LOW ENRICHMENT FUEL CONVERSION
FOR IOWA STATE UNIVERSITY

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Progress Report
for Period July 31, 1990 - July 31, 1991

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ABSTRACT

Work during the reported period was centered primarily in preparation for receiving the LEU fuel and the shipping of the HEU fuel. This included development of procedures and tools for the disassembly process. During the period we held many practice sessions applying these tools and practices to a dummy fuel assembly. The LEU fuel was received on April 10, 1991 and the reactor was shut down on May 3, 1991 for refueling. The twelve HEU fuel assemblies in the UTR-10 reactor core were removed and disassembled during the week of May 6-9, 1991. The disassembly process went smoothly with only a few minor problems. Also during this reporting period several experimental measurements and preventative maintenance tasks were accomplished. Finally procedures and practices have been developed for the new LEU fuel loading and critical experiments which are to be completed during the late summer of 1991.

Progress Report for
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INTRODUCTION: Progress during the reporting period proceeded in several areas. This included the preparation for the LEU fuel reception and the removal of the HEU fuel from the core and assembly dismantling. Prior to the fuel disassembly, preparation for the process included development of tools and procedures to ensure a safe operation with a minimum of radiation exposure to the students and staff.

Prior to the fuel removal, several experiments were conducted on the HEU fuel for comparison with measurements to be conducted on the LEU fuel. In addition, various measurements were done on core internals during the period while the core was void of fuel. Refurbishing of core internals and reactor preventive maintenance were also accomplished during this time.

HEU FUEL REMOVAL: As was noted in previous reports [1], there are no licensed containers in the country appropriate for shipping spent UTR-10 fuel assemblies. Therefore, it was necessary to disassemble our HEU fuel assemblies, so that the fuel can be shipped as groups of individual plates in 6M shipping containers. A major goal of the project was to accomplish the disassembly process with a minimum of radiation exposure to students and staff. This required the development of many special handling tools and very specific operating procedures to accomplish the task. Once developed, the techniques were practiced weekly using the UTR-10 dummy fuel assembly.

The LEU fuel was received at Iowa State University on April 10, 1991. The fuel was unloaded, inventoried, stacked in 24 plate bundles, and stored two bundles to a storage location in the fuel storage pit in the Reactor Room in the Nuclear Engineering Laboratory. The shipping containers were returned to the fuel vendor. Reactor operations with the HEU fuel ceased on May 3, 1991.

Operations for removal and disassembly of twelve HEU fuel assemblies in the UTR-10 core commenced on May 6, 1991. The procedures as outlined in [1] were followed. The fuel disassembly procedures are:

1. The disassembly process shall be monitored by the Radiological Health Physics Group from the University Environmental Health and Safety Department.
2. The transfer cask will be loaded with a fuel assembly from the reactor

core.

3. The transfer cask will be situated over an empty fuel storage pit position. The cask will be lowered onto steel plates separated by lead bricks. The bricks serve as the shield as the fuel assembly bolts are removed. The bricks will have access holes between them for the tools in the disassembly process. The bolt-type fasteners will be removed with specially fabricated screw drivers.
4. The fuel assembly will be lowered from inside the cask until the lower assembly bolt is lined-up with the screw driver shafts. Alignment marks will be established with the dummy fuel assembly. The lower bolts will then be removed. After the lower bolts are removed, the lower assembly hardware will drop onto the assembly support table and latter dropped into the lower storage location in the storage pit.
5. The partly disassembled fuel assembly will be lowered with the cask holder device such that the upper bolt fastener is in position for the screw drivers. The top bolt will be removed with the screw drivers. As the fuel plates break free the hardware will drop onto the support table and eventually into the lower storage location in the storage pit.
6. The free fuel plates will be secured by a "catcher" wire and reattached to the top assembly holder with a metal shuttle pin. The plates will be raised back into the transfer cask, and then moved and lowered into a fuel pit storage location until shipping is facilitated. Each storage location will contain plates from two fuel assemblies (24 plates).
7. When the fuel plates are to be eventually shipped, the fuel plates will be drawn from the lower pit storage location and placed on a fuel transport holding fixture. When sufficient plates are loaded, they will be pinned in place and the fixture loaded into the 6M shipping container.
8. The fuel container will be shipped.

The development and practices paid off since the actual disassembly process was accomplished with few minor problems and with low personnel exposure rates. The problems that arose during the disassembly process were easily solved because of the extensive preparations. It was known beforehand that each assembly fixture bolt was secured by Allen set screws. We developed tools for removal of these set screws. However, it was discovered after being in the reactor for more than thirty years some set screws were corroded. The set screws were constructed of a soft metal, probably stainless steel, and in

three instances the wrench turned within the set screw and the set screw remained locked to the fastening bolt. Therefore, we developed a long shanked drill bit and then successfully drilled out the setscrews. In this process precautions were taken to capture all drilled fragments. The waste was properly processed by the health physics group. As each fuel assembly was disassembled, the fuel plates were lowered into the fuel storage pit and stored as two fuel assembly packets per location.

As was mentioned, careful monitoring of the disassembly process was handled by the health physics group. This include the issuance of ring badges for the workers handling the disassembly tools. The average individual whole body exposure to staff and students during the disassembly process was 50 mrem. The average individual hand exposure to the personnel working with the disassembly tools was 150 mrem.

MAINTENANCE PRIOR TO LEU FUEL LOADING: After the fuel was removed from the reactor core in early May, a major effort was started to inspect, clean, replace, and repaint, as needed, components and experimental facilities. These projects were reviewed and approved by the Reactor Use Committee. In all cases, health physics personnel performed radiation surveys, monitored areas and personnel, and gave approval for working in all radiation environments.

