


REPORT ON THE POSSESSION
OF LOW ENRICHED URANIUM-235
IN EXCESS OF LICENSE LIMITS
AT THE UNIVERSITY OF MISSOURI-ROLLA
REACTOR FACILITY

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Approved:


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1.0 Executive Summary

On July 18, 1992, the University of Missouri-Rolla (UMR) Reactor received a partial shipment of twenty LEU (19.8 w/o enriched) elements totaling 3,982 grams of U-235 as part of the LEU conversion. On August 27, 1992, the UMR Reactor received the remaining eight LEU elements totaling 1,261 grams of U-235.

On October 28, 1992, the UMR Reactor staff identified that the sum total of LEU U-235 on site was (3,982 grams + 1,261 grams) 5,243 grams. This was immediately recognized as being in violation of Operating License R-79 that limited on-site LEU fuel to 4.95 kg. The Reactor Director was immediately notified. The NRC was promptly notified that same day by phone.

On October 29, 1992 (the next day) through conference calls with the NRC, it was agreed that no safety problem existed and that the UMR Reactor staff would quickly apply for a license amendment requesting an increase in the limit of LEU U-235 from 4.95 kg to 5.5 kg. The request for a license amendment was prepared and sent to the NRC by "Fax" and by registered mail on October 29, 1992. On November 10, 1992, the NRC issued Amendment Number 10 of the Operating License increasing the LEU limit to 5.5 kg as requested.

This report presents an analysis of the root cause of the license limit violation. Additionally, corrective actions taken and recommendations to preclude recurrence of this or similar situations are presented.

2.0 Analysis of Root Cause and Contributing Factors

In October of 1979, the UMR Staff submitted documents for the license renewal of Facility Operating License R-79. Several years lapsed prior to issuance of the new facility license. During this time (in the early 1980s), the LEU conversion project was initiated at UMR. The renewal license was finally issued in 1985 as Amendment Number 8. In an effort to eliminate the need to amend the license again as a result of the impending LEU conversion, the authors of Amendment Number 8 had the foresight to include a possession and use clause for LEU fuel. As it turned out, the license would again be amended as a result of the LEU fuel conversion. Ironically, Amendment Number 9 did not revise LEU related issues, but rather dealt solely with possession limits of HEU material - in particular with fission chamber and flux foil possession limits.

The LEU possession and use clause of License Amendment Number 8 was incorporated in Paragraph 2.B.2 which stipulated:

"... to receive, possess, and use up to a maximum of 9.9 kilograms of Uranium-235 at various enrichments ... the maximum limits on specific enrichments of U-235 are as follows:

<u>Maximum U-235</u>	<u>% Enrichment</u>	
4.95 kg	< 20	
4.95 kg	≥ 20	"

At the time of the license renewal (1985), the LEU fuel design was still in its early stages.

It is unclear what the exact motivation was to set the 4.95 kg limit of LEU fuel in the old license. Most likely, because the fuel element design phase was in its infancy in 1985, the 4.95 kg value was chosen because that was the existing HEU limit and we were expecting to essentially convert on a "one-to-one" element basis. Under this rationale, the fact that such a high loading of LEU per element would be required to compensate for the less potent (reactivity wise) LEU fuel had not yet been thoroughly analyzed.

One of the goals of the LEU element design was to provide similar core geometries. Thus a design that would allow for the direct "one-to-one" replacement of HEU fuel elements was sought. Consistent with this philosophy, a decision was made early on to have 28 LEU elements fabricated to replace the 28

HEU elements originally fabricated for our facility in 1961. (The 28 HEU elements consisted of 22 standard elements, 4 control elements, and 2 half elements. The 28 LEU elements include 18 standard elements, 5 control elements, 4 half elements, and one "irradiation facility" element.)

In the early design phases of the LEU element, a 16 plate standard element was proposed. Possibly, the 16 plate element was used as a basis for calculating the LEU limit in the 1985 license amendment. The U-235 inventory for the 28 LEU elements based on the 16 plate element model would have been about 4.67 kg - in such an instance the selection of 4.95 kg for a license limit would have been appropriate.

In 1989, work presented in a Master's Thesis¹ investigated both 16 plate and 18 plate LEU elements. Based on information presented, it was decided that 18 plate elements would provide superior performance and the 16 plate design was dropped.

Whatever the exact basis was behind the 4.95 kg LEU possession limit in the 1985 license, it is clear that specifying such a limit several years prior to finalization of the element design was premature. Had this issue not been addressed prematurely, then certainly an appropriate possession limit (i.e. 5.5 kg) would have been negotiated based on the finalized fuel element design.

The license was amended again (Amendment Number 9) to accommodate the LEU conversion. License Amendment Number 9 was solely a result of NRC concerns that the possession and use clause of Paragraph 2.B.2 should be revised to specifically address fission chambers and flux foils. Although we had verbal conversations concerning the revision, the first time the Reactor staff saw the license revision was when it was issued with the modifying order to convert. When we received the license revision, we reviewed it against the existing license (Amendment 8). The revision concerning fission chambers and flux (foils) appeared acceptable. The 4.95 kg limit on LEU had not been altered.

