustic environments in separate vessels) under tension to simulate the action of the weight suspended at the end of ENRAF gauge wire.

The post-test evaluation consists of visual examination, weight change, optical metallography, x-ray fluorescence, scanning electron microscope (SEM), electron spectroscopy for chemical analysis (ESCA), and determination of mechanical properties. The parameters measured are thickness, weight loss, composition of corrosion products, and tensile strength.

5.0 EXPECTED RESULTS

The four materials selected for the tests are expected to be fairly resistant to the test environments at the test temperature selected. Hastelloy C-22 may not perform as well as noble metal alloys in the HCl solution, but it should be extremely resistant to corrosion by the caustic solution. The wires fabricated from the Pt-Rh and Pt-Ir alloys should exhibit the best performance in both the HCl and caustic environments. The primary data obtained from this test are uniform corrosion rates, tensile strength, and composition of corrosion products of the candidate materials.

The success of this test depends on if at least one of the candidate materials resists the corrosivity of the two environments. As mentioned before, the test objective is to select one material from the candidate materials tested. Both corrosion rate and tensile strength will be the criteria that ultimately determine the final selection.

6.0 TEST PROCEDURE

The tests will be conducted in accordance with PNL Procedure PNL-CAG-001, "Corrosion Testing and Mechanical Testing of Wires in Irradiated Chemical Environments."

7.0 SAFETY, ENVIRONMENTAL, AND QUALITY ASSURANCE

All documentation generated by cognizant organization will be given to Safety Equipment Development to be transmitted to the appropriate safety, environmental, and quality assurance organizations for review/approval as required. All test data will include equipment identification and calibration dates as well as test personnel identification and any other information required to validate the accuracy of the data obtained.

8.0 ORGANIZATION AND FUNCTION RESPONSIBILITIES

The Materials Applications Group at PNL will be responsible for performing the laboratory experiments. The cognizant engineer is S. G. Pitman and the cognizant manager is R. E. Westerman.

The Materials and Corrosion Engineering group is responsible for technical coordination of the project. The cognizant engineer is R. P. Anantamula and the cognizant manager is P. C. Ohl. The cognizant engineer will collaborate with the PNL cognizant engineer in data analyses and interpretation of the results. The report on the test results, including the recommendation of material for the ENRAF gauge wire, will be prepared jointly by the two cognizant engineers.

Safety Equipment Development is responsible for providing support, direction, and funding to the cognizant organization. The project manager is T. L. Moore. This organization is also responsible for procuring the wires of the candidate materials, identifying the individuals responsible for review of all documentation, transmitting documentation needing review/approval to other organizations, and providing approval on documentation as required.

Waste Tanks Plant Engineering is the customer organization for this activity. S. H. Rifaey, Manager, Waste Systems Engineering, is the responsible manager for the customer organization. He will have final approval authority for accepting recommendations resulting from this activity and their implementation.

9.0 SCHEDULE

The schedule is as follows.

<u>Task</u>	<u>Start Date</u>	<u>End Date</u>
Test plan	10/05/94	11/11/94
Procure candidate materials	10/10/94	12/12/94
Initiate tests	12/13/94	12/20/94
Complete tests	12/20/94	03/20/95
Issue letter report	04/03/95	04/28/95

10.0 COST ESTIMATE

This cost estimate includes only the material cost and the costs associated with performing the laboratory experiments at PNL. The cost breakdown is as follows.

<u>Task</u>	<u>Expense</u>
Procure candidate materials	\$ 5K
Perform experiments	\$10K
Visual and optical metallography	\$10K
SEM/ESCA/X-ray fluorescence	\$10K
Analysis and interpretation	\$10K
Report writing	\$10K

11.0 REPORTS

Periodic reports will be issued as internal and external memos. A final letter report will be issued jointly by WHC and PNL.

12.0 REFERENCES

- 12.1 WHC-IP-1026, Engineering Practice Guidelines, dated May 27, 1994.
- 12.2 Internal Memo, R. P. Anantatmula to R. S. Popielarczyk, "Recommendation of Material for ENRAF Gage Wire," dated September 2, 1994.
- 12.3 WHC-SD-WM-ETP-119, Rev. 0, "Engineering Task Plan and Status of 241-S-106 ENRAF Level Gauge Wire Break," dated September 1994, Westinghouse Hanford Company, Richland, Washington.
- 12.4 Letters, S. G. Pitman, PNL, to R. S. Popielarczyk, WHC, dated August 18, 22, and 23, 1994.

13.0 DATA SHEETS

The data, communications, and correspondence for this project will be collected and filed in accordance with PNL's Records Inventory and Disposition Schedule system. Data for each activity will be stored on data sheets specific to that activity, and all data for the project will be stored as permanent project records.

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