UNIVERSITY *of* MISSOURI

RESEARCH REACTOR CENTER

March 11, 2011

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 you will find the University of Missouri-Columbia Research Reactor's responses to the U.S. Nuclear Regulatory Commission's (NRC) request for additional information, dated June 1, 2010, regarding our renewal request for Amended Facility Operating License R-103, which was submitted to the NRC on August 31, 2006, as supplemented.

If you have any questions, please contact John L. Fruits, the facility Reactor Manager, at (573) 882-5319 or FruitsJ@missouri.edu.

Sincerely,

Ralph A. Butler, P.E.
Director

RAB/djr

Enclosures

A020
NRR

UNIVERSITY *of* MISSOURI

RESEARCH REACTOR CENTER

March 11, 2011

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Mail Station P1-37
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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) regarding responses to the "University of Missouri at Columbia – Request for Additional Information Re: License Renewal, Safety Analysis Report, 45-Day Response Questions (TAC No. MD3034)," dated June 1, 2010

On August 31, 2006, the University of Missouri-Columbia Research Reactor (MURR) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) to renew Amended Facility Operating License R-103.

On June 1, 2010, the NRC requested additional information and clarification regarding the renewal request in the form of one hundred and sixty-seven (167) questions. By letter dated July 16, 2010, MURR responded to forty-seven (47) of those questions.

On July 14, 2010, via electronic mail (email), MURR requested additional time to respond to the remaining one hundred and twenty (120) questions. By letter dated August 4, 2010, the NRC granted the request. By letter dated August 31, 2010, MURR responded to fifty-three (53) of the questions.

On September 29, 2010, via email, MURR requested additional time to respond to the remaining sixty-seven (67) questions. On September 30, 2010, MURR responded to sixteen (16) of the remaining questions. By letter dated October 13, 2010, the NRC granted the extension request.

On October 29, 2010, MURR responded to sixteen (16) of the remaining questions.

On November 30, 2010, MURR responded to twelve (12) of the remaining questions. On November 30, 2010, via email, MURR requested additional time to respond to the remaining questions. By letter dated December 13, 2010, the NRC granted the extension request.

On January 14, 2011, via email, MURR requested additional time to respond to the remaining questions. By letter dated February 1, 2011, the NRC granted the extension request.

Attached are MURR's responses to twenty-one (21) of the remaining questions. With these responses, only the following five (5) 45-Day Response questions remain unanswered: 4.7, 6.2, 14.1, A.48 and C.1. Questions 6.2 and C.1 have previously been approved to be included in the 120-Day Response complex questions. Because additional time is needed, MURR requests that questions 4.7, 14.1 and A.48 also be included in the 120-Day Response complex questions. The current schedule to answer the remainder of the 120-Day Response complex questions is May 31, 2011.

1513 Research Park Drive Columbia, MO 65211 Phone: 573-882-4211 Fax: 573-882-6360 Web: www.murr.missouri.edu

If there are questions regarding this response, please contact me at (573) 882-5319 or FruitsJ@missouri.edu. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Carl A. Herbold
for John L. Fruits

John L. Fruits
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

Ralph A. Butler, P.E.
Director

Enclosed: Attachment 1: "Primary Coolant pH/Conductivity - Year 2010"

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

NOTARY PUBLIC
NOTARY SEAL
STATE OF MISSOURI

MARGEE P. STOUT
My Commission Expires
March 24, 2012
Montgomery County
Commission #08511436

Margee P. Stout

CHAPTER 4

4.8 Section 4.2.3, Neutron Moderator and Reflector, Page 4-19.

b. *Discuss if potential experiment facility malfunctions in the reflector could affect reactor core components.*

There are no potential experiment facility malfunctions in the reflector that could affect reactor core components.

There are two (2) experimental facilities that utilize the reflector: the graphite reflector region irradiation positions and the pneumatic tube system. Additionally, some of the graphite elements are designed to allow penetration of the beam tubes to the beryllium reflector. All three (3) of these facilities are described in detail in Chapter 10.0 of the SAR.

The mechanism used to verify that each experiment, or single experiment sample, complies with all of the applicable Technical Specifications (TS), and other limitations based upon good operating, engineering, and health physics practices, is called the Reactor Utilization Request (RUR). This formalized process, which is detailed in administrative procedure AP-RO-135, "Reactor Utilization Requests," specifically requires that a safety analysis be prepared, reviewed and approved by both the Reactor and Reactor Health Physics Managers before an experiment can be conducted. No material shall be irradiated in the graphite reflector region or pneumatic tube system unless it is in full compliance with an approved RUR. Additionally, as required by TS 6.2.a (2), proposed experiments significantly different from any previously reviewed or which involve a question pursuant to 10 CFR 50.59 shall be reviewed by the Reactor Advisory Committee (RAC).

Each safety analysis includes, but is not limited to, the following major criteria: criticality and/or reactivity considerations; heat generation considerations; shielding considerations; and off-gassing and/or chemical reactions. It also includes all credible accident and transient scenarios to ensure that the experiment does not jeopardize the safe operation of the reactor or constitute a hazard to the safety of the facility staff and general public.

The most likely experiment facility malfunction in the reflector region is a failure of a sample can by overpressurization and a discharge of its contents and possible damage to adjacent sample cans. In addition to the reactivity worth limitations placed on experiments (TS 3.1), the following are safety analyses that are required to be included in the RUR to demonstrate that the experiment meets all applicable TS requirements:

• Thermal Analysis	TS 3.6.h and TS 3.6.n
• Sample Decomposition-Pressure Analysis	TS 3.6.i
• Experiment Failure Analysis	TS 3.6.c
• Loss of Coolant Analysis	TS 3.6.f
• Failure of Other Experiments Analysis	TS 3.6.g
• Corrosion Analysis	TS 3.6.j and 3.6.k
• Explosive Analysis	TS 3.6.d

The **Thermal Analysis** is an estimation of the heat generation and heat transfer rates for an experiment, determining if a cooling design change is required to prevent the surface temperature of a submerged irradiated sample from exceeding the saturation temperature of the liquid it is submerged it. The intent of TS 3.6.h is to reduce the likelihood of reactivity transients due to accidental voiding in the reactor or the failure of an experiment from internal or external heat generation. An example of one of the thermal limits is the heat generation rate of a sample in the graphite reflector region, which is restricted to a heat flux limit of no greater than 36 w/cm^2 on the surface of its irradiation container. TS 3.6.n is intended to reduce the likelihood of damage to the reactor and/or radioactivity releases from experiment failure.

The **Sample Decomposition-Pressure Analysis** describes the form of the sample and component materials of the experiment during irradiation, with reasonable leeway for normal and abnormal conditions. The analysis confirms that a potential pressure buildup due to a complete decomposition of the sample material will not exceed the design pressure of the irradiation container. The intent of TS 3.6.i is to reduce the likelihood of damage to the reactor and/or radioactivity releases from an experiment failure.