This fact is pointed out to emphasis that a complete administrative license review was not performed upon the issuance of Amendment 9 because the scope of the license revision was limited to addressing possession limits for fission chambers and flux foils. In fact, the entire license was not reissued by the modifying order - only those

¹Covington, Lorne, J, "Neutronics Study of the Conversion of the University of Missouri-Rolla Reactor to Low Enriched Fuel", UMR, 1989.

paragraphs that were revised were reissued. Only the revised portions of the license issued with the modifying order were reviewed by the UMR Reactor administration.

It appears that no one on the UMR Reactor staff independently calculated the total amount of U-235 contained in the 28 elements and compared that total to the 4.95 kg limit in the license until after the fuel was onsite. Had this simple calculation and comparison been performed and documented, a revision to our possession limit could have been initiated and obtained prior to receiving the LEU fuel onsite.

It should be noted, however, that the problem was identified in a relatively timely fashion. The problem was identified during the very next semi-annual material inventory. Thus, the system of checks and balances already in place allowed for the identification of the discrepancy.

One of the factors that contributed to our not identifying the discrepancy immediately upon receipt of the LEU fuel was the fact that the fuel was shipped to us in two separate shipments. The shipper lacked the shipping containers required to ship the entire inventory. Thus, a compromise was reached and we received 20 elements on July 18, 1992 (totaling 3,982 grams of U-235) and the remaining 8 elements were received on August 27, 1992 (totaling 1,261 grams of U-235). Because of the partial shipments, both DOE/NRC 741 forms showed U-235 inventories well beneath our limit. The problem was not immediately identified upon receipt of the second shipment because we did not immediately sum the amounts received on the two 741 forms. Had all 28 elements been shipped in the same shipment, we and the shipper would have immediately identified that the U-235 inventory was over our limit by inspecting the DOE/NRC 741 Material Transfer Form.

Ideally, we should have had a procedure in place that required inventory review prior to receipt of a shipment. Such a procedure would have lead to the early identification of the discrepancy prior to receipt of the material.

Another factor was due to the fact that this is the first fuel change we have ever experienced at the UMR Reactor. Due to our low burnup, we were still operating with the original 28 HEU elements provided to us in 1961. Therefore, it is by no means "routine" for us to receive incoming fuel. As such, we had no Standard Operating Procedure in place to receive the LEU fuel. We did prepare, review and approve a "special procedure" to cover receipt of the new fuel prior to receiving the shipment; however, the need to keep a "running inventory" of incoming fuel was not foreseen.

To summarize the analysis, the following contributing factors

are identified:

1. Amendment Number 8 of License R-79 prematurely addressed LEU possession limits - years before the fuel element design was finalized.
2. The fuel element design was changed from 16 fuel plates to 18 fuel plates as the conversion project progressed.
3. Once the LEU fuel element design was finalized, there was a failure to calculate the total inventory of U-235 in the 28 elements to be fabricated to assure that the license limit would be met.
4. The LEU fuel was received in two separate shipments. Although each shipment was verified to be less than the license limit, no "running total" was calculated hence the violation was not immediately identified.

The root cause is believed to be due to the fact that no procedure was in place requiring the assessment of anticipated onsite inventories prior to the receipt of a shipment of licensed materials. Had such a procedure been in place, the problem would have been identified prior to receiving the material and could have been mitigated through normal channels without violating our license limits.

3.0 Corrective Actions and Recommendations to Prevent Reoccurrence

It should be noted that presently, there are no plans to receive any more fuel at the UMR Reactor. The LEU fuel now in-house is expected to last for the next 30 to 100 years. As such, recurrence of this problem is not expected with respect to fuel. However, it is quite possible that additional fission chambers and flux foils will be acquired at some time in the future. Thus, it is important to implement a corrective action to assure that license limits are always met with respect to incoming licensed material. The proposed corrective actions are as follows:

1. Establish a written procedure that requires the projected onsite inventory of licensed material to be assessed and compared with licensed limits prior to the receipt of any licensed material.
2. Fully brief each UMR Reactor staff member on this incident at a special staff meeting to make sure that each person understands exactly what happened and why and to present measures to prevent recurrence.

A new Standard Operating Procedure 311 "Receipt of Licensed Material" will establish a protocol that will require that the projected inventory onsite be assessed prior to receiving a planned shipment of licensed material. This procedure will assure the prior review and authorization of anticipated incoming shipments against licensed quantity limits.

The staff briefing will serve as important training making sure everyone learns as much as possible from this incident.

It is believed that the above corrective actions will prevent recurrence of this type of problem at the UMR Reactor facility.

4.0 Summary

On August 27, 1992, the UMR Reactor Facility violated its licensed limit of 4.95 kg of LEU fuel by receiving a total of 5.24 kg of LEU U-235. The violation was identified by the UMR Reactor Staff on October 28, 1992. The violation was identified through procedures in place at the facility (specifically, the semi-annual completion of the DOE/NRC Material Balance Reports). The NRC was promptly notified on the same day that the problem was identified. On November 10, 1992, the NRC issued Amendment Number 10 increasing our LEU license limit to 5.5 kg, thus bringing us into compliance.

The incident did not compromise the safety of any individual

or of the reactor system. The incident did show a failure by the reactor staff to identify the discrepancy prior to receipt of the fuel.

The root cause of this incident and several contributing factors have been identified.

Corrective actions implemented include establishing a new SOP directly addressing receipt of incoming material, and a full staff briefing of the incident. These corrective actions should preclude recurrence of this type of problem.