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June 8, 2007

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

Reference: Docket 50-186
University of Missouri – Columbia Research Reactor
Amended Facility License R-103

Enclosed is a request to amend the Technical Specifications appended to Facility License R-103 pursuant to 10 CFR 50.59(c) and 10 CFR 50.90.

If you have any questions, please contact Leslie P. Foyto, the facility Reactor Manager, at (573) 882-5276.

Sincerely,

Ralph A. Butler, P.E.
Director

RAB/djr

Enclosures

A020
NRR

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REFERENCE: Docket 50-186
University of Missouri – Columbia Research Reactor
Amended Facility License R-103

SUBJECT: Written communication as specified by 10 CFR 50.4(b)(1) requesting U.S. Nuclear Regulatory Commission approval to amend the Technical Specifications appended to Facility License R-103 pursuant to 10 CFR 50.59(c) and 10 CFR 50.90

Introduction

The University of Missouri Research Reactor (MURR) is requesting a change to the facility Technical Specifications (TSs) in order to perform an experiment in support of a U.S. Department of Energy (DOE) program to demonstrate the feasibility of producing fission product molybdenum-99 (Mo-99) using low-enriched uranium (LEU) foil targets.

Currently, the supply of Mo-99 is produced using highly-enriched uranium (HEU) targets. Because of global nonproliferation concerns, the future availability of HEU target material is uncertain. Research and development of an LEU target is the focus of various U.S. and foreign organizations.

Our objective is to perform a Mo-99 experiment that is similar in scope to the ones that have already been performed at the BATAN (Indonesia), ANSTO (Australia) and CNEA (Argentina) facilities. This experiment is planned to include target irradiation, disassembly and digestion, Mo-99 separation and purification, and quality control testing of the Mo-99/Tc-99m product. The quality control testing is designed to verify that the finished product meets the United States Pharmacopeia – National Formulary Sodium Pertechnetate Tc-99m Injection monograph acceptance criteria for radionuclide identity, radionuclidic purity, radiochemical purity, and chemical purity. The radioisotope Mo-99 is a precursor of Tc-99m, which is used extensively for medical diagnostic procedures.

The MURR is collaborating with Argonne National Laboratory (ANL) to perform this experiment. ANL has shared with the MURR results from the DOE's ongoing research and development efforts applicable to the LEU-foil target design and the LEU-modified Cintichem separation and purification process. The original Cintichem process, successfully used from 1970 to 1989, utilized HEU as the target material.

This Amendment request would allow the MURR to perform a key role in the continued research and development efforts of ANL for the production Mo-99 from an LEU target.

Fueled Experiment Technical Specification Background

There are currently two specifications regarding radioisotope limits for conducting fueled experiments at the MURR, both are based on the total inventory of iodine-131 (I-131) through iodine-135 (I-135) and strontium-90 (Sr-90) produced by the experiment.

TSs 3.6.a and 3.6.o specify the following radioisotope inventory limits for fueled experiments:

> 3.6.a. "*Each fueled experiment shall be limited such that the total inventory of iodine isotopes 131 through 135 in the experiment is not greater than 150 curies and the maximum strontium-90 inventory is no greater than 300 millicuries.*"
>
> 3.6.o. "*Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 curies or Strontium-90 greater than 5 millicuries shall be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.*"

Neither of these currently authorized specifications represents a maximum technical limit based on radiological safety. The higher radioisotope inventory limits stated in TS 3.6.a, when conducting an experiment that exceeds the limits of TS 3.6.o, are based on the requirement of ensuring that the experiment "*shall be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels,*" which minimizes a health and safety concern. This reflects the specific experiment that these limits were intended to control. The License Amendment that the MURR is requesting will authorize the type of experiment proposed by this project, namely an LEU-foil target designed for the production of Mo-99, and other fission product radioisotopes of interest.

TS 3.6.a was proposed by the MURR in a letter to the U.S. Nuclear Regulatory Commission (NRC) dated February 15, 1977 (Amendment No. 8 to License R-103) specifically to support an experiment in the reactor thermal column which utilized "unclad" fission plates to irradiate large rolls of thin polycarbonate film material.

The experiment initially consisted of 4 fission plates; metal plates with a thin coating of uranium oxide on one side. The uranium was highly-enriched with a total plate loading of 1.93 grams of

uranium per plate. Four such plates were used with a provision that the sizes of the plates and the mass of uranium could be adjusted to maintain the experiment within the TS total inventory limits for I-131 through I-135 and Sr-90. The initial experiment setup using the four fission plates consisted of 7.72 grams of HEU (~7.2 grams of uranium-235). It was anticipated that the experiment would be irradiated in a flux of 5E11 n/cm^2-sec. Calculations indicated a saturation activity of 32 curies of I-131 through I-135 and 56 millicuries of Sr-90 for the four plates. The heat generation of all four fission plates was calculated to be 152 watts.

TS 3.6.o was proposed by the MURR in its September 23, 1977 letter to the NRC (p. 24). This letter was one in a series of letters in support of an Amendment request to allow TS 3.6.a fueled experiment limits to be increased from 1.5 curies of I-131 through I-135 and 5 millicuries of Sr-90 to 150 curies of I-131 through I-135 and 300 millicuries of Sr-90, which are presently the radioisotope limits for fueled experiments stated in TS 3.6.a. This increase was requested in order for the MURR to perform the specific fueled experiment described above. The nature of the experiment, "unclad" uranium fission plates located outside of the reactor pool, required it to be vented to the ventilation exhaust system through continuously monitored HEPA and charcoal filters.