The **Experiment Failure Analysis** determines if products or components from the experiment have the potential to violate the limits of 10 CFR 20, Appendix B, Table I, if released to the atmosphere. This analysis ensures compliance with TS 3.6.c.

The **Loss of Coolant Analysis** describes how a loss of coolant (e. g., loss of pool coolant flow, loss of experiment cooling, etc.) to the experiment will not result in a release of radioactivity to the atmosphere or affect the safe operation/control of the reactor. This analysis ensures compliance with TS 3.6.f.

The **Failure of Other Experiments Analysis** identifies the possible effects upon reactor control and other experiments due to operating an experiment under abnormal conditions (failure). This analysis ensures compliance with TS 3.6.g.

The **Corrosion Analysis** ensures that the encapsulation provides enough corrosion resistance to endure the worst case scenario of corrosion for the duration of the experiment if corrosive materials are expected to be generated in an appreciable quantity during normal operation or as a result of the experiment failing. This analysis ensures compliance with TS 3.6.j. TS 3.6.k provides assurance that the integrity of the beamports will be maintained for all loop-type experiments.

The **Explosive Analysis** ensures that if explosive materials are present or are expected to be formed during the irradiation then the total mass of the explosive will not exceed the TS limitation. This analysis ensures compliance with TS 3.6.d.

In addition to efforts to ensure that a single experiment failure will not cause other experiments to fail, there are guideline limits on other variables to ensure that the entire irradiation facility, such as the graphite reflector region or pneumatic tube system, is protected from failure. These limits can include mass, flux, fluence, byproduct generation, and number and type of encapsulation.

Furthermore, any change to the structures, systems, and components (SSCs) described in the SAR is evaluated, documented and reviewed and approved by the Reactor Manager. This formalized processed, which is detailed in administrative procedure AP-RO-115, "Modification Records," specifically requires that a reactor safety evaluation be prepared to ensure that the change does not affect the original design and performance specifications of the SSCs. In addition to the reactor safety evaluation, a 10 CFR 50.59 evaluation is also performed to determine if the proposed change requires prior approval from the U.S. Nuclear Regulatory Commission. In this case, any proposed change to a reflector irradiation position or experiment sample holder will go through the Modification Record process.

Therefore, the RUR and Modification Record processes provide a continuity of protection to reactor core components, including the reflector region.

CHAPTER 5

5.2 Section 5.2, Primary Coolant System

a. *American National Standards Institute/American Nuclear Society Standard ANSI/ANS 15.1 recommends TS limits on conductivity and pH of the primary coolant water. Propose TS wording for primary water chemistry (pH and conductivity) and an appropriate surveillance frequency or justify why it is not needed. Provide a history of typical values for primary water pH.*

MURR feels that the current preventative maintenance surveillance system, sampling and analysis procedures, and conductivity and pH limits are more than sufficient to meet the intent of ANSI/ANS 15.1 regarding water chemistry requirements for the primary coolant system and ensures an acceptable level of corrosion control to essential components.

The primary coolant system is sampled weekly as required by preventative maintenance surveillance check R4-W1, "Primary Water Analysis," and in accordance with operating procedure OP-RO-531, "Primary and Pool Sample Station."

The primary coolant sample is then analyzed in accordance with operating procedure OP-RO-420, "Primary and Pool Water Analysis." The analysis includes measuring pH and conductivity, and performing a radio-chemical analysis for iodine-131 and other radioisotopes using a High Purity Germanium (HPGe) detector. A monthly tritium analysis is also performed using a Liquid Scintillation Counter (LSC).

In addition to the weekly sample, primary coolant conductivity is measured continuously with an online monitoring system. The monitoring system remote reading is displayed in the Control Room and its value recorded every two hours by the Control Room operators. Primary coolant conductivity and pH are maintained at less than 2.0 μS and in a range between 5.0 and 6.0, respectively, by a water purification loop consisting of filters and a mixed bed resin demineralizer (this system is described in greater detail in Section 5.5 of the SAR). Aluminum aqueous corrosion resistance is high in slightly acidic water.

Attached (Attachment 1) is a graph which shows the conductivity and pH analysis results of the weekly primary coolant sample for calendar year 2010. These results are typical of previous years.

5.4 Section 5.3, Pool Coolant System.

b. *Propose TS wording for pool water chemistry (pH and conductivity) and an appropriate surveillance frequency or justify why it is not needed.*

MURR feels that the current preventative maintenance surveillance system, sampling and analysis procedures, and conductivity and pH limits are more than sufficient to meet the intent of

ANSI/ANS 15.1 regarding water chemistry requirements for the pool coolant system and ensures an acceptable level of corrosion control to essential components.

The pool coolant system is sampled weekly as required by preventative maintenance surveillance check P5-W1, "Pool Water Analysis," and in accordance with operating procedure OP-RO-531, "Primary and Pool Sample Station."

The pool coolant sample is then analyzed in accordance with operating procedure OP-RO-420, "Primary and Pool Water Analysis." The analysis includes measuring pH and conductivity, and performing a radio-chemical analysis for iodine-131 and other radioisotopes using a High Purity Germanium (HPGe) detector. A monthly tritium analysis is also performed using a Liquid Scintillation Counter (LSC).

In addition to the weekly sample, pool coolant conductivity is measured continuously with an online monitoring system. The monitoring system remote reading is displayed in the Control Room and its value recorded every two hours by the Control Room operators. Pool coolant conductivity and pH are maintained at less than 2.0 μS and in a range between 5.0 and 6.5, respectively, by a water purification loop consisting of filters and a mixed bed resin demineralizer (this system is described in greater detail in Section 5.5 of the SAR). Aluminum aqueous corrosion resistance is high in slightly acidic water.

Furthermore, as described in Section 16.1.4 of the SAR, a detailed assessment of the reactor pool liner was performed in April and June 2000 by the engineering firm Sargent & Lundy^{LLC}. The conclusion from the inspection was that, based on the condition after 34 years of reactor operations, an additional 34 years of good performance by the aluminum pool liner is expected, with the operating conditions and operating procedures continuing as they have been.

CHAPTER 10

10.1 *Section 10.3.2.3, General Requirements. Discuss how the TSs protect against the production of unacceptable levels ozone from liquid nitrogen.*

Technical Specification (TS) 3.6.m states "Cryogenic liquids shall not be used in any experiment within the reactor pool." Liquid nitrogen cryostats are occasionally used on beamport experiments; however, these cryostats are located external to the biological shield rather than in the beam tubes and hence are not in the reactor pool.

