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HW-66235
Page 1

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SUPPLEMENT D, PRODUCTION TEST IP-314-A, MEASUREMENT OF FUEL ELEMENT TEMPERATURE CHANGES AS THE RESULT OF FILM DEPOSITION

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OBJECTIVE

The objective of this Supplement to PT-IP-314-A⁽¹⁾ is to authorize the substitution of different heater elements for those on the original thermocouple train and to provide a modified set of operating conditions and limits for the revised loading.

- (1) Kratzer, W. K. Production Test IP-314-A, Measurement of Fuel Element Temperature Changes as the Result of Film Deposition, HW-64800, April 15, 1960.

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HW-66235

Page 2

SUMMARY

The thermocouple train is modified by the substitution of one eighteen-inch enriched and four twenty-four inch natural uranium tubular elements for the two thirty-six inch enriched tubular elements used on the original thermocouple train. The operating limits for the loading have been changed because of the change in charge power. This supplement also authorizes the addition of fuel elements upstream of the thermocouple train if the thermocouple element and heater elements do not provide enough heat to operate the loop at the desired temperature.

BASIS AND JUSTIFICATION

The thermocouple train authorized by PT-IP-314-A consisted of one twelve-inch single rod element instrumented with thermocouples and two thirty-six inch enriched tubular elements 1.82 inches OD, 1.45 inches ID, to provide heat to the charge. The first thermocouple train was discharged because of a failure at an exposure of 1030 MWD/T on the enriched heater elements. The location, nature, and cause of the failure have not been determined. A second train authorized by Supplement B⁽²⁾ to PT-IP-314-A could not be used because of difficulties in charging the train. This Supplement authorizes a third thermocouple train to be used in completing the test program of evaluating the temperature effect of crud film build-up in a carbon steel system.

Different heater elements are necessary for the thermocouple train authorized by this Supplement because no more heater elements of the type used on the original train are available. The difficulties in charging the second train should be eliminated by more careful pre-irradiation checks. Since the location and cause of the fuel failure in the first train are not known, nothing can be done to assure better performance in this one. The maximum exposure of any of the fuel elements in the train, however, will be limited to 1000 MWD/T.

Use of natural uranium heater elements on the thermocouple train will reduce the heat from the charge from about 430 KW obtained from the first train to about 290 KW. Because of the possibility that this amount of heat is inadequate to maintain the loop at the desired operating temperature, this test authorizes the addition of fuel elements upstream of the thermocouple train after the need for additional heat has been demonstrated by a period of equilibrium reactor operation.

TEST DETAILS

1. Fuel Elements

The heater elements authorized by this Supplement are 1.82 inch OD, 1.45 inch ID, coextruded tubular elements with 0.020 inch Zircaloy-2 jackets. One element is eighteen inches long containing 1.6% enriched U-2 w/o zirconium alloy and four elements are twenty-four inches long containing unalloyed natural uranium. All elements have 0.250 inch unbonded end caps and semi-flexible supports.

The elements added upstream of the thermocouple train to supply additional heat, if they are needed, may be any elements previously authorized for KER

(2) Kratzer, W. K. Supplement B, Production Test IP-314-A, Measurement of Fuel Element Temperature Changes as the Result of Film Deposition, HW-65615, June 13, 1960

DECLASSIFIED

HW-66235

Page 3

loop irradiation provided the operating limitations initially imposed on the elements, such as maximum uranium temperature and exposure, are compatible with this test. Elements that may be used include, but are not restricted to, enriched seven-rod cluster elements authorized by PT-IP-226-A (3,4,5) and natural uranium tube-and-tube elements authorized by PT-IP-300-A(6).

2. Loading

The loading will consist of the assembled thermocouple train made up of the nozzle insert downstream, fourteen eight-inch perfs or spacers, four twenty-four inch natural uranium tubular elements, one eighteen-inch enriched tubular element, one eight-inch perf, and the twelve inch thermocouple element upstream.

- If additional elements are needed upstream of the thermocouple train, a revised loading and set of operating conditions approved by Process and Reactor Development Operation and Process Technology Operation will be provided prior to charging.

