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SUBJECT: Docket No. 50-602, Request for Evaluation of Process to Seek Approval for Using Lightly-Burned TRIGA Fuel

Sir:

The Department of Energy is storing irradiated TRIGA elements that were discharged from domestic and foreign research reactors. A substantial set of elements in the inventory have relatively low burnup and might feasibly be placed in service at other reactor facilities. Before committing resources to the use of this lightly burned fuel in research reactors, facilities are seeking assurance that there is a path to success. This proposal seeks to define a process acceptable to the USNRC to support authorization for utilization of these fuel elements in research reactors that use (standard or conversion) 8.5%, stainless-steel clad TRIGA fuel. Consideration is given to:

(1) assuring the lightly burned fuel elements are acceptable for use,

(2) ensuring the utilization is authorized by the facility operating license and Technical Specifications

(3) ensuring the utilization is supported by engineering and safety analysis, and

(4) operational issues to be considered in programs and procedures

Please advise if this process as described is acceptable.

FUEL ELEMENT ACCEPTABILITY

The fuel elements transferred to the DOE storage facility from operating research reactors were maintained in facilities either licensed by the USNRC (domestic facilities) with storage requirements that ensure fuel integrity, or stored in conditions based on the manufacturer's recommendations (foreign

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facilities). Storage history and records are readily available for domestic reactors, less accessible for those fuel elements used in foreign reactors.

A rigorous inspection of each element was conducted at the reactor site before shipment, with the visual inspections recorded. The elements were evaluated prior to acceptance for storage, and on receipt at the storage facility. Nevertheless, the process was in support of interim storage prior to disposal, and did not anticipate the elements would be placed back in service. Additional inspections and tests may be required or useful, and could be performed by DOE or the reactor facility.

Although analysis in GA Report No. 4313 indicates successful burnup to 75% of the ^{235}Uin TRIGA fuel (other GA reports assume a maximum of 50%), in practice the fuel temperature reactivity deficit associated with operation at power does not allow power operation at these burnups. Some facilities indicate minimum acceptable ^{235}U content in an element at about 28 grams, so that actual burnup that will support power operation is less than 25-30% burnup (based on initial loading, which varies). At less than about 28 grams ^{235}U, a TRIGA fuel element contributes negligible or negative reactivity during power operation.

Surveillance and inspection requirements at TRIGA pulsing reactors assure any deformation does not affect the ability to insert and remove the element from the grid plate (a limit on axial bend), and any growth of the fuel and axial reflector does not exhibit elongation (indicating fuel and axial reflectors might have expanded to the limit of the gas gap). The low burnup of elements under consideration provides confidence that conditions for deformation have not occurred. The fuel elements are maintained in facility in a dry environment at the DOE storage facility, minimizing potential degradation in storage. Inspection and baseline measurements conducted prior to use at a facility assures that the element is useable and can be monitored to detect any deformation from subsequent operation.

Utilization of TRIGA fuel previously irradiated at other domestic facilities has been accomplished under facility operating licenses issued by the USNRC, although not all U.S. TRIGA reactors have provisions which would allow the receipt and utilization of previously irradiated fuel elements. The utilization of fuel irradiated at other nuclear research reactors has been accomplished by Reed College in Portland (Oregon) and The University of Texas at Austin (Texas). The utilization of lightly irradiated elements from the DOE storage facility was accomplished by the Atominstitut in Vienna (Austria).

The TRIGA reactor located in the Atominstitut of Vienna conducted a fuel exchange to receive lightly burned elements from INL in 2012. The fuel elements were irradiated in the Musashsi, (Japan) and Cornel University (USA) facilities. Optical inspection of 100% of the fuel element surface was performed at INL hot cells with representatives of the Vienna facility to determine acceptability. Significant scratches or dents disqualified 2 of the potential elements.[1]

The Department of Energy and individual facilities participating in utilization of previously irradiated fuel will collaboratively determine if established acceptance criteria is adequate to determine acceptability of the fuel. If it is determined that additional criteria is required, the approved facility administrative control will be revised to reflect the change.

[1] "The Core Conversion of the TRIGA Reactor Vienna," 22nd International Conference Nuclear Energy for New Europe, Sep. 2013

The Department of Energy will request an assessment of records of (1) conductivity associated with the reactor pool where the utilization occurred, and (2) conductivity associated with on-site storage if the irradiated elements were stored wetted in locations other than the reactor pool. If the conductivity can be reliably determined to have remained within the limits described in ANSI 15.4 and NUREG 1537, the elements will not be disqualified as acceptable for use in domestic facilities because of water chemistry.