The Isotope Use Subcommittee (IUS), as described in Section 12.2.5.4 of the SAR, is an advisory group to the Reactor Advisory Committee (RAC) in matters relating to the custody and use of radiation and radioisotopes within the MURR. The IUS reviews the safety aspects of reactor license project applications for the use of radiation sources, in this case the radiation emanating from a beam tube. Although there is no specific TS regarding ozone levels from liquid nitrogen used in support of experiments conducted outside of the biological shield, strict operating procedures have been established on the use of cryostats in experiments using a beam tube based on the safety evaluations performed for reactor license project applications.

Additionally, sufficient shielding in conjunction with the distance from the reactor core ensures that any possible failure of a liquid nitrogen cryostat could not propagate through a beam tube and adversely affect any reactor core components.

10.2 *Section 10.3.3.2, Description. The SAR discusses a rod withdrawal inhibit if the thermal column door is in the open position. Discuss the actions that occur if the door is opened with the reactor in operation.*

Operation of the thermal column door is administratively controlled by operating procedure EX-RO-126, "Thermal Column Door." Included within the "Precautions and Limitations" and "Prerequisites and Initial Conditions" of this procedure is that the reactor must be shut down and remain shut down while the thermal column door is open. The intent of the Rod Withdrawal Prohibit Circuit is to prevent start up the reactor unless all five (5) of the conditions listed in Section 7.5.3.1 of the SAR, which include the thermal column door being closed, are satisfied.

The thermal column door is a multi-ton shield piece that requires very deliberate action to be operated, including removing a large radiography beam stop, relocating extremely large shielding pieces and electrically connecting the drive motor.

However, if the reactor was in operation and the thermal column door was inadvertently opened, the associated contact in the Rod Withdrawal Prohibit Circuit would open preventing the withdrawal of any control rod and provide annunciation in the Control Room. This would not remove any ability of the reactor operator to insert control rods; however it would prevent any increase in reactor power and allow the reactor operator to determine what necessary actions need be taken. The operation of the thermal column door at power would not be a reactor safety issue; it would be a radiation protection concern. The thermal column door would only need to travel a very short distance (a few inches) to cause the west wall Area Radiation Monitor (ARM) to reach the alarm set point of 20 mr/hr. This alarm would provide additional information to individuals locally at the door and also to the Control Room to ensure prompt corrective action. The Control Room operators would then initiate the immediate and subsequent actions of reactor emergency procedures REP-4, "High Radiation Levels," and REP-12, "Experimental Apparatus Failure."

10.3 Section 10.4, Experiment Review.

a. *This section of the SAR lists criteria that are considered during review and approval of reactor experiments. Explain the relationship between these criteria and the TSs.*

The mechanism used to verify that each experiment, or single experiment sample, complies with all of the applicable Technical Specifications (TSs), and other limitations based upon good operating, engineering, and health physics practices, is called the Reactor Utilization Request (RUR). This formalized process, which is detailed in administrative procedure AP-RO-135, "Reactor Utilization Requests," specifically requires that a safety analysis be prepared, reviewed and approved by both the Reactor and Reactor Health Managers before an experiment can be conducted.

Each safety analysis includes, but is not limited to, the following major criteria: criticality and/or reactivity considerations; heat generation considerations; shielding considerations; and off-gassing and/or chemical reactions. It also includes all credible accident and transient scenarios to ensure that the experiment does not jeopardize the safe operation of the reactor or constitute a hazard to the safety of the facility staff and general public.

The seven safety analyses listed in Section 10.4 of the SAR address the following TSs:

1. Thermal Analysis addresses TS 3.6.h and 3.6.n

2. Sample Decomposition-Pressure Analysis addresses TS 3.6.i
3. Experiment Failure Analysis addresses TS 3.6.c
4. Loss of Coolant Analysis addresses TS 3.6.f
5. Failure of Other Experiments Analysis addresses TS 3.6.g
6. Corrosion Analysis addresses TS 3.6.j and 3.6.k
7. Explosive Analysis addresses TS 3.6.d

TS 3.6.l ensures that operating procedures are established that include controls on the use or exclusion of corrosive, flammable, and toxic materials in experiments or in the reactor containment building.

TS 3.6.a, 3.6.n and 3.6.o are specifications that are specific to fueled experiments.

The safety analysis process outlined also includes all of the criticality and reactivity limitations of TS 3.1 which are applicable for experiments.

10.3 Section 10.4, Experiment Review.

b. *The SAR states that the Reactor Safety Subcommittee and the Reactor Advisory Committee are involved in the review process if required. Please discuss when these committees would be involved in the review process.*

The Reactor Safety Subcommittee (RSSC) is a subcommittee of the Reactor Advisory Committee (RAC) established to act in their behalf in performing reviews of proposed experiments *significantly* different from any previously reviewed or which involve a question pursuant to 10 CFR 50.59. Upon completion of the review, the RSSC shall make a recommendation concerning the proposed experiment and report this recommendation to the Chairman of the RAC and to the Reactor Manager. When the review results in a negative recommendation, the RSSC shall recommend alternatives for the proposed experiment and report this conclusion to the Chairman of the RAC and to the Reactor Manager. In the latter instance, the Reactor Manager shall apprise the Chairman of the RSSC of the alternative selected, or he shall submit a new proposal for review.

Additionally, the Reactor Manager may, at any time, submit a proposed experiment to the RSSC for its review if he feels that the experiment represents a new class of experiment or a change to an existing experiment with safety significance.

10.4 *Section 10.4.2, Reactor Utilization Request. The SAR states that fueled experiments are an exception to the experiment failure analysis. Provide a discussion of the analysis performed for the failure of fueled experiments.*

The experiment failure analysis performed for any proposed fueled experiment follows the same basic failure methodology that is performed for all other experiments; however, the release limits [Technical Specification (TS) 3.6.c] are exempted from 10 CFR 20 Appendix B Table I and replaced by the limits imposed by TS 3.6.a. Additionally, TS 3.6.n and TS 3.6.o are specifications that are specific to fueled experiments.

An experiment failure analysis was performed in support of Amendment No. 34, which was approved by the U.S. Nuclear Regulatory Commission (NRC) on October 10, 2008, which allowed MURR to perform a fueled experiment for 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. The total iodine inventory in the failed experiment was essentially at the TS 3.6.a limit of 150 curies. This analysis, which is also the response to RAI 13.9.a (by letter dated October 29, 2010), is specific to the LEU target; however, the same experiment failure analysis methodology would be used for any other proposed fueled experiment.

Additionally, currently approved TS 3.6.o was revised by Amendment No. 34 to read: "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." MURR wishes to replace TS 3.6.o, which was submitted as part of relicensing, with the currently approved one.