- * The shield tank facility, an all-concrete tank 5' x 6' x 11.5', was drained, cleaned, and repainted with two coats of an epoxy paint; the tank was refilled with a fresh batch of demineralized water after the epoxy cure-time had expired. After more than thirty years of service, the old paint was beginning to show signs of failure, especially on the aluminum plate that is the interface between the tank and the graphite duct from the core region.
- * All the steel surfaces of the operating and shutdown shield closures and plugs, and the interior of the cavity above the core region were cleaned, prepared, and painted with an epoxy paint. The old rust-inhibitor paint was flaking leaving small areas bare, mostly due to wear and tear during movements of shield parts. Residue from wet-sanding these surfaces was monitored for radioactivity by health physics personnel.

- * All in-core components of the control rods systems -- drive shafts, bearings, couplings, Boron plates and sheaths, and reel subassemblies -- were inspected, photographed, and found to be in excellent condition.
- * The steam flow controller for the dump tank heater was replaced with a new unit that should provide better temperature selection and control of the dump tank temperature. This new system should improve the stability of the heat source so that measurements of moderator temperature coefficient and thermal power output will be less influenced by systematic errors. Operational testing had not begun before the end of this reporting period.

The unusual opportunity to perform maintenance in the core region was a result of the required conversion to LEU fuel. So to aid in decommissioning planning we sought a partial answer to one question: What are the specific activities of some reactor components exposed to the highest neutron flux? An effort to obtain measurements of radioisotopes in small samples taken from a steel-encased shield plug, the inner surface of the concrete biological shield, and a piece of structural hardware was undertaken in July 1991. A brief summary of the results follows.

- * The concentration of tritium in air was measured within the space above the core region with the shield closures removed. The results, obtained by liquid scintillation counting, showed that the reactor shield is contaminated with tritium, but that the amount of tritium emitted from the concrete is fairly low, i.e., it leads to a concentration in air that is about 50% of the maximum permissible concentration for unrestricted areas.
- * Steel filings taken from the bottom of a shield plug were analyzed for specific activity using standard gamma ray measurements methods, ^{59}Fe and ^{60}Co , the only significant isotopes found in the sample, were present in the range of approximately 4 to 8 nanocuries per gram. A small steel nut, taken from a neutron detector support, had about five times more activity in ^{60}Co and about the same activity in ^{59}Fe as the shield plug filings.
- * Analysis of two small concrete samples, whose masses were about 60 mg and 130 mg respectively, revealed ^{60}Co as the only significant radioisotope present, other than ^{40}K . These samples were analyzed in the same manner as the steel samples cited above. The counting rate of the ^{60}Co present in the heavier sample was essentially at the minimum

detectable level for the detection system. The specific activity of ^{60}Co in the concrete sample was estimated to be approximately 200 picocuries per gram.

CORE EXPERIMENTAL MEASUREMENTS: The original proposal for the conversion project addressed the experimental tasks needed to verify that the technical specifications are not violated, and to investigate the reactor characteristics most likely to be affected by the conversion to LEU fuel. The technical specifications concerns are handled by routine maintenance procedures that are a normal component of the surveillance program. Measurements of reactor characteristics are aimed at the ratio of delayed neutron fraction to prompt neutron lifetime and the effect of neutron flux spectrum hardening.

The delayed neutron fraction to prompt neutron lifetime ratio was measured for the HEU core in late 1989, and the same procedure and equipment will be used after the initial startup tasks for the LEU core are completed.

Measurements to assess the effect of flux spectrum hardening were begun by exposing metal foils to neutrons in the most frequently used experimental facilities, the rabbit tube and the thermal column beam port, while the HEU fuel was in use. These data are stored awaiting analysis. (No measurements were attempted between the fuel plates, as originally proposed, since the space between plates in the LEU assembly is only 0.17 inch versus 0.40 inch for HEU; the spacing was judged to be too small to obtain credible results since cadmium covers, when used, are expected to cause unacceptable flux depressions in the water gap.) Data derived from HEU foil measurements will be analyzed and prepared for comparison with LEU results when activated foil data obtained at the same locations, after the LEU core is ready for high power operation, are available.

SPENT FUEL TRANSPORT: Communication have been ongoing with Chemical Processing Plant (CPP) at the Idaho National Engineering Laboratory to receive the HEU fuel plates. A holder device for the fuel plates within the 6M shipping container has been designed and fabricated. The device will need to be approved by CPP before final design is accomplished. However, progress will continue especially with respect to practicing, again with the dummy fuel plates, to load the fuel plates onto the holding fixture and then to load the fixture into the 6M shipping container. Procedures will be developed so that students, staff, and building personnel will have minimum radiation exposures during the actual fuel transfer. Health physics personnel will be in charge of the radiation exposure decisions.

Measurements have been taken with spent fuel plates to determine the number of plates that can be shipped per shipping container without violating transportation requirements. These experimental measurements are factored into a computer code developed for analyzing the shipping requirements. With the use of the code and the fuel element exposure history, we can make estimates of the number of plates per container that can be shipped by a specified date. These data will allow us to make estimates of the number of shipments required for the spent UTR-10 fuel.

REMAINING WORK: There are certain remaining tasks to be performed with the new LEU fuel. The tasks to be accomplished by May 31, 1992, the contract termination date, are the following:

- * Develop procedures for fuel transport according to regulations and submit fuel details to CPP at INEL.
- * Generate procedures for startup experiments, requalification of operators, etc
- * Continue the criticality experiments for determining the critical core configuration.
- * Verify calculated results for reactor parameters such as rod worths, shutdown margin, etc. by experimental measurements to complete the initial startup report.

REFERENCES:

1. Rohach, A. and Hendrickson, R. "Low Enrichment Fuel Conversion for Iowa State University". Department of Energy progress report DOE/ER/75360--2. August, 1990.

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