3. Operating Conditions

The coolant shall be pressurized water with the pH adjusted to 10 ± 0.5 by the addition of LiOH. The desired operating flow is 50 gpm with the low flow trip set at 40 gpm. The desired operating outlet temperature, high outlet temperature trip, and boiling point suppression trip are given in Figure 1 as functions of the observed tube ΔT .

Dashed lines indicating the desired operating temperature and trip settings needed to maintain the maximum uranium temperature below 660°C are also included in Figure 1. In the absence of other information, the dashed lines will guide the selection of operating conditions. One of the thermocouples in the thermocouple element, however, indicates the maximum uranium temperature directly. Based on the thermocouple readings, the outlet temperature and trip settings may be set to exceed or fall short of the values designated by the dashed lines provided:

- a. The temperatures do not exceed the limitations set by the solid lines; which are based on the requirements that boiling will not occur on the fuel elements during normal operation and burnout will not occur at the limiting trip conditions.
- b. The maximum uranium temperature shall not exceed 660°C .

- (3) Kratzer, W. K. Production Test IP-226-A, Irradiation of Enriched Seven-Rod Cluster Elements with Twenty and Thirty Mil Zircaloy-2 Jackets, HW-58781, January 8, 1959
- (4) Kratzer, W. K. Supplement A to Production Test IP-226-A, Irradiation of Enriched Seven-Rod Cluster Elements with Twenty and Thirty Mil Zircaloy-2 Jackets, HW-60112, April 21, 1959
- (5) Kratzer, W. K. Supplement B to Production Test IP-226-A, Irradiation of Enriched Seven-Rod Cluster Elements with Twenty and Thirty Mil Zircaloy-2 Jackets, HW-61511, August 13, 1959
- (6) Kratzer, W. K. Production Test IP-300-A, Irradiation of Twenty Inch Natural Uranium Tube and Tube Elements with Hot Headed Inner Tubes, HW-63610, January 22, 1960

DECLASSIFIED

HW-66235
Page 4

4. Exposure

- The maximum exposure authorized for any elements in the fuel loading is 1000 MWD/T.

5. Hazards

The probability of failure of the fuel elements authorized by this Supplement cannot be assessed because of the inability to find and analyze the failure that caused premature discharge of the preceding thermocouple train. Previous experience would indicate, however, that the principal risk involved is that of an unscheduled reactor outage. This risk is justified to obtain information about the temperature effects of crud film deposition in a carbon steel system.

6. Other Aspects of the Production Test

All requirements of the original production test and approved supplements not specifically modified by this supplement will remain in effect.

RESPONSIBILITIES

Hanford Laboratories Operation

Reactor and Fuels Research and Development Operation

Fuels Development Operation

Fuel Element Design Operation is responsible for fabrication of the thermocouple element assembly and the tubular elements, analysis of data, and issuance of technical reports.

Materials Development Operation

Coolant System Development Operation is responsible for assembly of the thermocouple train, providing and maintaining the thermocouple leads, junctions, and temperature recorders, analysis of data, and issuance of technical reports.

Irradiation Processing Department

Research and Engineering Operation

Component Testing Operation is responsible for post-irradiation examination and testing of components in the test charge.

Coolant Testing Operation is responsible for:

- Operation of the KER Loops.
- Taking basic operating data.
- Scheduling the loop charge with the concurrence of KE Processing Operation.
- Reactor safety and production continuity as they are affected by loop operation.

Process and Reactor Development Operation is responsible for:

- Technical aspects of the fuel element irradiation.
- Termination of the production test and issuance of the final report.

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HW-66235

Page 5

KE-KW Reactor Operation

KE Processing Operation is responsible for:

- a. Operational safety.
- b. Production continuity, except where inconsistent with provisions of this test.

W. K. Kratzer

W. K. Kratzer
Process & Reactor Development
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

D. W. Peacock

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DECLASSIFIED

HW-66235
Page 6

FIGURE I
OPERATING TEMPERATURE AND TRIP SETTINGS
AS A FUNCTION OF THE OBSERVED TUBE T

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HW-66235
Page 7

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