CHAPTER 12

12.1 *Section 12.1.2, Responsibility, Figure 12-1 and TS Figure 6.0. SAR Figure 12-1 and TS Figure 6.0 indicate that the Reactor Health Physics Manager reports to the MURR Director. However, Section 12.1.2.4 of the MURR SAR indicates that the Reactor Health Physics Manager reports to the Associate Director, Regulatory Assurance Group. Please clarify the reporting relationship for the Reactor Health Physics Manager and list the responsibilities of the Associate Director, Regulatory Assurance Group and show the position on the organizational chart. Show the Chief Operating Officer position on the organizational chart.*

At the time of submittal, the Reactor Manager reported to the Chief Operating Officer (COO) and the Reactor Health Physics Manager reported to the Associate Director, Regulatory Assurance Group (RAG). The COO and the Associate Director, RAG, reported to the Director.

Since then, reorganization has occurred at the facility and the COO position has been eliminated. A new position titled Associate Director, Reactor and Facility Operations (RFO), was created which assumed many of the previous duties and responsibilities of the COO. The Reactor Manager now reports to the Associate Director, RFO. The Associate Director, RFO, reports to the Director.

Although the Reactor Manager and Reactor Health Physics Manager report to the Associate Director, RFO, and the Associate Director, RAG, respectively, this reporting chain is for nonreactor license-related items. While the Associate Director, RFO, and the Associate Director, RAG, provide supervision and guidance, all decisions regarding the reactor license are made by the Reactor Facility Director, Reactor Manager and Reactor Health Physics Manager.

MURR wishes to keep the organizational chart as depicted in SAR Figure 12-1 and TS Figure 6.0.

12.4 Section 12.2, Review and Audit Activities and TS 6.2, Review and Audit.

a. *The information in the SAR and proposed TS should, at a minimum, meet the recommendations of ANSI/ANS 15.1, "The Development of Technical Specifications for Research Reactors," 2007 (ANS 15.1). Please discuss the minimum number of members of the Reactor Advisory Committee (RAC) and limitations on members of the MURR staff serving as members and meeting quorum requirements.*

The Reactor Advisory Committee (RAC) consists of eight (8) regular voting members and five (5) *ex-officio*, non-voting members. *Ex-officio* members include MURR staff members, while voting members include faculty and University staff. The RAC charter demands that members of the RAC be "selected for appointment to the Committee because of their expert knowledge of experimental activities, reactor operations, University business policy, or related subjects." Per the charter, a quorum consists of fifty percent of voting members, and excludes *ex-officio* members from quorum.

12.4 Section 12.2, Review and Audit Activities and TS 6.2, Review and Audit.

b. *Please discuss the dissemination, review and approval of committee minutes in a timely manner.*

Per the RAC Charter: "The Committee will maintain minutes of its meetings to include the items considered, actions taken, and the recommendations made. Copies of these minutes are to be distributed promptly to the membership. Actions taken and recommendations made by the subcommittee in the name of the Committee are to be reviewed and approved by the Committee at its next regular meeting." The RAC meets at least quarterly per TS 6.2.b.

12.4 Section 12.2, Review and Audit Activities and TS 6.2, Review and Audit.

c. *Please discuss how your proposed review functions meet the recommendations of ANS 15.1. There are no audit functions listed for the RAC as recommended by ANS-15.1. Please propose audit requirements or justify why they are not needed.*

Existing review functions meet the intent of the ANSI/ANS 15.1 regarding review. The Technical Specification (TS) enumerates the appointment authority, committee composition, meeting frequency, quorums, use of subgroups, and dissemination, review, and approval of minutes for the RAC, the primary review body. The RAC Committee charter details the appointment process and use of subgroups, and charges the committee with carrying out its TS mission.

The existing TS requires that the committee review the topics enumerated in ANSI/ANS 15.1 Section 6.2.3, with two exceptions. First, TS 6.2.a(3), which requires review of the circumstances of all abnormal occurrences and violations of TSs, does not explicitly require review of violations of the license as mentioned in ANSI/ANS 15.1 6.2.3(5). The relevant section has been updated in the proposed revision below. Second, although the terminology of "violations" of internal procedures in ANSI/ANS 15.1, Section 6.2.3(5) is not used, such incidents are treated as "changes" to procedures, and are reviewed and documented by a subcommittee of the RAC created to handle procedure related issues, the Reactor Procedure Review Subcommittee (RPRS).

The relevant administrative procedure, AP-RO-110, "Conduct of Operations," explicitly requires documentation and RPRS review of deviations.

ANSI/ANS 15.1 6.2.3(8), requiring RAC review of audit reports, was reflected in previously proposed TS 6.2. In order to meet the requirements of ANSI/ANS 15.1 regarding audit functions, MURR proposes revising TS 6.2 to read:

6.2 **Review and Audit**

a. A Reactor Advisory Committee (RAC) shall provide independent oversight in matters pertaining to the safe operation of the reactor and with regard to planned research activities and use of the facility building and equipment. The RAC shall review:

(1) Proposed changes to MURR equipment, systems, or procedures when such changes have safety significance, or involve an amendment to the facility operating license, a change in the Technical Specifications incorporated in the license, or a question pursuant to 10 CFR 50.59. Changes to procedures that do not change their original intent may be made without prior RAC review if approved by the TS designated manager, either the Reactor Health Physics Manager or Reactor Manager, or a designated alternate who is a Health Physicist or Senior Reactor Operator, respectively. All such changes to the procedures shall be documented and subsequently reviewed by the RAC;

(2) Proposed experiments significantly different from any previously reviewed or which involve a question pursuant to 10 CFR 50.59;

(3) The circumstances of reportable occurrences and violations of the Technical Specifications or license and the measures taken to prevent a recurrence;

(4) Violations of internal procedures or operating abnormalities having safety significance; and

(5) Reports from audits required by the Technical Specifications.

b. The RAC may appoint subcommittees consisting of students, faculty, and staff of MU when it deems it necessary in order to effectively discharge its primary responsibilities. When subcommittees are appointed, these are to consist of no less than three members with no more than one student appointed to each committee. The subcommittees may be authorized to act on behalf of the parent committee.

The RAC and its subcommittees are to maintain minutes of meetings in which the items considered and the committees' recommendations are recorded. Independent actions of the subcommittees are to be reviewed by the parent committee at the next regular meeting. A quorum of the committee or the subcommittees consisting of at least fifty percent of the appointed members must be present at any meeting to conduct the business of the committee or subcommittee. The RAC shall meet at least once during each calendar quarter.

