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IRRADIATION ANALYSIS - PT-IP-714 - IRRADIATION OF SOLID ALUMINUM IN KER-1, KER-2, KER-3, and KER-4 WITH PROCESS WATER COOLING

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August 27, 1964

IRRADIATION ANALYSIS
PRODUCTION TEST IP-714
IRRADIATION OF SOLID ALUMINUM IN KER-1, KER-2, KER-3, AND KER-4
WITH PROCESS WATER COOLING

K. W. Gerdes

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August 27, 1964

IRRADIATION ANALYSIS
PRODUCTION TEST IP-714
IRRADIATION OF SOLID ALUMINUM IN KER-1, KER-2, KER-3, AND KER-4
WITH PROCESS WATER COOLING

Introduction

Production Test IP-714 authorizes the irradiation of full length charges of solid aluminum in the KER loops while on single-pass operation with process water cooling.

Discussion

The initial loading shown in the production test have been reviewed for compliance with Process Standard K-020, Single-Pass Operation Without Fissionable Material Charged. Specified flow rates and trip points will be complied with. The coolant will be single-pass process water; normal operating flow will be maintained at 10,000 lbs/hour on KER-1 and 2, and 18,000 lbs/hour on KER-3 and 4. Flow annunciator alarms will be set at 8,000 lbs/hour on KER-1 and 2, and 15,000 lbs/hour on KER-3 and 4; the temperature rise expected across the process tube at this minimum flow is 45 C for KER-1 and 2 and 31 C for KER-3 and 4. The only incremental operating hazard associated with irradiation of solid aluminum in the KER loops instead of operating them as water columns is the possibility of melting down the aluminum if coolant were lost.

In the event of a complete loss of coolant to the facility with the reactor continuing to operate, and assuming that 30 per cent of the heat transferred from the graphite stack to the test facility were absorbed by the aluminum, approximately 6.0 minutes would be required to melt down the aluminum in KER-1 or 2 and about 7.5 minutes for KER-3 or 4.

Flow and temperature alarms are required by the production test with a mandatory reactor shutdown specified two minutes after receipt of the alarm if an interruption of flow or other hazardous condition exists. A complete loss of flow is considered very unlikely. This small potential for occurrence combined with the specified corrective action will make the probability of aluminum meltdown or damage to the facility negligible.

The specified operating flow will result in a maximum coolant velocity of approximately ten feet/second. Chattering of the aluminum dummy in the tube is not considered likely at this velocity with the specified loading.

Introduction of solid aluminum into the KER loops will not significantly increase the hazards associated with these test facilities.

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Temperature rise expected across process tube as a result of irradiating solid aluminum in the KER loops:

Assume

A heat generation of 0.7 watts/hour/gram of aluminum

KER-1 and KER-2

Weight of aluminum dummies, 38,200 grams, heat generated in aluminum:

$$38,200 \text{ grams} \times 0.7 \text{ watts/hour/gram} = 26.7 \text{ KW}$$

Heat from stack*

$$150 \times \frac{600 - 20}{600 - 60} = 161.0 \text{ KW}$$

$$\text{Total heat to test facility} = 188.0 \text{ KW}$$

Temperature rise across tube at 8,000 lbs/hour

$$\Delta T = 188 \text{ KW} \times 3,413 \text{ BTU/KW Hr} \times \frac{1}{8,000 \text{ lbs/hour} \times \frac{1 \text{ BTU}}{15 \text{ F}}} = 80 \text{ F or } 45 \text{ C}$$

KER-3 and KER-4

$$\text{Weight of dummies} = 72,000 \text{ grams}$$

$$\text{Heat generated in dummies} = 72,000 \times 0.7 = 51.0 \text{ KW}$$

$$\text{Heat from stack*} = 180 \times \frac{600 - 20}{600 - 60} = 193.0 \text{ KW}$$

$$\text{Total heat to test facility} = 244.0 \text{ KW}$$

Temperature rise across tube at 15,000 lbs/hour

$$\Delta T = 244 \text{ KW} \times 3413 \times \frac{1}{15,000} = 56 \text{ F or } 31 \text{ C}$$

*Formula taken from page 88, HWN-2670, KER Test Design Calculations

Time to reach the melting point of aluminum assuming a complete loss of coolant and continued reactor operation; assume a heat generation in the aluminum of 0.7 watts/hour/gram and assume 30 per cent of the heat transferred from the graphite stack to the test facility is absorbed by the aluminum:

KER-1 and KER-2

$$\text{Specific heat of aluminum} = .00016 \text{ watts/gram/F}$$

$$\text{Weight of aluminum} = 38,200 \text{ grams}$$

$$\text{Heat from stack} = 161,000 \text{ watts/hour}$$

$$\text{Melting point of aluminum} = 1,219 \text{ F}$$

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KER-1 and KER-2 (continued)

$$\frac{0.7 + \frac{(.3)(161,000)}{33,200}}{.00016} = 11,800 \text{ F/hour}$$

$$\frac{11,800}{60} = 197 \text{ F/minute}$$

$$\frac{1.219}{197} = \text{six minutes to meltdown}$$

KER-3 and KER-4

$$\frac{0.7 + \frac{(.3)(192,000)}{72,000}}{.00016} = 9,400 \text{ F/hour}$$

$$\frac{9,400}{60} = 156 \text{ F/minute}$$

$$\frac{1.219}{156} = 7.5 \text{ minutes to meltdown}$$

Conclusions

The irradiations will not result in any foreseen reactor or personnel hazards and can be safely performed in the KER facilities.

Prepared by *[Signature]*
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