Additionally, TS 3.6.o provided assurance that any experiment exceeding the limits of TS 3.6.o, and up to the limits of TS 3.6.a, would be vented to the exhaust system through continuously monitored HEPA and charcoal filters, and it specifically applied to the experiment described in MURR letters to the NRC dated February 15, 1977, September 23, 1977 and January 20, 1978.

Technical Specification Change Requested

In order for the MURR to conduct the Mo-99 experiment that will be described in more detail below, we request that TS 3.6.o be revised. TS 3.6.o currently states:

> "*Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 Curies or Strontium 90 greater than 5 millicuries shall be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.*"

At the time that this specification was first proposed by the MURR, no other types of fueled experiments greater than the limits of TS 3.6.o, which were originally the limits stated in TS 3.6.a, were contemplated. This effectively assured that any new fueled experiment that would be designed to use the limits of TS 3.6.a, and could not be vented to the exhaust stack system as required by TS 3.6.o, would require a review by the NRC.

Therefore, it is requested that TS 3.6.o be revised as follows (Attached is the proposed TS 3.6 page 4 of 5 that will implement the requested change):

> "*Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 Curies or Strontium 90 greater than 5 millicuries shall be in irradiation containers that satisfy the requirements of specification 3.6.i or be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.*"

For reference, TS 3.6.i states:

> "*Irradiation containers to be used in the reactor, in which a static pressure will exist or in which a pressure buildup is predicated, shall be designed and tested for a pressure exceeding the maximum expected pressure by at least a factor of two (2).*"

Proposed Experiment Description

The proposed LEU-foil target experiment will include target irradiation; target disassembly and digestion; Mo-99 separation and purification; and quality control testing of the Mo-99/Tc-99m product.

The encapsulated LEU-foil target will be placed in a predetermined graphite reflector irradiation position with the reactor shutdown. The target will then be removed only after the reactor is shutdown again during the next weekly scheduled shutdown period. A target having a mass of $\leq$ 5 grams of LEU ($\leq$ 1 gram of uranium-235) should not present a reactivity concern during reactor operation, but its reactivity worth will be measured before commencing the 150-hour irradiation run to assure it does not exceed the limits of an unsecured experiment as stated in MURR TS 3.1.j ("The magnitude of the reactivity worth of each unsecured experiment shall not exceed 0.0025 ΔK.").

The encapsulated LEU-foil target will be held in place in its irradiation position by a sample-handling device. The length of this device will be designed to assure the target is placed in the flux location for which the experiment is designed. The flux profile for the reflector irradiation position will be mapped prior to conducting the experiment to validate the desired flux position.

Summary

The development of an LEU target source for Mo-99 production is considered important to national interests with respect to nonproliferation efforts. This Amendment request would allow the MURR to provide ANL important data in support of their Reduced Enrichment for Research and Test Reactor (RERTR) Program activities.

The scale of the experiment proposed by the MURR is designed to be well within the current TS 3.6.a limit for fueled experiments that was approved by the NRC in 1978 for an "unclad" experiment using HEU material.

A detailed experiment plan and analysis will be developed to assure that this experiment does not pose a significant risk to the MURR staff and the general public. We anticipate no releases during normal operation that will approach TS stack gaseous and particulate activity release limits. The experiment plan will incorporate a gradual escalation to full power, while monitoring the temperature of the target as required by MURR TS 3.6.n ("The maximum temperature of a fueled experiment shall be restricted to at least a factor of two below the melting temperature of any material in the experiment. First-of-a-kind fueled experiments shall be instrumented to measure temperature.").

The MURR concludes that the experiment described in this document can be carried out safely. In addition, we will continue to refine our calculations to assure that we have characterized this experiment accurately. Any significant changes to the experiment as described above are not anticipated. Attached is the proposed TS page that will implement the requested change.

If there are questions regarding this request, please contact me at (573) 882-5276. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Leslie P. Foyto
Reactor Manager

ENDORSEMENT:
Reviewed and Approved

Ralph A. Butler, P.E.
Director

Attachment

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. James S. Coleman, Vice Chancellor for Research
Mr. Craig Basset, U.S. NRC
Mr. Alexander Adams, U.S. NRC

State of Missouri
County of Boone

On this 8th day of June in the year 2007, before me, the undersigned notary public, personally appeared Leslie Foyto & Ralph Butler, known to me to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged that he/she/they executed the same for the purposes therein contained. In witness whereof, I hereunto set my hand and official seal.

Diane Strump
Notary Public

TECHNICAL SPECIFICATION

UNIVERSITY OF MISSOURI
RESEARCH REACTOR FACILITY

SUBJECT: Experiments (continued)

o. Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 Curies or Strontium 90 greater than 5 millicuries shall be in irradiation containers that satisfy the requirements of specification 3.6.i or be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.

Bases

a. Specification 3.6.a restricts the generation of hazardous materials to levels that can be handled safely and easily. Analysis of fueled experiments containing a greater inventory of fission products has not been completed, and therefore their use is not permitted.

b. Specification 3.6.b is intended to reduce the likelihood of accidental voiding in the core or water annulus surrounding the center test hole by restricting materials which could generate or accumulate gases or vapors.

c. The limitation on experiment materials imposed by specification 3.5.c assures that the limits of Appendix B of 10 CFR 20 are not exceeded in the event of an experiment failure.

d. Specification 3.6.d is intended to reduce the likelihood of damage to reactor or pool components resulting from detonation of explosive materials.

e. Specification 3.6.e is intended to limit the experiments that can be moved in the center test hole while the reactor is operating, to those that will not introduce reactivity transients more severe than one that can be controlled without initiating safety system action (Ref. Add. 5 to HSR).