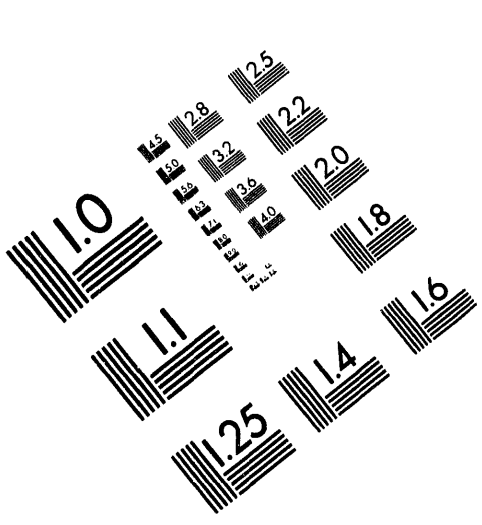

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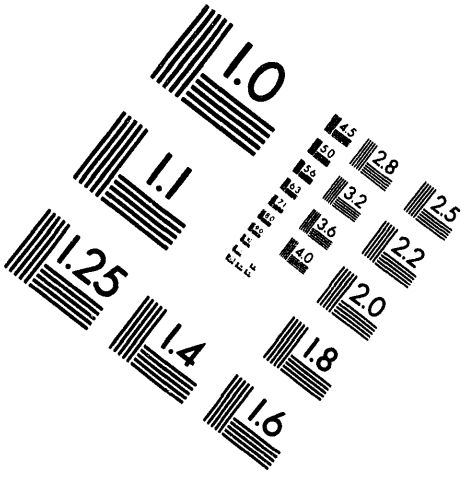

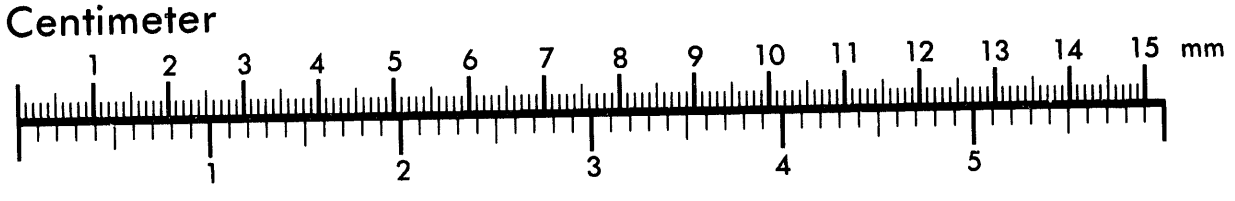

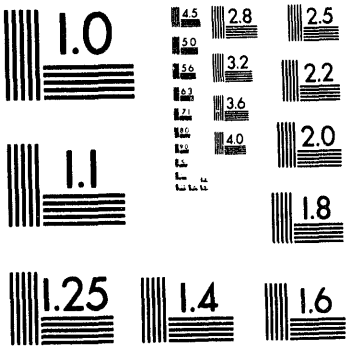

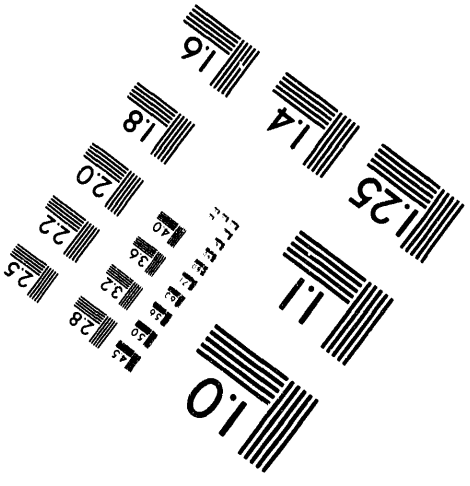

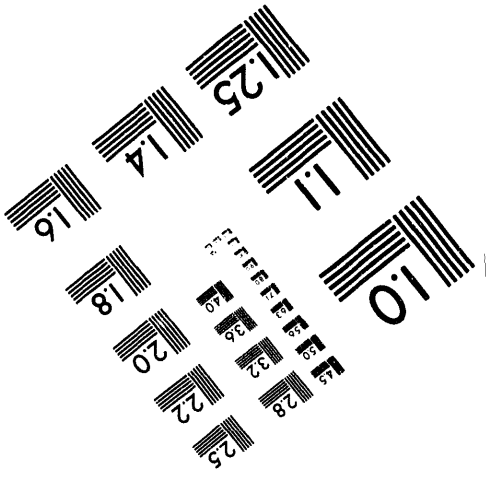

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October 16, 1959

PRODUCTION TEST IP-288-A, EVALUATION OF SEVEN-ROD CLUSTER ELEMENTS WITH MODIFIED END CLOSURES

OBJECTIVE

The objective of this production test is to obtain irradiation experience with the hot-headed closure for co-extruded Zircaloy-2 jacketed rod.