If the conductivity records are not available, the domestic facility will collaborate with the Department of Energy to establish any additional assessment protocol and acceptance criteria. For facilities that will require license amendment/revision to utilize previously irradiated fuel, any testing and acceptance criteria not currently in the facility's Technical Specifications will be considered for incorporation in the license amendment/revision request.

FACILITY OPERATING LICENSE

Facility operating license limits (including Technical Specifications, as a license condition) on uranium-235, special nuclear material, alnd byproduct material contained in TRIGA fuel will be met during receipt of TRIGA fuel previously irradiated at other facilities. If the reactor facility license does not permit receipt, possession and utilization of material produced by operation of TRIGA fuel at other facilities, a license amendment or revision will be required prior to shipment. If a request to increase possession limits is required, the facility should either (1) ensure that the proposed change does not affect the security level or (2) revise the security plan or procedures to the applicable requirements.

Radioactive material shipping regulations require verification by the shipper that the receiver's license permits receipt of the material. ANSI/ANS-15.1-2007 5.3 states:

> "Each type of authorized fuel shall be described. This shall include type such as MTR, TRIGA, PULSTAR, etc.; material; enrichment; physical description; and other special features."

Since the fuel inventory under consideration is standard and standard/conversion TRIGA fuel, it is likely that the current facility Technical Specifications permit utilization of the fuel. If the Technical Specifications does not permit use of the fuel type, a Technical Specifications amendment or revision will be required prior to shipment.

The University of Texas at Austin has two license provisions that authorize the use of TRIGA fuel previously irradiated in other facilities. The first clause permits the University of Texas at Austin to "receive, possess, and use, but not separate, any amount of special nuclear material produced by the operation of other facilities, contained in TRIGA fuel transferred from other facilities." The second addresses byproduct material, authorizing the facility "to receive, possess, and use, but not separate, any amount of byproduct material produced by the operation of other facilities, contained in TRIGA fuel transferred from other facilities."

ANALYSES

The use of lightly burned elements is implicit within normal, routine fuel management for current operations. If a revision or amendment is required to support the use of lightly burned elements irradiated by operation at other facilities, analysis will be performed to demonstrate that use of the lightly burned fuel is within the bound of analysis (i.e., that core peaking factors will not cause a hot channel to exceed limits). If specific fuel management requirements are identified to ensure that

thermal hydraulic limits are met, the requirements will be incorporated in the revision (or amendment) and operational procedures.

OPERATIONAL ISSUES

ANSI/ANS-15.1-2007 3.1 (6) recommends limits should be established for "fuel inspection, if appropriate." TRIGA pulsing reactors generally require periodic visual inspection of fuel elements and measurements or tests demonstrating any transverse bend and any elongation are within acceptable limits. Baseline measurements are made prior to initial insertion. If tests or inspections not specified in a facility's Technical Specifications are determined to be necessary to assure lightly burned TRIGA elements are acceptable for use, a Technical Specification revision or amendment will be required.

ANSI/ANS-15.1-2007 5.3 identifies procedures should be generated for "fuel loading, unloading and movement within the reactor." If analysis indicates that specific limits on fuel management will be required to assure thermal hydraulic limits are met, a Technical Specification revision or amendment will be required.

Material failures and repairs of in-pool equipment or water chemistry issues may require the fuel be removed from the core structure and pool. Ex-pool fuel storage capacity as a matter of good practice should therefore be adequate to fully remove all fuel from the reactor pool, even with an increase of fuel inventory by the addition of lightly burned fuel.

The facility Radiation Protection Program should be reviewed to assure that procedures and equipment are robust enough to deal with the challenge of handling irradiated fuel.

Conclusion

Each research and test reactor is unique, and defining specific facility requirements for incorporation of fuel elements irradiated at other facilities may be impossible or inappropriate. Nevertheless, if a facility is able to (1) assure that the elements are acceptable for service, (2) ensure that the utilization is authorized by the facility operating license and Technical Specifications, (3) demonstrate that thermal hydraulic limits are not challenged, and (4) control the utilization under facility programs and procedures, then the use of lightly burned elements from other facilities is acceptable.

This letter has been reviewed by representatives of the Department of Energy and members of the U.S. TRIGA facilities who have been identified as having interest in the process. Please contact me by phone at 512-232-5373 or email whaley@mail.utexas.edu if you require additional information or there is a problem with this submittal.

Thank you for your attention,

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