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DPW-56-179

CC: A. R. Kaufmann-J. T. Harris-
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DU PONT

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE

EXPLOSIVES DEPARTMENT

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A8 VIII

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March 12, 1956

Mr. H. L. Kilburn, Director (2)
Technical and Production Division
Savannah River Operations Office
U. S. Atomic Energy Commission
Post Office Box A
Aiken, South Carolina

RECEIVED
FOR NUCLEAR METALS, INC.
By L. Busnaser

MAR 14 1956

RECORDED BY C. Busnaser
INDEXED BY
P. O. REGISTRY NO. 19166

Dear Mr. Kilburn:

NUCLEAR METALS, INC. -
FABRICATION OF URANIUM TUBES

Nuclear Metals recently developed a process for producing bare uranium tubes with acceptable surface characteristics. In a letter from M. F. Spraggins to A. R. Kaufmann dated February 17, 1956, DPW-56-152, we asked if Nuclear Metals would make a proposal for the fabrication of sixty tubes. A copy of their proposal dated March 8, 1956 was sent by them to Paul Hagelston, and an additional copy is being transmitted to you.

At this time it is important to the progress of the tubular fuel element program that experimental quantities of bare tubes be obtained for cladding development and for hydraulic, nuclear, and, later, irradiation tests. Accordingly, we recommend that the SROO take immediate steps to implement Nuclear Metals' proposed program, which they estimate will cost $122,500 plus fee.

The second paragraph of the proposal mentions that the tubes will have an internal diameter of 2.505" and an external diameter of 2.895". These dimensions were selected earlier to establish a standard size for the various phases of the development program. Other components fitting these tubes are in hand. The first portion of the sixty tubes will be produced to these dimensions. It is possible that work now in progress will indicate a different set of dimensions for the production prototypes. If so, the remainder of the sixty tubes will be made to these new dimensions.

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Very truly yours,

ATOMIC ENERGY DIVISION

Hood Worthington

Hood Worthington, Director
Technical Divisi [redacted]

MASTER

Reviewing Official: J. E. Banick, AED Class Officer

LGE:EV

Attach.

Date 3/4/89

[redacted]

[redacted]

[redacted]

E. I. DU PONT DE NEMOURS AND COMPANY
EXPLOSIVES DEPARTMENT
WILMINGTON 98, DELAWARE

DPW-56-187

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March 12, 1956

M E M O R A N D U M

TO: A. A. Johnson

FROM: D. F. BABCOCK-L. BERNATH
DFB - L.B.

ORIENTATION OF CONTROL RODS

INTRODUCTION

Your group has recommended (RTM-951) that the control rods in the septifoils of the reactor be reoriented in order to improve the flux shaping. No mention is made of burnout. This memorandum re-examines the problem of orientation of the control rods considering not only flux shaping but also burnout.

SUMMARY

It is suggested that the central position of each septifoil contain a cadmium control rod and that these rods be the first ones removed from the reactor during the start-up procedure. All of the remaining rods will be in the peripheral positions. The orientation of the full rods and the half rods should be changed by 60° on going from one pie-shaped segment of the reactor to another, thereby preserving radial symmetry and reducing the flux tilt.

It is believed that this method of orienting the control rods, not only gives good control of the flux tilt

[redacted]

[redacted]

but also provides maximum protection against control rod burnout. Some minor difficulty for the electricians is foreseen in obtaining a different orientation in each pie-shaped segment but once this orientation has been achieved it need never be changed.

It is suggested further that the helium bubbler monitor be instated as the full-time flow detection system for septifoil coolant. This measure will insure that melting of a control rod cannot occur at power levels attainable with the Byron-Jackson pumps.

DISCUSSION

I. Flux Shaping

Works Technical memorandum (RTM-951) recommends that the full control rod remaining in the reactor during power operation be placed in the central channel of the septifoil. The two half-rods are to be placed in peripheral channels so that the three rods are arranged in a straight line. This rod orientation exists in C and R reactors, and has been found to reduce the flux tilt markedly.