SUMMARY

Seven Zircaloy-2 jacketed natural uranium seven-rod cluster elements with hot-headed end closures and spark machined end supports will be irradiated in the KER Loops to an exposure of 2000 MWD/T in pH 8-11 coolant.

BASIS AND JUSTIFICATION

The hot-headed end closure[1] on co-extruded Zircaloy-2 jacketed rods provides a closure in which the jacket is bonded over most of the end of the rod and two welds are employed between the uranium and the coolant. In contrast, the current end closure method uses an unbonded end cap and a single weld. This test will provide the initial irradiation of fuel element rods with the hot-headed closure. The method is being adapted to tubular elements, but has not been developed far enough for irradiation testing.

TEST DETAILS

1. Fuel Elements

The fuel elements consist of seven 0.593 inch diameter rods with 0.020 inch thick Zircaloy-2 jackets arranged in the form of a cluster with 0.078 inch clearance between rods. Each rod contains 11.9 inches of uranium. The overall cluster length is 12.0 inches. The rods are supported at the ends by spark machined Zircaloy-2 spiders. Details of the element are shown in SK-3-8912.

Steps in the fabrication of the elements from the coextruded rods include:

a. Cutting the rod to length (~12 inches).
b. Extrusion heading the rods to form the jacket over both ends.
c. Beta heat treatment in the vertical position.
d. Chemical removal of copper and lubricant from the rods and vapor blast cleaning.
e. Machining extrusions from rod ends.
f. Ring projection welding the caps to rod ends.
g. Ultrasonic bond testing.
h. Pickling in nitric - 4% HF.
i. Autoclaving in 400°C, 1500 psi steam for 12 hours.
j. Electron beam fusion welding caps to jackets.
k. Autoclaving in 400°C, 1500 psi steam for 48 hours.
l. Welding to end spiders.
m. Autoclaving 400°C, 1500 psi steam for 12 hours.

2. Loading

The loading shall consist of thirty downstream eight-inch spacer elements, seven seven-rod cluster elements, and up to sixteen eight-inch spacer elements upstream. Coupon holders of a design approved by Coolant Testing Operation and Process and Reactor Development Operation may be substituted for any of the eight-inch spacers except those adjacent to the cluster elements.

3. Irradiation Facility

The fuel elements may be irradiated in any of the high temperature recirculating KER Loops with a 2.020 inch ID process tube.

(1) Allison, G.S., P. A. Ard, and W. L. Wyman, "A Process for Nuclear Fuel Element End Closures," HW-61233, June 23, 1959. (Confidential-Undocumented).

TEST DETAILS (cont'd)

4. Operating Conditions

The coolant will be pressurized water with the pH adjusted to 8.0 to 11.0 by the addition of Li OH. The desired operating flow is 60 gpm with a low flow trip of 48 gpm. The low pressure trip will be set at 1500 psig. The desired operating outlet temperature, high outlet temperature trip, and boiling point suppression trip are given in Figure 1.

For recirculation with system pressures less than 1500 psig is required, the outlet temperature will be reduced and maintained at least 100°C below the system saturation temperature.

5. Power and Temperature Limits

The operating conditions have been chosen so that surface boiling will not occur on the fuel elements during normal operation, surface will not occur at the limiting trip conditions, and the maximum [illegible] temperature will not exceed 660°C.

6. Exposure

The maximum exposure authorized by this production test is 2000 MWD/T for the sectioned cluster elements.

7. Special Procedures

The fuel elements from this production test will be discharged into a special tray to avoid damage resulting from their fall to the basin. A detailed discharge procedure approved by the Processing Operation and Coolant Testing Operation will be issued prior to discharge.

8. Priority

Additional down-time is authorized if charging or discharging cannot be accomplished during a normal outage.

9. Costs

a. Cost Code - XXX.5320-XXX.09
b. Time

	Elevator Time, Hours		Manhours
	Front	Rear	
Charge	1	1	4
Discharge	2	4	10
	3	5	14

10. Data Desired

Routine operating data, including coolant flow, inlet and outlet temperature and pressure, system pressure, and operating time at temperature, will be taken during irradiation.

11. Hazards

The cluster elements authorized by this production test incorporate a new closure which has not been previously irradiation tested. Although the closure modification

is intended to produce a weld and end cap less susceptible to failure than those used in previous cluster element irradiations, there is always the possibility that the untried closure will fail. Detection and characterization of such operational difficulties is the basic purpose of this test.

The geometry, fabrication (other than end caps and welds), and testing procedures of the fuel elements in this test were sufficiently similar to those of previous cluster element tests to give no basis to assume that the probability of failure or severity of failure will be any different for these elements than for other seven-rod cluster elements that have been irradiated.

