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PRODUCTION TEST AUTHORIZATION - 057
EVALUATION OF REDUCED DICHROMATE CONCENTRATION
B REACTOR

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January 25, 1967

DOUGLAS UNITED NUCLEAR, INC.
RICHLAND, WASHINGTON

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PRODUCTION TEST AUTHORIZATION - 057
EVALUATION OF REDUCED DICHROMATE CONCENTRATION
B REACTOR

OBJECTIVE

The objective of this test is to determine the corrosion effects resulting from a reduction of sodium dichromate inhibitor from 1.0 ppm to 0.5 ppm in pH 6.6 process water.

JUSTIFICATION

The Hanford plant process water has recently undergone changes in an attempt to gain increased corrosion resistance of aluminum components. It has been demonstrated that a reduction of pH to its present level of 6.6 results in lower uniform aluminum corrosion rates without markedly affecting the corrosion performance of other materials in the process water systems. Another of the process water variables being studied is the effect of reduced concentrations of the sodium dichromate corrosion inhibitor. While pH principally affects uniform corrosion rates, the dichromate addition has historically been used to control localized pitting corrosion of aluminum components. No in-reactor experience is available for operation with pH 6.6 process water at a dichromate concentration of 0.5 ppm.

The primary justification for this test is the saving which can be realized through reduced inhibitor usage. The high cost of this chemical and the large water throughput combine to make inhibitor addition a significant fraction of water treatment cost. Potential total plant savings of approximately \$135,000 per year are possible, provided satisfactory performance can be demonstrated.

Results from previous laboratory and reactor testing neither support nor offer any basis for rejecting the proposed operation with reduced dichromate. Initial reactor experience¹ with water containing 0.5 ppm dichromate is not applicable as this test was conducted at a nominal pH of 7.6. Recent reactor testing² with water containing 1.0 ppm dichromate at a pH of 6.6 showed slightly increased uniform corrosion of the 1100 aluminum tube alloy, but no difference in localized corrosion of any components. Earlier laboratory experiments³ at pH's greater than 6.6 have shown that the addition of 0.1 ppm dichromate was as effective as 2.0 ppm dichromate in controlling localized pitting attack.

Thus, a half-plant test appears mandatory to define aluminum corrosion effects resulting from the use of pH 6.6 water containing 0.5 ppm sodium dichromate.

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TEST DETAILS

A. Reactor

The test will be conducted at B Reactor.

B. Process Water

After initiation of this test, the pH and dichromate feed rate of the 100-B Area process water will be maintained as follows:

<u>Water Variable</u>	<u>Control Side</u>	<u>Test Side</u>
pH	6.6 $\pm$ 0.1	6.6 $\pm$ 0.1
Dichromate Feed Rate, ppm	1.0 $\pm$ 0.1	0.5 $\pm$ 0.1

C. Corrosion Monitoring

1. Process Tubes

Eight pre-measured, ribbed aluminum tubes (four each on the test and control sides) will be installed. One tube from each side will be removed and examined at four-to-six month intervals.

2. Probologging

One hundred (100) existing tubes (50 from each side) will be monitored during this test. These tubes will be probologged before each fuel charge during the test period.

3. Fuel Element Corrosion

Up to four groups of 28 tubes of fuel (14 on each side) are authorized by this test. Pre- and post-irradiation weight and visual examination measurements will be made for these numbered fuel columns. The discharged fuel elements from each side may be mixed and combined in pickup buckets, but mixing fuel elements between sides must be avoided.

4. Coupons

Coupon holders (Drawing No. SK-1-23211) will be installed in the

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downstream dummy pattern of selected charges. Weighed metal coupons of various aluminum and carbon steel alloys will be included. The number and location of these holders will be selected by the test authors in conjunction with B Processing Unit. In addition, one fuel-size aluminum piece will be installed in the downstream dummy pattern of four of the eight new tubes during each metal cycle. This piece will be machined to the dimensions of the O3NB fuel (Drawing No. H-3-7950); however, bumper rails may not be attached. These will be charged from the rear face into the position normally occupied by the second most upstream perf. A coolant flow rate reduction of about 0.75 gpm will result from the addition of the aluminum piece. No significant change in Panellit pressure will occur.

5. Downstream Thermocouple Probes

To better define corrosion environment parameters, four downstream thermocouple probes (Drawing No. H-1-11198) will be installed in new tubes during each metal cycle.

6. Corrosometer Probes

In addition to weighed metal specimens in the downstream coupon holders, corrosometer probes will be installed as required to detect and define the extent of carbon steel corrosion.

7. Rear Face Borescoping

To monitor the incidence and severity of the pitting attack associated with Van Stone insert usage at B Reactor, 100 tubes (50 on each side) will be examined following each metal cycle. These tubes will be selected by the test authors in conjunction with the Process Engineering and B Processing Units.

D. Fuel Charge and Exposure

1. Mixer Tubes

Charges of O3NB fuel with mixers will be irradiated to the normal variable goal exposure (or 550 Mwd/t average exposure) in 20 existing process tubes.

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2. No-Mixer Tubes

Charges of O3NB fuel will be irradiated without mixers in the eight new tubes to accelerate fuel and tube corrosion. These eight tubes will run to 80 percent of normal variable goal exposure (or 450 Mwd/t average exposure) when mixers are not used.

E. Start and Duration of Test

The test will be initiated as soon as possible following approval and will terminate one year after test initiation, or by the mutual concurrence of the Managers of B Processing and Reactor Engineering.