A meeting of a subcommittee shall not be deemed to satisfy the requirement of the parent committee to meet at least once during each calendar quarter.

c. Any additions, modifications or maintenance to the systems described in these Specifications shall be made and tested in accordance with the specifications to which the system was originally designed and fabricated or to specifications approved by the U.S. Nuclear Regulatory Commission (NRC).

d. Following a favorable review by the NRC, the RAC, or the Reactor Facility Management, as appropriate, and prior to conducting any experiment, the Reactor Manager shall sign an authorizing form which contains the basis for the favorable review.

e. Audits

(1) Audits of the following functions shall be conducted by an individual or group without immediate responsibility in the area to be audited:

i. Facility Operations, for conformance to the Technical Specifications and license conditions, at least annually;

ii. Operator Requalification Program, for compliance with the approved program, at least every two years; and

iii. Corrective action items associated with reactor safety, at least annually.

(2) Audit findings which affect reactor safety shall be immediately reported to the Reactor Facility Director.

12.5 *Section 12.3, Procedures, and TS 6.3, Procedures. The information in the SAR and proposed TS should, at a minimum, meet the recommendations of ANS 15.1. Please discuss how the SAR and proposed TS meet the recommendations of ANS 15.1 or justify why meeting the recommendations is not needed.*

In order to meet the requirements of ANSI/ANS 15.1 regarding procedures, MURR proposes revising TS 6.3 to read:

6.3 **Procedures**

a. Written procedures shall be in effect for operation of the reactor, including the following:

(1) Startup, operation, and shutdown of the reactor;

(2) Fuel loading, unloading, and movement within the reactor;

(3) Maintenance of major components of systems that could have an effect on reactor safety;

(4) Surveillance checks, calibrations, and inspections that may affect reactor safety;

(5) Administrative controls for operations and maintenance and for the conduct of irradiations and experiments that could affect reactor safety or core reactivity; and

(6) Implementation of the Emergency Plan.

b. Written procedures shall be in effect for radiological control, and the preparation for shipping and the shipping of byproduct material produced under the facility operating license.

c. The Reactor Manager shall approve and annually review the procedures for normal operations of the reactor and the Emergency Plan implementing procedures. The Reactor Health Physics Manager shall approve and annually review the radiological control procedures and the procedures for the preparation for shipping and the shipping of byproduct material.

d. Deviations from procedures required by this Specification may be enacted by a Senior Reactor Operator or member of Health Physics, as applicable. Such deviations shall be documented and reported within 24 hours or the next working day to the Reactor Manager or Reactor Health Physics Manager or designated alternate.

Note: ANSI/ANS 15.1 6.4(8) is addressed by the provisions of TS 6.3.b and, for non-MURR produced isotopes, MURR's broad scope materials license.

12.9 *Section 12.5, Records and TS 6.4, Records. The information in the SAR and proposed TS should, at a minimum, meet the recommendations of ANS 15.1. In addition to the record recommendations of ANS 15.1, 10 CFR 50.36 requires reports of violations of safety limits, limiting safety system settings, and limiting conditions for operation to be retained until the Commission terminates the facility license. Propose appropriate changes to the SAR and TS to meet the recommendations of ANS 15.1 and the requirements of 10 CFR 50.36, or justify your TS and SAR as proposed.*

To clarify compliance with ANSI/ANS 15.1, MURR recommends that Technical Specification (TS) 6.4 and its substeps be replaced with the wording similar to what is in Section 12.5 of the SAR. TS 6.4 will be revised to read:

6.4 **Records**

Records of the following activities shall be maintained and retained for the periods specified below. The records may be in the form of logs, data sheets, or other suitable forms or documents. The required information may be contained in single or multiple records, or a combination thereof.

a. Lifetime Records - The following records are to be retained for the lifetime of the reactor facility: (Note: Applicable annual reports, if they contain all of the required information, may be used as records in this section.)

(1) Gaseous and liquid radioactive effluents released to the environs;

(2) Off-site environmental-monitoring surveys required by the Technical Specifications;

(3) Radiation exposure for all monitored personnel; and

(4) Updated drawings of the reactor facility.

b. Five Year Records - The following records are to be maintained for a period of at least five years or for the life of the component involved, whichever is shorter:

(1) Normal reactor facility operation (but not including supporting documents such as checklists, log sheets, etc. which shall be maintained for a period of at least one year);

(2) Principal maintenance operations;

(3) Reportable occurrences;

(4) Surveillance activities required by the Technical Specifications;

(5) Reactor facility radiation and contamination surveys required by applicable regulations;

(6) Experiments performed with the reactor;

(7) Fuel inventories, receipts, and shipments;

(8) Approved changes to operating procedures; and

(9) Records of meetings and audit reports of the review and audit group.

MURR's license contains an explicit commitment to compliance with the numerous applicable requirements, including records retention requirements, of the Codes of Federal Regulations, which appears in 70.32(a)(8). For this reason, MURR does not feel a specific statement of compliance with 10 CFR 50.36 is necessary in our TSs.

APPENDIX A, TECHNICAL SPECIFICATIONS

A.5 *Definition 1.7, Experiment. The definition provided differs from that given in ANS 15.1. In TS 1.7 a. please explain what is considered "significant radiation." In TS 1.7 b. an operation to monitor reactor parameters is an experiment. The reactor operators in the control room are monitoring reactor parameters during reactor operation. Is routine reactor operation considered an experiment? Please clarify.*

The definition of an "experiment" that was submitting as part of relicensing is the same definition that is in MURR's currently approved Technical Specifications (TSs). To be consistent with the definition of an "experiment" given in ANSI/ANS 15.1, TS 1.7 will be revised to read:

1.7 **Experiment** - Any operation, hardware, or target (excluding devices such as detectors or foils) which is designed to investigate non-routine reactor characteristics or which is intended for irradiation within an irradiation facility. Hardware rigidly secured to a core or shield structure so as to be part of their design to carry out experiments is not normally considered an experiment.

A.16 *TS 3.1 provides Limiting Conditions for Operation (LCOs) for Reactivity Limitations. However, there are no corresponding Surveillance Requirements for these LCOs. Propose appropriate TS Surveillance Requirements for TS 3.1 or justify why none are needed. There appears to be no requirement for the periodic determination of the worth of control blades. Propose and justify a TS or discuss why no TS is needed.*

TS 3.1.a and 3.1.b: These specifications address the core temperature and void coefficients which are fundamental reactor characteristics and are calculated during the design phase of the reactor and carefully verified during the initial core physics measurements. No surveillance requirements are placed on these design characteristics. These coefficients would not change unless major alterations were made to the fuel design or core arrangement. Neither is planned during this relicensing period.