Deviation from Process Standards

This production test authorizes deviation from process standard K-000, Section 00001, which limits the maximum uranium temperature to 600°C. Uranium temperatures up to 660°C may occur at maximum tube power conditions, although the anticipated maximum uranium temperature will be less than 600°C.

RESPONSIBILITIES

Hanford Laboratories Operation

Reactor and Fuels Research and Development Operation

Fuels Development Operation

Fuel Fabrication Development is responsible for the fabrication of the cluster elements, 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:

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

Process and Reactor Development Operation is responsible for:

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

KE-KW Reactor Operation

KE Processing Operation is responsible for:

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

W. K. Kratzer
Reactor Fuels Unit
Process and Reactor Development Sub-
IRRADIATION PROCESSING DEPARTMENT

WK Kratzer:gb

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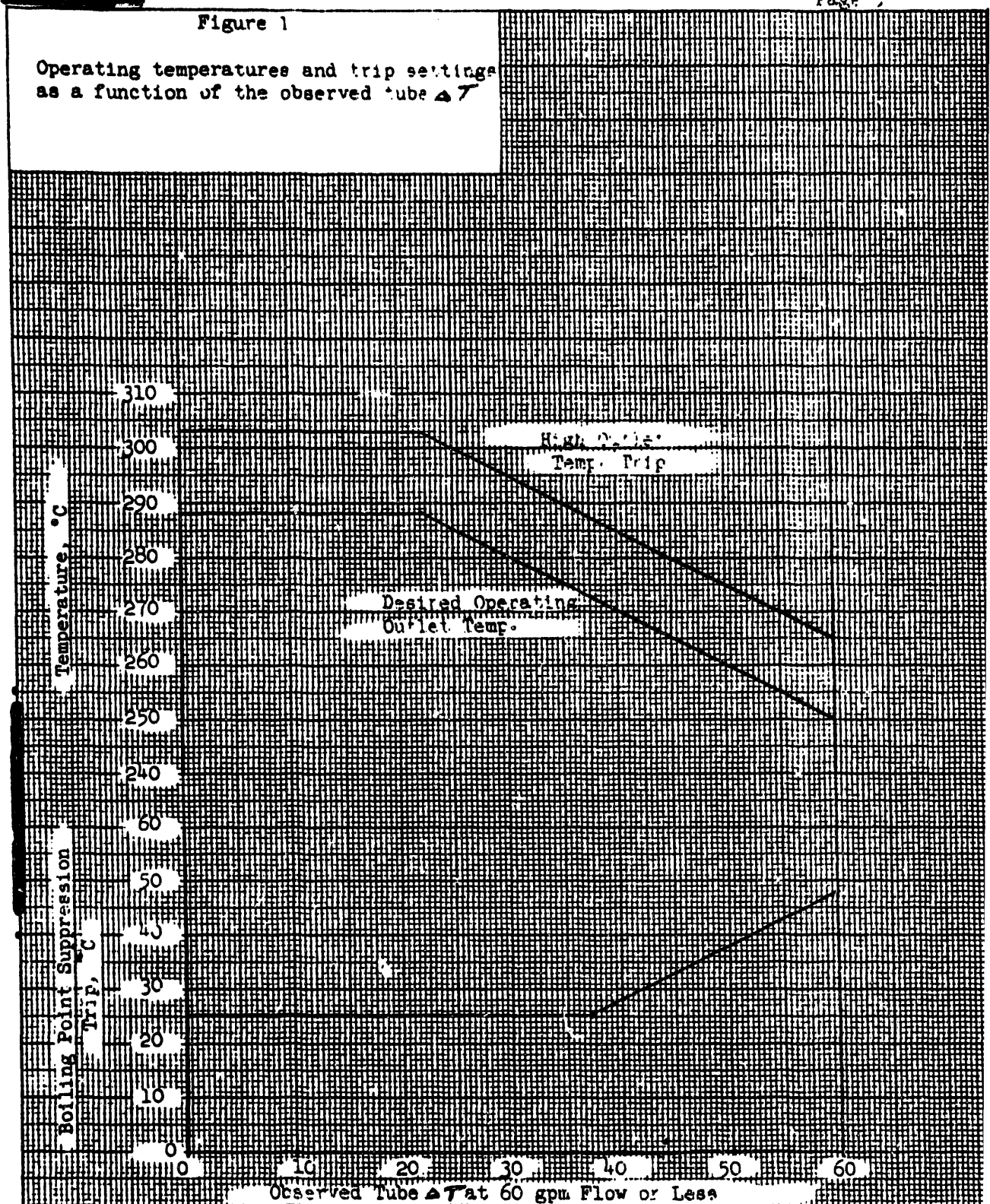
Figure 1

Operating temperatures and trip settings as a function of the observed tube ΔT



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