F. Operating Data Required

1. Daily

The following data are to be recorded daily.

- a. Average outlet coolant temperature of each of the eight corrosion monitor tubes.
- b. Downstream thermocouple probe temperatures.
- c. Average pH and dichromate concentrations to each side of the reactor.
- d. Frequency of purging.
- e. The period and extent of deviations from the specified test conditions.

2. Weekly

Panellit and front crossheader pressures will be recorded weekly for the eight corrosion monitor tubes.

G. Costs

All outage time and monitoring expenditures will be absorbed by B/C Reactor Subsection. The saving in reduced sodium dichromate usage is estimated at approximately \$8500 per year. The estimated cost schedule for other items is:

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1. Tube Probologging: 20 hours/100 tubes
2. Tube Replacement: 24 hours/8 tubes
3. Charge-Discharge: 22 hours/28 tubes
4. Coupon Installation: 3 hours/12 tubes
5. Tube Borescoping: 2 hours/20 tubes

H. Process Standards

This Production Test authorizes the following specific deviations from Process Standards. All other aspects of these Process Standards will apply.

1. Process Standard - Water Plant - 183-A-010, Section 10.01 -- Water Quality Requirements

The deviation from this Process Standard is to permit reactor operation with 0.5 ppm sodium dichromate. The intent of the test is to investigate the performance of process water containing 0.5 ppm sodium dichromate corrosion inhibitor.

2. Process Standard - Water Plant - 183-A-020, Section 20.01 -- pH Adjustment

The deviation from this Process Standard is to disallow changes in pH during reactor shutdown. Since in-reactor films may be highly sensitive to short exposures to nonequilibrium chemical concentrations, the operating water parameters will be maintained during shutdown conditions.

3. Process Standard - Reactor - F-010, Section 10.03 -- Aluminum Spacers and Van Stone Seal Inserts

The deviation from this Process Standard is to allow inclusion of corrosion monitoring coupon holders in portions of the downstream dummy pattern. Corrosion coupons (aluminum and carbon steel) and coupon holders (aluminum and carbon steel) will be substituted into perf positions in the downstream dummy patterns. The design of the coupon holders assures that the coupons cannot be dislodged and result in coolant exit blockage. These coupons have essentially no effect on coolant flow and Panellit pressures.

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4. Process Standard - Reactor - F010, Section 10.03 -- Aluminum Spacers and Van Stone Seal Inserts

The deviation from this Process Standard is to permit the substitution of downstream thermocouple probes for downstream dummy patterns. The fuel-size aluminum probe head causes slightly increased Panellit pressures and slightly reduced tube flow.

5. Process Standards - Reactor - F-010, Section 10.03 -- Aluminum Spacers and Van Stone Seal Inserts

The deviation from this Process Standard is to permit the substitution of one 03NB, fuel-size aluminum piece in place of the second most upstream perf. This substitution will result in slightly increased Panellit pressures and slightly reduced tube flow.

6. Process Standards - Reactor - A-021 -- Tube Outlet Temperature - Annulus Boiling Limit

No deviation is allowed from this Process Standard. The calculation of this limit for the eight new tubes charged with 03NB fuel, without mixers, and having the nonstandard downstream dummy patterns allowed by items (C), (D), and (E) will be made according to the "R" values given in this Process Standard. The nonstandard downstream dummy patterns allowed by (C), (D), and (E) cause increased pressures on the most downstream fuel element, and provide added conservatism in the application of this Process Standard.

I. Hazards

Increased localized and uniform corrosion rates to fuel jackets and process tubes are potential hazards associated with this test. Post-irradiation measurements and results will be continuously monitored and interim recommendations will be made should unexpected difficulties be encountered.

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R. G. Geier

R. G. Geier, Specialist
Research and Development
Research and Engineering Section

D. W. Peacock

D. W. Peacock, Senior Engineer
Reactor Process Development Unit
Research and Engineering Section

RESPONSIBILITIES

Production Fuels Section will be responsible for the canning, finishing, pre-irradiation testing, quality control, and pre-irradiation measurement and marking of fuel elements used in this test.

W. M. Mathis, Manager
Production Fuels Section

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Research and Engineering Section

Reactor Engineering Subsection will be responsible for coordination of test functions, process recommendations, and supplying data forms; for analysis of all test data; for selection of tubes for probologging and removal; for specification of operating limits for no-mixer tubes; and for test continuity and issuance of interim and final reports.

R. W. Reid, Manager
Reactor Engineering Subsection

Testing and Irradiation Services Subsection will be responsible for bore-scoping and probologging of process tubes, and post-irradiation examination of fuel elements and process tubes.

L. V. Barker, Acting Manager
Testing and Irradiation Services Subsection

Manufacturing Section

B/C Power Unit will be responsible for providing process water as specified in this test and for recording water variables specified in this test.

C. E. Harkins, Manager
B/C Power Unit

B Processing Unit will be responsible for operational safety and production continuity; for installation, removal, and special handling of specified process tubes; for scheduling probologging of selected process tubes, for charge-discharge of corrosion monitoring fuel; and for recording operating data specified in this test.

J. W. Baker, Manager
B Processing Unit

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APPROVALS

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R. W. Reid, Manager
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Research and Engineering Section

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3. DeHalas, D. R., "Final Report, Effects of Various Small Dichromate Concentrations on Front Process Tube Corrosion," HW-30884, February 18, 1954.

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