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DATE:

June 19, 1956

SUBJECT:

 Letter with attachment, Apparent Carburation and
 Sensitization of APPR-1 Fuel Plates

TO:

Kenneth Kasschau

FROM:

R. J. Beaver

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UCC

POST OFFICE BOX P

OAK RIDGE, TENN.
June 19, 1956

ALCO Products, Incorporated
Atomic Energy Division
Schenectady 5, New York

Attention: Mr. Kenneth Kasschau

Gentlemen:

We are attaching a preliminary analysis and proposed actions on "Apparent Carburization and Sensitization of APFR-1 Fuel Plates", which were results of a meeting held at ORNL on Friday afternoon and Saturday, June 15 and 16, between ORNL, AEC and APB representatives. We regret that none of your representatives were present; however, the decision to hold such a meeting was not made until Friday afternoon and by that time John Tully and R. D. Robertson, who are familiar with the problem, had returned to Schenectady.

As you will note in reviewing the attachment, the immediate problem is to determine the reason for the apparent carburization and sensitization of the 304L cladding material, and decide the severity of this effect in relationship to APFR-1 fuel elements. Under the proposal for immediate action, we plan to act on item "A" and on items 1, 3, 4, 5, 6 and 7 under "B". We suggest that you be responsible for the literature survey proposed in item 2 of "B". We plan to also initiate investigations described under "A" of "Possible Additional Technical Action". It is recommended that a meeting be held on June 28 at ORNL to determine the status of the APFR-1 fuel elements insofar as their use in the reactor is concerned.

Meanwhile, we would appreciate an immediate answer to the following questions:

1. How many of the following fuel elements which meet all dimensional specifications are acceptable for the work required in your critical facility which is to begin in August?

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June 19, 1956

Fuel Element Number

Braze splattered over all fuel plates

One plate has a blister approximately $\frac{1}{2}$ inch in diameter 3R

Loose joint on one side of one fuel plate 1

Braze runout over top fuel plate

Braze runout on inner plates 12

Plates flattened annealed twice, and cleaned in 15% HNO_3 -5% HF solution prior to assembling

No record of cleaning plates prior to assembly, but extremely likely that some plates were cleaned in the 15% HNO_3 -5% HF solution

Meet all dimensional, brazing and cleaning specifications 26

2. We have a number of finished plates which have been flattened annealed twice and cleaned in 15% HNO_3 -5% HF aqueous solution. These plates show little, if any, intergranular attack after examination under a low power microscope. Will fuel elements brazed with these plates be suitable for use in your critical experiments?
3. Are any of the substitute materials listed in item "A" under "Possible Additional Technical Action" suitable for reactor use in the APFR-1?
4. Is the meeting date of June 28 at ORNL satisfactory?

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Kenneth Kasschau

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June 19, 1956

It is most regrettable that this unexpected problem materialized. From all appearances, we had solved most of our manufacturing difficulties as evidenced by the brazing of seven consecutive units well within all dimensional specifications.

Very truly yours,

R. J. Beaver
Metallurgy Division

RJB:fwh

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Attachment I, "Apparent Carburization and Sensitization
of APPR-1 Fuel Plates"

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Attachment I

Apparent Carburization and Sensitization of APFR-1 Fuel Plates

During the course of manufacturing the enriched composite fuel plates for APFR-1, an unexpected phenomenon was observed. This phenomenon was revealed after a recent process modification in which the finished composite fuel plate was given a brief brightening dip in a 15% HNO_3 -5% HF aqueous solution, and may be related to a previous process modification requiring additional flattening annealing operations.

On June 13, 1956 a batch of 37 composite fuel plates, which had been subjected to three flattening annealing treatments, revealed severe intergranular attack after cleaning in the above acid solution. This attack was so severe that actual grains of stainless steel were removed by this cleaning treatment. Intergranular attack is generally related to sensitized stainless steel. Since type 304L stainless steel should theoretically not be subject to sensitization, it appears that during processing of APFR-1 fuel components, the type 304L stainless steel clad of the composite fuel plate is becoming contaminated with carbon, rendering it susceptible to sensitization.

A meeting was held on Friday and Saturday, June 15 and 16, to determine the necessary action which will be required to clarify the nature and severity of this problem. Those present were: R. J. Beaver, J. E. Cunningham, R. C. Waugh, of ORNL; A. Giambusso, APB; L. D. Schaffer, Y-12; and H. Behrman, AEC OROO (Saturday only). The actions proposed were divided into three categories - immediate, short range, and long range.

I. Immediate Action

- A. Continue manufacturing APFR-1 fuel elements in accordance with present fabrication procedures, but eliminate (1) the 15% HNO_3 -5% HF aqueous cleaning solution on the final fabricated plate, and (2) confine flattening annealing operations to a maximum of two (maximum of 7 hrs at 1130°C on a batch of 40 plates).
- B. Determine whether or not fuel elements manufactured as in "A" above will be satisfactory for APFR-1 reactor operation.
 1. Investigate all possible sources of carbon which might cause sensitization of the type 304L stainless steel clad of the APFR-1 fuel plate.
 2. Conduct a literature survey relating effect of corrosion on sensitized stainless steel under pressurized high temperature water conditions at least as severe as those expected in the APFR.
 3. Analyze fuel plates manufactured under existing conditions by metallographic examination, carbon analyses and Strauss testing.

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4. Analyze previously fabricated APPR-type fuel element, containing depleted UO_2 , which had been tested in a loop at WAPD for 6000 hrs in pressurized water.
 - a. Review the techniques applied to processing the fuel element, and the results of tests performed on the unit at WAPD.
 - b. Section fuel plates from the element and analyze by metallographic examination, carbon analyses and Strauss testing.
5. Compare analysis of item 3 and 4 above.
6. Determine the effects of one flattening annealing operation, followed by the brazing cycle, and two flattening annealing operations, followed by the brazing cycle, on the carbon content of the 304L cladding material in the presently fabricated fuel plate.
7. Determine the number of fuel elements already manufactured which are acceptable only for measurements to be made in the ALCO critical facility in August.
8. Determine the effect of B_4C in the core on presently fabricated plates subjected to treatments outlined in 6.
9. After investigations listed in items 1 to 8 have been completed, hold a meeting between ALCO Products, ORNL and AEC representatives to determine whether or not fuel elements manufactured in accordance with item "A" will be acceptable for APPR-1.

II. Possible Additional Technical Action

In the event the fuel elements are not suitable for APPR-1, the following additional technical action is proposed:

A. Short Range

Substitute materials based on the assumption they are compatible in APPR-1.

	<u>Clad</u>	<u>Frame</u>	<u>Core</u>	<u>Poison</u>
1.	304L	304L	304B*	B_4C
2.	304L	304L	304B*	ZrB_2
3.	304L	304L	347	B_4C
4.	304L	304L	347	ZrB_2
5.	347	347 or 304L	304B*	B_4C
6.	347	347 or 304L	304B*	ZrB_2
7.	347	347	347	B_4C
8.	347	347	347	ZrB_2

*Type 304 stainless steel with high silicon (present stainless core material)

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Plates fabricated from these materials will be compared for carburization and sensitization of the cladding material on the basis of carbon analysis of the clad, metallographic examination and Strauss testing.

B. Long Range

In the event none of the above measures lead to a satisfactory solution, it will be necessary for ORNL to resume their original long range development program.

RJB:fwh

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