FTR FUEL SUBASSEMBLY PROCESS DEVELOPMENT

MASTER

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The FTR reference fuel subassembly design¹ consists of 217, 1/4 inch OD x 71 inch long fuel pins assembled into a hexagonal array and spaced by means of stainless steel wire spirally wound on each pin. Fuel pins contain a 32-inch long section of UO_2 - PuO_2 fuel pellets, a neutron reflector and a fission gas plenum.

This report presents: (1) the major factors to be considered in the selection of unit processes and control techniques for the fabrication of FTR fuel subassemblies (excluding fuel pin fabrication), (2) the description of a process for fabrication of the reference design FTR subassembly, and (3) the process experience gained in fabrication of full scale subassemblies for hydraulic testing in flowing sodium and water. New and significant data are related principally to scale up of processes, fuel bundle assembly concepts, radiation shielding concepts and criticality control procedures required for the manufacture of FTR driver fuel subassemblies.

The major factors considered in the selection of unit processes and control techniques are fuel design criteria², fuel bundle dimensional tolerances, radiation exposure control and criticality safety control.

The dimensional tolerance between a close packed fuel bundle and the inner flow duct wall is important because of its effect upon assembly operations, coolant velocity distribution and fuel pin

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restraint. While the latter two considerations favor minimal spacing from the standpoint of heat transfer and potential of fretting of unrestrained fuel pins, some tolerance is required for assembly and for free axial movement during irradiation. Dimensional tolerance stackup within the fuel bundle is controlled by compensating for any change in lot average clad OD by using a different average diameter spacer wire, thereby maintaining a near constant average total (fuel pin + spacer wire) diameter. An analytical model and a computer simulation study based upon this assembly mode indicate a small probability (< 2%) of occurrence of a variation in total free space across flats greater than ± 0.010 inch.

Both gamma and neutron radiation levels from an unirradiated FTR driver fuel subassembly will be sufficient to require special handling considerations and shielding. A shielding concept for the protection of assembly personnel has been devised based upon theoretical calculations³ and process requirements.

Large plutonium inventories and the concentration of plutonium in small areas during the fabrication FTR driver fuels will require improved design and management of a criticality safety system. Calculated minimum critical mass data associated with fuel pins and subassemblies are tabulated below.⁴

	Water Reflected Dry MCM <u>Cylindrical Geometry</u>	Water Reflected Water Moderated MCM <u>Cylindrical Geometry</u>
Fuel Pins	3000	124*
Subassemblies	14	10

*Pins spaced 0.6 inch apart for optimum moderation.

The fuel pin and subassembly process steps consist basically of: (1) the attachment of wire wrap to completed fuel pins, (2) fuel bundle assembly, and (3) flow duct installation. Two full scale subassemblies have been fabricated for hydraulic testing in flowing sodium and water. Reliable processing techniques with sufficient throughput capability have been developed. Dimensional tolerance stackup has not been a problem. The refinement of control techniques and test and inspection procedures will be a continuing task. Subassemblies fabricated to date contain depleted UO_2 pellets. A full scale subassembly containing UO_2 - PuO_2 fuel pellets will be assembled during the latter half of FY 1969 in order to obtain measured radiation levels and to demonstrate an acceptable gamma and neutron shielding concept.

References:

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