TS 3.1.c and 3.1.d: TS 3.1.c places upper limits on the total reactivity worth and maximum rate of reactivity insertion of the regulating blade. TS 3.1.d places an upper limit on the maximum rate of reactivity insertion for the four shim blades. These values were calculated with eight (8) fresh, poison-free, highly-enriched uranium (HEU) fuel elements in the core and current shim blade design and then measured during the initial reactor physics testing. These initial measurements correspond to the maximum values for these shim blade worths and reactivity insertion rate since the shim blades are at their most reactive state during the initial measurement. Any change in their values, due to shim blade material burnout, will move the blade worths further away from the TS limits in the conservative direction (Note: Speed of the shim blades can not be adjusted without major physical alterations to the drive system). Whenever the regulating blade or a shim blade is replaced their total reactivity worth and reactivity insertion rate are measured. MURR feels that no surveillance requirements are necessary for these TS LCOs.

T.S 3.1.e: This specification is indirectly satisfied with the surveillance specified for the core excess reactivity, viz., TS 3.1.f. The higher the excess reactivity is, the lower the shutdown margin is, and vice versa. By ensuring the excess reactivity criteria is satisfied after each core refuel (TS 3.1.f), the shutdown margin requirement is also being met since the shim blade worths do not change significantly from one startup to the next.

T.S 3.1.f: This specification is covered under the surveillance specified in this TS requirement. Every time a change is made to the core configuration (such as a refuel), the core excess reactivity is calculated based on the critical rod height information obtained during startup.

T.S 3.1.g through k: Before any new experiment, or sample can, is irradiated in the reactor, the safety of that experiment during irradiation is carefully analyzed and documented through a Reactor Utilization Request (RUR) process (this process is explained in detail in the response to RAI 10.3.a). One of the key aspects analyzed during this comprehensive RUR process is the reactivity effect of the new experiment/sample. After the RUR review is completed, and before the experiment can be irradiated, the reactivity of the sample is measured to obtain a good value of the sample worth that is used to calculate the reactivity worth of the sample wherever located in that experiment holder. Only after these analyses and measurements is a reactivity worth assigned to the sample. No further changes are allowed to that experiment without prior approval of the Reactor Manager.

Similarly, before installation in the reactor, the multiple sample cans that go into the center test hole canister (sample holder within the flux trap region) are individually measured and their reactivity effects are appropriately combined to analytically obtain a net reactivity worth of all the samples installed in the center test hole. Periodic measurement of the total worth of the loaded center test hole canister plus the tight tolerance limits placed on the Estimated Critical Position (ECP) and the actual critical rod height during startup ensures that the center test hole reactivity is accurately accounted for and below the TS limit.

These protocols will ensure that the reactivity worths of the various experiments (secured, unsecured and movable) that are installed in the reactor are fully quantified. Because of these controls, we feel that no additional TS surveillance requirements are necessary for TS 3.1.g through k.

T.S 4.3.b: This specification ensures that one out of the four shim blades is inspected every six months so that every blade is inspected every two years. MURR accomplishes this requirement by replacing, every six months, an installed shim blade and its corresponding offset mechanism (described in Section 4.2.2.1 of the SAR) with a rebuilt offset mechanism (bearings replaced) and a shim blade that is either new (unirradiated) or one that has been previously used and that has decayed sufficiently to handle. The visual inspection of the blade is accomplished during this change out process, as required by TS 4.3.b. A shim blade at MURR typically goes through 1 to 4 such two-year cycles before permanently being removed from service. Whenever a shim blade is changed out the integral worth of the new (or recycled) blade is measured as required by Compliance Procedure No. 25 (CP-25), "Offset Removal, Installation and Control Blade Inspection," and in accordance with reactor procedure RP-RO-200, "Measurement of Differential Worth of a Shim Blade, RTP-11(D)."

Also, because of the power history of the cores that are typically loaded, only 5 to 6 inches of the lower tip of the shim blade is exposed to significant flux and experiences measurable depletion. The rest of the roughly 28 to 29 inches of the blade (Boral Portion) remains out of the core (flux) during a majority of the operating time. Because of this, the worth of a blade changes significantly only during the first year of its operation. As required by preventative maintenance surveillance check RX-Q4, "Control Blade," the worth of a new shim blade is measured every quarter during the first year of its operation and at least once every two years of operation after that. We feel this is adequate to ensure the right control blade worth is available for use and no additional TS surveillance is required regarding the shim blade worths.

A.17 *TS 3.2.b requires that above 100 kW, the maximum distance between the highest and lowest shim blade is one inch. However, there is no Surveillance Requirement for this LCO. Propose an appropriate TS Surveillance Requirement for TS 3.2.b or justify why one is not needed.*

MURR feels that no additional surveillance is required for this Limiting Condition of Operation (LCO). Technical Specification (TS) 3.2.b requires that above 100 kW, the maximum distance between the highest and lowest shim blade shall not exceed one (1) inch. Step 6.6.6.c of MURR administrative procedure AP-RO-110, "Conduct of Operations," further limits the maximum distance between shim blades to 0.9 inches above 100 kW. In addition, this limitation is discussed in OP-RO-210, "Reactor Startup – Normal," OP-RO-211, "Reactor Startup – Hot," OP-RO-212, "Reactor Startup – Recovery from Temporary Power Reduction," and OP-RO-230, "Changing Reactor Power Level."

All shim blade (control rod) height indications are on constant display at two locations in the Control Room. The instrument panel and the reactor control console both have a prominent indicating panel which contains each shim blade height on continuous display (The Control Rod Position Indication system is described in further detail in Section 7.5.6 of the SAR). The

Control Room operator is required to frequently monitor these displays during reactor operations. The shim blade heights are recorded during reactor startup on MURR form FM-55, "Startup Nuclear Data," and at least hourly during reactor operation on MURR form FM-43, "Nuclear and Process Data." This data receives an independent review by a second licensed operator after it is collected.

MURR feels that due to the stringent administrative controls placed on shim blade height and the fact the shim blade height is continuously monitored by the Control Room operators during all conditions of reactor operation, no additional surveillance TS should be required.

A.22 *TS 3.4, Reactor Instrumentation. There does not appear to be requirements for any interlocks in the TSs. Please discuss the interlocks provided by the reactor I&C system and proposed TSs or explain why they do not need to be TS requirements.*

The interlocks provided by the Reactor Instrumentation and Control Systems are discussed in detail in Chapter 7 of the SAR and are summarized below. These interlocks serve to protect Nuclear Instrumentation, the Rod Control System, the Process Instrumentation and Control Systems, the Engineered Safety Features Actuation Systems and the Radiation Monitoring Systems.

Protection to these systems is either a follow-up action after the system has performed its direct safety function, or a redundant input to existing safety functions. These interlocks therefore represent *additional* actions beyond the Technical Specification (TS) definition relating to Limiting Conditions for Operation (LCOs), which states, "The LCOs are the lowest functional capability or minimum performance level which ensures that the reactor will not be damaged, that the reactor will be capable of performing its intended function, and that no one will suffer undue radiological exposures because of reactor operations."

