



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION REPORT BY THE
OFFICE OF NUCLEAR REACTOR REGULATION
SUPPORTING AMENDMENT NO. 27 TO
FACILITY OPERATING LICENSE NO. R-28
THE UNIVERSITY OF MICHIGAN (UM)

DOCKET NO. 50-2

INTRODUCTION

In the national program to mitigate unauthorized fuel diversions by reducing the enrichment of U-235 in nuclear fuels to below 20%, the Department of Energy has mounted an extensive Low Enrichment Uranium (LEU) fuels development and safety program. Argonne National Laboratories is providing testing and development data on LEU fuels and DOE is providing LEU fuels to the 2MW Ford Nuclear Reactor (FNR) at the University of Michigan for an in-core demonstration.

By letter dated April 2, 1980, supplemented by letter dated June 25, 1980, the University of Michigan requested modifications to their license (R-28) to permit the use of LEU fuels, an increase in fuels inventory, and a change to the Technical Specifications.

Two types of LEU fuel are planned for use in the 2MW FNR, aluminide and oxide fuel plates. LEU fuel elements to be delivered to the FNR for the initial core loading are physically identical in dimensions to the existing MTR-type HEU fuel elements now in the core. The proposed LEU fuel is enriched to 19.5% U-235. This initial demonstration will constitute a complete core loading of intermetallic uranium aluminide ($UA1_3$, $UA1_4$, $UA1_5$) clad in aluminum 6061. This fuel type is already licensed for use in the FNR and has been safely operated for approximately one year.

The fuel elements consist of MTR-type plates of 0.060 inches thickness. The fuel meat thickness is increased to 0.030 inches from the HEU fuel thickness of 0.020 inches and the clad thickness will be decreased to 0.015 inches from the HEU clad thickness of 0.020 inches. This will maintain the same overall fuel plate thickness while accommodating the increased amount of U-238. In order to provide the proper U-235 loading, the weight percent of the fissile material in the fuel element is approximately 56.5 weight percent $UA1_x$ or 49.6 weight percent U_3O_8 . Proposed uranium loading is 42.0 weight percent. The fuel loading is increased from an existing value of 140 grams to 167.3 grams of U-235 per 18-plate element to compensate for increased neutron absorption in the U-238 and spectrum hardening.

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The LEU fuel specifications are such that this fresh LEU core will exhibit the same excess reactivity as the existing HEU fueled core.

DISCUSSION

Extensive testing experience is available from five test reactors that utilize components of the proposed LEU fuel to be used in the FNR. Extensive experience is also available from the 25-30 HEU fuel elements now in the FNR core. The various test elements are described in Table I. The physical characteristics and operating parameters of these fuels are similar to the proposed LEU fuels as shown in Table II.

Fuel Swelling

The FNR SAR provides data on fuel swelling. The measured swelling rate is below that which was calculated. As is expected, the measured swelling rate is less than the calculated, due to the presence of voids in the fuel which would tend to reduce the effects of swelling.

The available data indicated the proposed UAl_x and U_3O_8 LEU fuels can be safely utilized in the FNR core at the proposed operating conditions without concern for swelling.

The SER for Amendment No. 25 corroborated this assessment on the absence of swelling in the proposed fuel. In addition the existing highly enriched UAl_x fuel that is currently in the core shows no signs of swelling.

Fuel Blistering

The data provided in the FNR-SAR indicates that no blister failures will occur at FNR operating temperatures. This analysis was corroborated in the SER for Amendment No. 25 for the use of high enrichment UAl_x and U_3O_8 fuels.

Fuel Specifications

Fuel specifications are identical to those specified for ATR fuels and call for uranium aluminide powder containing at least 50% UAl_3 .

U_3O_8 fuel specifications will be developed in cooperation with ORNL and BNL when and if U_3O_8 is used in the FNR.

Densities

The LEU fuels necessitate a higher weight percent of uranium aluminide (56.5 w/o UAl_x , 42.0 w/o U) than is presently used for the FNR high enrichment fuel of 19.1% w/o UAl_x . However, the Advanced Test Reactor (ATR) routinely operates using comparable aluminide fuel densities and obtains higher fission densities than the 1.5×10^{21} fissions/cc limit of the FNR.

The SER performed for Amendment No. 25 also indicated that the fission density limit of 1.5×10^{21} was satisfactory.

Heat Transfer

As indicated above, the external fuel element dimensions of the proposed LEU and existing HEU fuel elements are identical. Heat flux in the existing and proposed elements are identical. Peak fuel temperature in the hottest fuel plate is calculated to be 172°F.

Design Basis Event

The applicant did not provide a DBE. For the type of reactor, power level and use, it was determined by the staff and UM that a conservative DBE would be a LOCA. Though FNR operating temperatures and pressures probably would never generate an accident of this type, the applicant has agreed to provide the scenarios and thermodynamic calculations that will describe the impact and effects on the fuel elements. It was agreed by the staff that a DBE can be submitted at a later date. The applicant has agreed to submit the necessary information by September 30, 1981. The staff has further agreed that the reactor may operate during the preparation and review of the DBE.

Summary

A review of an initial submittal performed indicated the need for additional information. This was provided in the formal response dated April 2, 1980. The modification of the Technical Specifications was supplied July 12, 1980.

The information provided in the response was subsequently reviewed together with the SAR and it was determined that there will be no operating conditions stemming from the use of LEU fuels in the FNR core that will produce risks that are any greater than those that have been evaluated in previous FNR accident analyses or safety analysis reports and found to be acceptable.

The U_2O_3 fuel specifications will be geometrically the same as the above $UA1_x$ fuel; however, the final specifications will be developed in cooperation with ORNL and Brookhaven National Laboratory to ensure standardization should this fuel be used in the FNR in the future.

The margin of safety is not reduced when the proposed $UA1_x$ and U_2O_3 fuels are operated in the FNR in accordance with requirements to be established in the Technical Specifications and limiting the fission density to 1.5×10^{21} fission/cc. The powder metallurgy manufacturing process is considered superior to alloying because of improved dimensional stability during reactor operation and the reduction in fuel hot spots.

We therefore agree that use of the $UA1_x$ and U_2O_3 fuels proposed by the University of Michigan in the FNR is acceptable.

Environmental Consideration

We have determined that this amendment will not result in any significant environmental impact and that it does not constitute a major Commission action significantly affecting the quality of the human environment. We have also determined that this action is not one of those covered by 10 CFR §51.5(a) or (b). Having made these determinations, we have further concluded that, pursuant to 10 CFR §51.5(d)(4), an environmental impact statement or negative declaration and environmental impact appraisal need not be prepared in connection with the issuance of this amendment.

CONCLUSION

We have concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously considered and does not involve a significant decrease in a safety margin, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Dated: February 10, 1981