The elimination of flux tilt is desirable if it can be accomplished without affecting adversely the cooling provided the control rods. It is believed that this can be accomplished by placing the active control rods in the peripheral positions of the septifoils and orienting the septifoils in a radially symmetrical manner.

II. Heat Transfer

The experimental work summarized in DPST-56-136, simulates the heat generation in 3.5% lithium-aluminum control rods and, specifically, in the full rod which remains in the septifoil during operation. These data clearly show that the central channel of the septifoil is most vulnerable to boiling and to burnout. The table below summarizes the reactor power at which boiling a d burnout will occur in the two types of septifoil channels under two conditions of reduced coolant flow.

3.5% Li-Al Control Rods

Flow Condition	Heat Transfer Result of Postulated Flow Condition*	
	Peripheral Channel	Central Channel
A. Loss of Coolant to one sub-channel (**)	Boiling at 240 MW Burnout at 1300 MW	Boiling at 170 MW Burnout at 1000 MW
B. Total loss of coolant to S-Foil.	Boiling at 240 MW Burnout at 860 MW	Boiling at 100 MW Burnout at 340 MW

* Based on the heat flux at the point of maximum heat generation in the rod and 80°C coolant supplied.

** S-foil flow is reduced to 72 gpm (85% of normal) and the remaining full control rod is placed in the starved channel.

The monitoring devices available for detecting reductions in flow to the individual septifoils are -

a) a United-Electric Co. pressure switch connected to the base of upflow pin, and

b) a helium bubbler that actuates a "Meletron" pressure switch attached to the "forest" guide tube. The U.-E. pressure switch is a coarse detector and it is doubtful that a 15% reduction in flow (all flow may be lost to one channel) can be indicated reliably. The helium bubbler is more sensitive, but is subject to extraneous complicating effects, such as, positions of the rods in the septifoils, variations in the gas plenum pressure, and tightness of juncture of the "forest" matching plate. Since the existing monitor instruments are more than adequate for determining gross (> 50%) reductions in flow, peripheral placement of the rod will protect against melting. However, to minimize the possibility of boiling on the rod surface, it will be necessary to monitor closely with the helium bubbler system.

Since 1% lithium-aluminum control rods are to be installed in all areas during the next 3 or 4 months, it is pertinent to review the heat transfer characteristics of these rods. Experiments in the PDP (DPST-55-17-5) have shown that the heat generated by neutron capture in the 1% lithium rods will be about one-half that in the 3.5% lithium rods. Therefore, the above tabulation becomes:

[redacted]

1% Li-Al Control Rods

Flow Condition	Heat Transfer Result of Postulated Flow Condition* Peripheral Channel	Central Channel
A. Loss of coolant to one sub-channel.**	Boiling at 440 MW Burnout at $>$ 2000 MW	Boiling at 320 MW Burnout at 1900 MW
B. Total loss of coolant to S-Foil.	Boiling at 440 MW Burnout at 1600 MW	Boiling at 190 MW Burnout at 570 MW

*,** Notes as before.

Thus, peripheral placement of the control rods in the reactor during operation will protect against rod melting at power levels up to the maximum attainable with the Byron-Jackson-pumps.

Use of the septifoils as distributors for cold moderator to eliminate the "hot-spot" problem probably will not affect adversely their heat transfer characteristics, and the lower coolant temperature will permit higher power levels.

Installation of the Bingham pumps and the attendant piping changes should result in more flow to the control clusters and should, therefore, further reduce the likelihood of boiling and burnout.

References:

1) F. S. Manning, Heat Transfer from Septifoils, DPST-56-136, February 2, 1956.

2) E. W. Hones, Heat Generation in Control Rods, DPSP-55-383, May 16, 1955.

3) A. A. Johnson, Re-Orientation of Control Rods, RTM-951, February 24, 1956.

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END