Secondary interlocks which are present for operator assistance, convenience, and/or redundancy, rather than direct safety functions, are considered to be operational in nature. On the other hand, interlocks which must perform a direct function in ensuring the LCOs are satisfied must also be required by TSs. An interlock that provides secondary enhancement to system function, such as those that complete a system shutdown following a direct function, should not be required by the TSs. A discussion of existing TSs and associated interlocks follows.

7.4 <u>Nuclear Instrumentation</u>

<u>Nuclear Instrument Anomaly Interlock</u>:

<u>Neutron Flux Monitors</u>: A self-diagnostic operation monitoring circuit provides a continuous analysis of the integrity of the detector, the cables, and the power supplies. A malfunction (inoperative) signal generated by this circuit will cause the following actions to occur:

1. Initiation of the "Nuclear Instrument Anomaly" annunciator alarm; and
2. Initiation of a reactor scram.

The inoperative signal indicates that one or more of the following conditions exists:

a. The ±15-VDC supply has failed;
b. Magnitude of the detector excitation high voltage supply is low;

c. Detector signal is low; or
d. One of the front panel switches (S1 thru S5) on the signal processor drawer has been actuated.

The Nuclear Instrument Anomaly annunciator and its associated interlock conditions provide operational indication that a required instrument channel is fully functional. MURR has interpreted this interlock to be part of the nuclear instrumentation channel for Power Range Channels 4, 5 and 6 and thus has included it under TS 3.3 and the surveillance requirements of TS 4.4. The interlock is tested semiannually during the performance of Compliance Procedure No. 9 (CP-9), "Nuclear Instrumentation Scram and Rod Run-In," and prior to each reactor startup during performance of the Startup Checksheet. MURR feels no additional TS should be required.

Wide Range Monitor: If one or more of the following conditions are met, an instrument drawer inoperative trip will occur and a "Nuclear Instrument Anomaly" annunciator alarm will initiate:

a. A module is removed from the instrument drawer;
b. Drawer selector switch S1 is placed in any position other than OPERATE; or
c. The high voltage power supply output drops below a predetermined minimum voltage.

The Nuclear Instrument Anomaly annunciator and its associated interlock conditions provide operational indication that a required instrument channel is fully functional. This interlock also serves the Wide Range Monitor (WRM). This portion of the interlock is tested prior to each reactor startup during performance of the Startup Checksheet. The WRM is not part of the safety system, and for this reason MURR feels no additional TS should be required for this interlock.

7.5 Rod Control System

Rod Withdrawal Prohibit: The Rod Withdrawal Prohibit circuit prevents the control blades from being withdrawn unless all of the following control system logic conditions have been satisfied:

1. The Master Control Switch (1S1) in the "ON" position;
2. No Nuclear Instrument anomaly;
3. Shim rods bottomed and in contact with their electromagnets;
4. Source range level indication greater than 20 cps or intermediate range level recorder indication greater than 2×10^{-5}% power; and
5. Thermal Column door closed.

When all of the foregoing conditions have been satisfied, the Reactor Safety and Rod Run-In System Trip Actuator Amplifiers (TAAs) may be reset and the control blades withdrawn. There is no interlock or prohibit circuit which prevents the control blades from being driven inward in either the manual or automatic control modes.

If a control rod loses contact with its electromagnet while being withdrawn, all shim blades must be fully inserted before they can be withdrawn again. The Rod Withdrawal Prohibit circuit may be bypassed (rod drive test permissive) for testing if the following conditions are met:

1. The Master Control Switch (1S1) is in the "Test" position; and
2. Power to the control rod electromagnets is secured (relays 2K20 and 2K21 are de-energized).

The Rod Withdrawal Prohibit circuit and its associated interlock conditions aid the operator in ensuring rod withdrawal conditions have been met prior to withdrawing the control rods. This circuit provides only a follow-on permissive function as the first three of the above-described conditions will themselves prevent rod withdrawal through independent means. Because the conditions of this circuit do not provide the primary protection against rod withdrawal, MURR feels that this interlock should not be required by the TSs.

<u>Auto Control Prohibit</u>: The reactor may be placed in automatic control after the following four conditions have been met:

1. Reactor period as indicated by Intermediate Range Channels 2 and 3 greater than 35 seconds;
2. Indicated reactor power level greater than the "auto control prohibit" set point on the wide range monitor recorder;
3. The regulating blade position greater than 60% withdrawn; and
4. The Range Selector Switch (1S2) in the 5-kW red scale position or above.

Once the reactor is placed in automatic control, the Rod Control System will remain in this mode unless any one of the following actions occur:

a. Control mode transferred to manual (push button S1-2 depressed);
b. Regulating rod control switch (1S5) actuated;
c. Regulating rod inserted to the 10% withdrawn position;
d. A reactor scram or rod run-in; or
e. Indicated reactor power reaching a level less than the "auto control prohibit" set point on the wide range monitor recorder.

The Auto Control Prohibit circuit and its associated interlock conditions aid the operator in ensuring conditions have been met to assuming automatic control of the reactor. There is no requirement for automatic operation of the reactor. The reactor may always be placed in manual operation mode, and reactor power is always maintained by the reactor operator in either manual or automatic mode. As a result, MURR feels that this interlock should not be required by the TSs.

<u>Range Switch 1S2 Interlock</u>: Range Switch 1S2 has a primary function of allowing the reactor operator to observe reactor power over ten decades via position selection of the eighteen-position switch. Various positions and groups of positions provide mode interlocks associated with Mode I, Mode II and Mode III operation. Switch 1S2 works in conjunction with other interlocks described here, such as the Auto Control Prohibit Interlock and Power Level Interlock (PLI).

Range Switch 1S2 Interlock is a secondary function of Switch 1S2. Its interlock functions are incorporated into other interlocks described here. This interlock is part of the Power Level Interlock and thus falls under the PLI associated TS as described below.

<u>Master Control Switch 1S1 Interlock</u>: Master Control Switch 1S1 provides perhaps the most wide-ranging interlock function for the Instrumentation and Controls Systems, including both Rod Control and Process Instrumentation.

Switch 1S1 provides power to the entirety of the Rod Control System. This includes inputs to the Reactor Safety System, Rod-Run-in System, Rod Withdrawal Prohibit circuit, Control Rod and Regulating Rod Drive Mechanisms, Auto Control Prohibit circuit, and Range Switch 1S2.

Master Control Switch 1S1 provides a precursor interlock to the other interlocks and direct protective functions described above. Due to its precursor nature, the direct protective functions cannot be brought onto service until this switch is properly positioned. As a result, MURR feels that no additional TS should be required for this interlock.

