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FILE DESIGNATION

HW-56704 C

TITLE

Process Improvement Transition Authorization
IP-2-I-99-FP - Irradiation Of X-8001 Alloy
Jacketed Fuel Elements In Production Quantities

AUTHOR

R. R. Bloomstrand

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PROCESS IMPROVEMENT TRANSITION AUTHORIZATION IP-2-I-99-FP IRRADIATION OF X-8001 ALLOY JACKETED FUEL ELEMENTS IN PRODUCTION QUANTITIES (1)

OBJECTIVE

The objective of this test is to authorize large-scale irradiations of X-8001 (formerly designated M-388) alloy jacketed fuel elements in order to evaluate their suitability to the reactor process.

- (1) HW-56704-A, "Design of PITA IP-2-I-99-FP, Irradiation of X-8001 Jacketed Fuel Elements in Production Quantities", W. H. Hodgson and R. R. Bloomstrand, (Secret).

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BASIS AND JUSTIFICATION

Various production tests (2,3,4,5,6,7) have authorized the irradiation of X-8001 (~1% Ni, 0.5% Fe) aluminum alloy jacketed fuel elements in small or semi-production quantities. The testing revealed several problems relating to the ultimate suitability of X-8001 as a fuel jacketing material; the tests also confirmed certain properties of the alloy that should ultimately prove advantageous to the reactor process. Following is a summary of information which has, thus far, been developed:

- (1) In the laboratory, X-8001 has been shown to be resistant to intergranular attack under conditions which caused severe attack in the conventional 1245 alloy. Reactor experience, to date, qualitatively implies the same quality.
 - (2) In the laboratory the uniform corrosion rate of X-8001 and 1245 have been found to be roughly comparable. In the reactor X-8001 has been superior to 1245, in terms of overall jacket weight loss, under the most severe conditions yet tested. The X-8001, however, is apparently more susceptible to a pitting or localized type of attack. The operating parameters that control this type of attack, however, are not adequately understood. The problem may be related to segregation of the nickel alloying constituent, and steps have been taken to correct this situation. (8)
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- (2) HW-44255-C, "Production Test IP-95-A-79-MT, Irradiation of Lead Dip Canned I & E Slugs in D Reactor", R. E. Hall, March 6, 1958. (██████).
 - (3) HW-44256-C, "Production Test IP-70-A-80-MT, Irradiation of Lead Dip Canned I & E Slugs in K Reactors", R. E. Hall, January 17, 1958. (██████).
 - (4) HW-47221-C, "Production Test IP-43-A-84-MT, Evaluation of the Uniform Corrosion Resistance of M-388 Alloy Slug Jackets", F. W. VanWormer, January 15, 1957. (██████).
 - (5) HW-54010, "Production Test IP-124-A, Investigation of Conditions Leading to the Severe Pitting of M-388 Alloy Slug Jackets", N. R. Miller, December 3, 1957. (██████).
 - (6) HW-54018, "Production Test IP-120-A-94-FP, Comparison of Performance of Ingot and Low Hydrogen Dinged Uranium Fuel Elements", R. E. Hall, December 6, 1957. (██████).
 - (7) HW-50141-C, "Production Test IP-80-A-91-FP, Evaluation of M-388 Alloy Fuel Element Jackets in Semi-Production Quantities", F. W. VanWormer, July 1, 1957. (██████).
 - (8) HW-55095, "Status Report, Nickel Segregation Study - X-8001 Alloy", J. E. Bergman, May 14, 1958, (Unclassified).

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- (3) The initial semi-production scale irradiations of X-8001 clad solid and cored natural uranium fuel elements (conducted primarily at the DR and KE Reactors) indicated that the side rupture rate for these elements was higher than for their 1245 jacketed counterparts. The majority of the ruptures were of the hot spot type. Only one of the ruptures showed evidence of intergranular corrosion. The attack occurred in a region that apparently had been mechanically damaged, as well.
- (4) Current engineering opinion is that the high rupture rate in the X-8001 clad solid and cored fuel elements was related to the integrity and strength of the metallurgical bond between the jacket and the uranium core. (9) FPD has instituted process improvements to attempt to overcome this problem. (10)
- (5) To date, irradiation experience with I & E natural uranium fuel elements has been insufficient to determine if the X-8001 and 1245 clad materials differ from one another, in terms of rupture performance.

Summarizing, there are two main areas of concern regarding the suitability of X-8001 as a fuel element jacketing material. First, what are the parameters that describe the pitting or groove corrosion attack that has been observed, and how is reactor power level potential affected thereby? Secondly, will the canning process changes already instituted, and any additional developments, significantly improve the rupture resistance of fuel elements canned in this alloy and allow full utilization of its superior qualities? These questions must ultimately be answered by reactor testing.

Due to previous commitments which were arranged prior to the conclusion of small scale testing, a substantial fraction of the plant's fuel elements will be canned in X-8001 components. Irradiation of these elements, on a large-scale, is therefore necessary from the standpoint of fuel element availability. These irradiations will also serve to accelerate the evaluation of the X-8001 alloy to the point of a final decision on its suitability.

