Final Technical Report

Conversion and Evaluation of the University of Massachusetts Lowell Research Reactor From High-Enriched To Low-Enriched Uranium Fuel

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LEU Conversion

The process for converting the University of Massachusetts Lowell Research Reactor (UMLRR) from high-enrichment uranium (HEU) fuel to low-enrichment uranium (LEU) fuel began in 1988. Several years of design reviews, computational modeling, and thermal hydraulic analyses resulted in a preliminary reference core design and configuration based on 20 standard, MTR-type, flat-plate, 19.75% enriched, uranium silicide (U_3Si_2) fuel elements. A final safety analysis for the fuel conversion was submitted to the Nuclear Regulatory Commission (NRC) in 1993. The NRC made two additional requests for additional information and supplements were submitted in 1994 and 1997. On July 31, 1997, the UMLRR was issued an NRC order modifying the reactor license to convert from HEU to LEU fuel. Due to a lack of Department of Energy (DOE) funding, manufacture of the LEU was not authorized until October 1999. During the interim between the NRC order and the funding authorization, the UMLRR reactor manager (Reactor Supervisor) had retired and was replaced. The new UMLRR Reactor Supervisor initiated an effort to change the LEU reference core configuration to eliminate a complicated control rod modification needed for the smaller core.

Once DOE funding was authorized, the analysis for a new core configuration began. The UMLRR staff began the parallel development of a detailed Conversion Plan (CP). The CP included procedures for HEU fuel offloading and storage, new fuel receipt and inspection, new fuel loading, and various reactor core physics evaluations. The final CP and new core configuration were reviewed and approved by the UML Reactor Safety Subcommittee (RSSC).

With the completion and the delivery of the LEU fuel, the actual process of converting the UMLRR began on July 27, 2000. The receipt and inspection of the new LEU fuel was completed on August 1 and the reactor core was loaded to a critical configuration on August 4. After achieving a final core configuration, the process of evaluating the reactor operating characteristics was undertaken. Several weeks of testing and data analyses ensued. The LEU core was found to operate well within the license technical specifications based upon the design parameters submitted in the safety analysis. A full report of this process and evaluation was submitted in a previous technical report.

HEU Analysis and Shipment

An analysis of HEU fuel burn-up and transuranics data for the Department of Energy spent-fuel Appendix-A documentation was completed as part of a Nuclear Engineering graduate student thesis. This thesis provided a computational method for accurately and efficiently tracking burn-up of UML reactor fuel. The methodologies and computer programs developed were applied to the HEU burn-up and transuranics analysis. In addition, it is now used to track the LEU fuel burn-up.

During the 26 years of operation of the HEU-fueled system (1974 to 2000), thirty-three HEU fuel assemblies were utilized to produce about 276 MWD of energy. In preparation

for shipment of the 33 used HEU assemblies to the Savannah River Site (SRS), a detailed analysis of the post irradiation nuclide inventory and decay heat level for each assembly was performed. The key data from the analysis are summarized in a previous technical progress report and presented in the form specified by the DOE's "Appendix-A Spent Nuclear Fuel Acceptance Criteria." These data will be used for planning a formal shipment of the 33 HEU fuel assemblies to SRS.

The original June 2002 shipping date was postponed pending a decision by INEEL and Department of Energy personnel that funding for a third party shipper (NAC) was not available. The University of Massachusetts Lowell had requested a third party shipper for several reasons.

First, the reactor is critically understaffed, having three full-time and two part-time staff to maintain all operations of the reactor and Co-60 irradiators. To maintain current operations and a future viability requires the full combined efforts of UMLRR staff, with a primary focus on safety and security, while also encouraging research and service development.

Second, the use of the DOE-owned BMI cask requires the development and the NRC approval of a UMLRR-specific quality assurance plan, operations procedures, training program, shipping route, coordination with state agencies, etc. -- all which relate to the issue of staffing. Spent fuel shipment for the UMLRR is a rare endeavor (now and for eventual decommissioning). None of the current staff have performed a spent fuel shipment. This inexperience and a steep learning curve ensure a great inefficiency for the process.

Third, communications with Westinghouse Savannah River Site (WSRS) have confirmed that "fuel cropping" of the MTR-type flat plate HEU fuel elements used by UMASS Lowell Research Reactor (UMLRR) will be necessary if the Department of Energy (DOE) owned BMI shipping cask is to be used. Currently, UMLRR does not have the equipment, facilities, or staff available to perform the cutting of the HEU fuel elements.

Fourth, the UMLRR will require four shipments with the BMI and only two with NAC. Each shipment carries risk, which may be compounded by the inexperience factor.

A June 2003 shipping date has also been postponed due to increased security regulations imposed by the Nuclear Regulatory Commission in September 2002. The regulatory changes have resulted in the inability of all university research reactors to ship used fuel. We are currently awaiting a resolution to the situation that is being brokered by the National Organization of Test Research and Training Reactors through interactions with DOE, NRC and Congress.

Since it is unknown when this resolution will occur, the decision has been made to close out this project and submit all the required final documentation, including this final report.