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Records

Requirements for Capsule Disassembly
and Post-irradiation Analysis

Fuel Irradiation Program
Series T-T

Phase I

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A. Introduction

The Westinghouse Post-Irradiation Facility (W-PIF) will receive six irradiation capsules directly from the GETR. Each capsule will contain three samples of irradiated fuel material. The capsules are to be disassembled within the hot cells and various chemical analyses and metallographic examinations are to be performed upon the fuel. The work required is outlined below.

B. Capsule Disassembly

The burnup analyses which are to be performed must be based on the relatively short lived radio-nuclide Mo^{99} . Consequently, it is imperative that each capsule be disassembled immediately after its receipt.

During the process of disassembly, the capsules must be punctured and the internal gas pressure determined. Therefore, suitable equipment must be designed and fabricated by W-PIF. The necessary equipment should be completed and calibrated prior to the receipt of the first capsule.

A total of six capsules are to be disassembled. The recommended disassembly procedure is outlined in Appendix I.

C. Burnup and Chemical Analyses

Two segments of each fuel sample are to be transferred to the radio-chemical section for burnup and chemical analyses. The following determinations are to be made:

- 1) Uranium content in matrix
- 2) Uranium content in NbC liner
- 3) Fission density in matrix (fiss./cm³)

The burnup is to be based on the radio-nuclide Mo⁹⁹.

A total of 36 samples are to be analyzed for burnup and matrix uranium content. Twelve samples have no liner and, consequently, only 24 liner analyses are to be made. The recommended method of analysis is discussed in Appendix II.

D. Flux Wire Analysis

Each capsule has associated with it three cobalt-aluminum flux monitor wires. Each wire will be 3 inches long and its upper and lower ends will be suitably identified. The integrated neutron flux to which each wire has been exposed is to be determined at 0.25 inch intervals along the length of each individual wire. The analysis is to be performed on a total of 18 wires.

All pertinent data such as the chemical composition of the wires and dates and duration of exposure will accompany each group of wires.

E. Metallography

Metallographic examination is required to ascertain the condition of the fuel material and NbC liner. The techniques for metallographic examination of NERVA fuel material have been developed at WANL. It is suggested that the WANL metallographic section be consulted as to the

suitable methods of mounting, polishing and etching.

The requirements for the metallographic examination are outlined in Appendix III. At least 54 metallographic specimens are to be prepared. Numerous measurements and photomicrographs of each specimen will be necessary.

F. Summary

The total number of capsules or samples needed for each specific operation or determination are summarized in Table 1.

Table I

Summary of Required Post-irradiation Operations or Determinations

<u>Operation or Determination</u>	<u>Total Number Of Samples</u>
Capsule Disassembly	6
Internal Gas Pressure Determination	6
Burnup Analysis	36
Determination of Uranium Content in Matrix	36
Determination of Uranium Content in NbC Liner	24
Flux Wire Analysis	18
Metallographic Examination	54

Capsule Disassembly

The following is the recommended procedure for capsule disassembly. An assembly drawing of the capsule (WANL-drawing 574F130) accompanies this document.

- 1) Cut through the outer capsule at a point 0.25 inch from the top of the capsule. Do not discard the top of the outer capsule.
- 2) Slip the inner capsule out of the outer capsule. Discard the outer capsule.
- 3) Three flux monitor wires are mounted on the outer surface of the inner capsule. Cut each flux wire at a point one inch from the bottom face of the capsule and then cut the wire at a point four inches from the bottom face of the capsule.
- 4) Mark the upper and lower ends of each flux monitor wire and place them in suitably marked containers.
- 5) Puncture the inner capsule and determine the internal gas pressure.
- 6) Cut through the inner capsule at a point 0.25 inch from the top. The cut should be made through all thermocouples.
- 7) Carefully remove the graphite sleeve from the inner capsule. Discard the capsule.
- 8) Carefully open the graphite sleeve assembly and remove the thermocouples. Place the thermocouples in a suitably marked container.

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9) Carefully remove the fuel samples from the graphite sleeve. Each sample is to be identified as to its relative position within the capsule. The upper and lower ends of each sample are to be suitably marked.

10) Place the fuel samples in suitably marked containers.

11) Place the graphite parts in a suitably marked container.

12) Transfer the fuel samples to the metallographic section.

13) Transfer the flux wires to the radio-chemical section.

14) Ship the following items to WANL:

- a. The top of the outer can
- b. All thermocouples
- c. All graphite parts.

Appendix II

Recommended Method for Burnup and Chemical Analyses

It is suggested that each sample be burnt in oxygen until the matrix graphite is completely gone. When the oxidation is complete, the matrix uranium will be in the powered oxide form and the liner in the form of cylinders of niobium oxide. The liner material is then separated from the matrix material prior to the addition of any solvents.

The burnup analysis is to be performed on the matrix uranium. The analysis is to be based upon the radio-nuclide Mo^{99} . The uranium content

of the matrix can then be determined using the residue.

The uranium content of the liner is to be determined by either emission spectroscopy or x-ray florescence.

Appendix III

Requirements for Metallographic Examination

All fuel samples will be transferred, intact, to the metallographic section. It will be the responsibility of the metallographic section to cut appropriate segments from the fuel samples and transfer them to the radio-chemical section for analysis. Prior to cutting the entire sample must be mounted in a suitable mounting material. This is done so that the liner will remain intact during the cutting operations. All cutting operations are to be performed with a thin diamond cut-off wheel with a minimum of vibration.

The remaining portion of each of the fuel sample will be sectioned so as to give three metallographic specimens. Each specimen is to receive extensive metallographic examination which includes:

- 1) Examining the condition of the liner
- 2) Examining the condition of the fuel particles
- 3) Measuring the extent of fuel migration.

Numerous photomicrographs are to be taken of each specimen.

The following is the recommended procedure for preparing the

metallographic specimens.

- 1) Mount the fuel sample in hy-sol. (Contact WANL metallography for technique.
- 2) Carefully cut 0.25 inch segments from the top and bottom of the sample. Each disk is to be identified as to the sample from which it has been cut and as to whether it has been cut from the bottom or top of the sample.
- 3) Place the segments in suitably marked containers and transfer them to the radio-chemical section.
- 4) Identify the top and bottom of the remaining portion of the fuel sample.
- 5) Cut the remaining portion of the sample along its axis. This cut should be made through the center hole and two periferal holes.
- 6) Mount one of the longitudinal sections so that the cut face can be examined.
- 7) Cut the remaining section in half radially.
- 8) Mount each transverse section so that the sample top and bottom ends (see 4) can be examined.