TEST DETAILS

Charging

This test authorizes the irradiation of X-8001 jacketed fuel elements of the following types:

- (1) Standard 8 inch solid natural uranium material, in normal or truline type components.

(9) "Mechanisms of Hot Spot Failures and Indicated Actions", E. C. Wood, May 23, 1958, (██████████ - Undocumented).

(10) "Interim Report on Brittle Bond Problem", C. A. Strand, June 17, 1958, (██████████ - Undocumented).

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- (2) Standard 6 inch solid enriched uranium material, canned in normal or truline components.
- (3) Standard 8 inch I & E natural uranium material, with the following nominal dimensions:

<u>Element Designation</u>	C-II-N	K-II-N	O-II-N
<u>Core Dimensions (inches)</u>			
I.D.	0.481	0.481	0.416
O.D.	1.370	1.385	1.356
Length	8.325	8.325	8.325
<u>Canned Dimensions (inches)</u>			
I.D.	0.375	0.375	0.310
O.D.	1.460	1.474	1.445
Length (overall)	8.965	8.965	8.965

- (4) Standard 6 inch I & E enriched uranium material, with the following nominal dimensions:

<u>Element Designation</u>	C-II-E	K-II-E	O-II-E
<u>Can Dimensions (inches)</u>			
I.D.	0.481	0.481	0.416
O.D.	1.370	1.370	1.351
Length	6.00	6.00	6.00
<u>Canned Dimensions (inches)</u>			
I.D.	0.375	0.375	0.310
O.D.	1.454	1.474	1.440
Length (overall)	6.640	6.640	6.640

This test does not authorize the charging of various small-scale tests designed to evaluate specific parameters, nor does it authorize the testing of redesigned I & E geometry fuel elements.

The quantities of the various fuel elements to be irradiated will be determined by the Production Operation, with advice of the Process Technology Operation and with concurrence of the Reactor Operations involved.

Goal Exposures

Nominal 1245 clad fuel element exposure goals will apply, initially, to the X-8001 clad material irradiated under this test. Changes in exposure goals are authorized, as deemed necessary based on rupture experience and other available information.

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Solid X-8001 material canned prior to July 1, 1958, is being and should continue to be irradiated in low power tubes. (11) Process changes designed to improve bond quality have been incorporated in the solid fuel element canning process; solid X-8001 material canned after July 1, 1958, will be improved, in this sense.

Similar improvements, where technically feasible, are being incorporated in the I & E canning process. It should be noted that I & E elements, because of their higher surface-to-volume ratio, have an inherent advantage over solid elements with respect to ease of obtaining a sound metallurgical bond. Experience with I & E X-8001 material, however, has not been sufficient to evaluate its performance relative to I & E 1245 material; nominal goal for the X-8001 material is currently set at 800 MWD/T.

Limits

TOA corrosion limits, TAI limits, and all other limits as specified in the Process Standards are applicable to the X-8001 clad material.

COSTS

Reactivity Loss: About 30 inhours per reactor fully loaded with X-8001 jacketed fuel elements.

RESPONSIBILITY

Research and Engineering Operation

Process Technology Operation will be responsible for the technical aspects of the irradiation to include:

1. Analysis and reporting of reactor performance of the fuel elements.
2. Providing recommendations to the Production Operation in the matters pertaining to utilization of inventories and goal exposures.

Production Operation

The Production Operation will be responsible for scheduling of X-8001 alloy component deliveries and discharges in accordance with plant production requirements and limitations.

(11) "Utilization of M-388 Solid Material", H. G. Spencer, April 28, 1958.
([REDACTED] - Undocumented).

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Reactor Operations

The Reactor Operations involved will be responsible for the operational safety and production continuity of the reactors.

RR Bloomstrand

Process Analysis Operation
Research and Engineering Operation
IRRADIATION PROCESSING DEPARTMENT

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APPROVALS:

J. F. MusicJ. F. Music, Acting Manager
Process and Reactor Development Operation
IRRADIATION PROCESSING DEPARTMENT ✓E. C. WoodE. C. Wood, Acting Manager
Process Technology Operation
IRRADIATION PROCESSING DEPARTMENTR. L. DickemanR. L. Dickeman, Acting Manager
Research and Engineering Operation
IRRADIATION PROCESSING DEPARTMENT ✓C. A. PriodeC. A. Priode, Manager
Production Operation
IRRADIATION PROCESSING DEPARTMENT ✓or A. R. MaguireA. R. Maguire, Manager
B - C Reactor Operation
IRRADIATION PROCESSING DEPARTMENTfor J. H. BrownJ. H. Brown, Manager
D - DR Reactor Operation
IRRADIATION PROCESSING DEPARTMENTS. L. NelsonS. L. Nelson, Manager
F Reactor Operation
IRRADIATION PROCESSING DEPARTMENTR. T. Jessen / for
R. S. BellR. T. Jessen, Manager
H Reactor Operation
IRRADIATION PROCESSING DEPARTMENTR. S. Bell, Manager
KE - KW Reactor Operation
IRRADIATION PROCESSING DEPARTMENT

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