7.6 Process Instrumentation and Control System

Power Level Interlock: The Power Level Interlock (PLI) scram provides assurance that the reactor cannot be operated with a power level greater than that authorized for the mode of operation selected on PLI Switch 1S8. The PLI scram also provides the interlocks to assure that the reactor cannot be operated in Mode I with a primary or pool coolant low flow scram bypassed (2S40 and 2S41). The Power Level Selector Switch is interlocked with the bypass switches (2S40 and 2S41) to prevent reactor operation with a bypass function unless the reactor is lined up for the proper mode of operation.

If core differential pressure decreases to approximately 90% of the normal operating value, a reactor scram is initiated. The Alarm Meter Unit will de-energize relay 2K9 which opens a contact in the PLI circuit causing relays 1K13 and 1K26 to de-energize. Relay 1K13 opens a contact in the process input string to E3B of the Reactor Safety System NCLUs, thereby interrupting power to the control blade electromagnets. Relay 1K26 opens a contact in the process input string to E4A of the Non-Coincidence Logic Units (NCLUs). De-energizing either relay 1K13 or 1K26 also causes the following actions to occur:

1. "Power Level Interlock Scram" annunciator alarm will be initiated; and
2. In-Pool Heat Exchanger Isolation Valves V546A and V546B will open.

The PLI circuit and its associated interlock conditions are a direct requirement of TS 3.3. Its associated surveillance is performed using Compliance Procedure No. 23 (CP-23), "DPS-929," Compliance Procedure No. 27 (CP-27), "Power Level Interlock Static Scram," and Compliance Procedure No. 22 (CP-22), "Pressure Transmitters PT-944 A/B and PT-943" which includes verification of both the instrument channel portion and mode interlock portions of the reactor scram. This surveillance is included under TS 4.4 as discussed in the answer to RAI A.40.

Primary Coolant System Interlock: In the event either primary coolant isolation valve V507A or V507B leaves its fully-open position, a limit switch mounted on each valve actuator causes relays 2K10, 2K11, and 2K27 to de-energize and the following actions occur:

1. Reactor will scram (relays 1K13 and 1K26 de-energize);
2. Primary Coolant Circulation Pumps 501A and 501B will stop;
3. In-Pool Heat Exchanger Isolation Valves V546A and V546B will open;
4. Anti-Siphon System Isolation Valves V543A and V543B will open;
5. Surge Line Isolation Valve V527C will close;
6. "Power Level Interlock Scram" annunciator alarm will be initiated; and
7. "Pump 501A/B On Valve 507A/B Closed" annunciator alarm will be initiated.

The Primary Coolant System Interlock circuits and associated interlock conditions aid the operator in ensuring the primary coolant system is safely shut down following actuation of primary coolant isolation valves V507A or V507B. The direct safety function is provided by the actuation of the isolation valves. This circuit provides a follow-on function to secure the primary coolant system and provide a redundant input to scram the reactor and open the in-pool heat exchanger isolation valves V546A and V546B, as these two functions are accomplished independently from this circuit. This interlock is also included in the PLI circuitry and included under TS 3.3 and 4.3. MURR feels that no additional TS should be required for this interlock.

Pool Coolant System Interlock: In the event the pool coolant isolation valve V509 leaves its fully-open position, a limit switch mounted on the valve actuator will cause relay 2K12 to de-energize and the following actions will occur:

1. Reactor will scram (a contact in the process input string to E4A opens);
2. Pool Coolant Circulation Pumps 508A and 508B will stop;
3. Pool Coolant Demineralizer Pump 513B will stop; and
4. "Pool Loop Valve 509 Off Open Scram" annunciator alarm will be initiated.

The Pool Coolant System Interlock circuits and associated interlock conditions aid the operator in ensuring the pool coolant system is safely shut down following actuation of pool coolant isolation valve V509. The reactor scram function of the interlock is directly included in TS 3.4 and thus also TS 4.4. This surveillance is performed in Compliance Procedure No. 7B (CP-7B), "Pool Flow Orifice 921 (Yellow Leg) V509 Off Open." The remaining portions of the interlock serve as operator aids in the protection the pool coolant and demineralizer pumps and are not part of the safety system. Therefore, MURR feels that no additional TS should be required for this interlock.

Master Control Switch 1S1 Interlock: Master Control Switch 1S1 provides a wide-ranging interlock function for the Instrumentation and Controls Systems, including Rod Control (described above) and Process Instrumentation.

In the Process Instrumentation System, Switch 1S1 provides process control interlocks in the form of a 'test permissive' function for nearly all remotely-operated process system valves. A typical valve control scheme allows the valve to be manually operated when Switch 1S1 is in the "Test" position, and automatically operated when Switch 1S1 is in "Off" or "On."

Master Control Switch 1S1 provides a precursor interlock to the operation of nearly all remotely-operated process system valves. Due to its precursor nature, the direct protective functions or operational functions of these valves cannot be made operational until this switch is properly positioned. For the Process Instrumentation System, MURR feels that this interlock should not be required by the TSs.

7.7 Reactor Safety System

Trip Actuator Amplifier (TAA) Interlock: The reactor safety system TAAs must be reset prior to resetting the rod run-in TAA (relays 2K20 and 2K21 must be energized).

The reactor safety system TAAs provide the direct safety function, the rod run-in TAA provides a secondary function. Therefore this interlock is operational in nature only. MURR feels that this interlock should not be required by the TSs.

7.8 Engineered Safety Features Actuation Systems

7.8.2 Containment Actuation (Reactor Isolation) System

Isolation of the reactor containment building can be automatically initiated by radiation detectors located at the reactor pool upper bridge and in the containment building ventilation exhaust plenum. A radiation level which is one decade above background at these locations will cause relays 2K1A and 2K1B to de-energize. Relay 2K1A is actuated by the containment building exhaust plenum No.1 and the reactor pool upper bridge ALARA radiation monitors. Relay 2K1B is actuated by the containment building exhaust plenum No. 2 and reactor pool upper bridge radiation monitors. De-energizing either of these relays will cause the following actions to occur:

1. A reactor scram is initiated by the "green leg" of the Reactor Safety System by a process input string to E3B of the NCLUs;
2. Parallel relays R2A and R2B and relay 2K2 in the containment actuation system (CAS) will de-energize;
3. Containment building ventilation exhaust plenum backup doors will close; and
4. "Bldg Air Plenum & Bridge Hi Activity Scram" annunciator alarm will be initiated.

De-energizing either relay R2A or R2B (see No. 2 above) of the CAS will cause the following actions to occur:

1. Containment building ventilation supply and exhaust duct electric-motor-driven isolation doors 504 and 505 will close;
2. Containment building hot exhaust line isolation valves 16A and 16B will close;
3. The reactor isolation horns will activate; and
4. The warning light at the entrance to the containment building personnel airlock will illuminate.

These radiation monitors feature a failure mode that occurs if they do not receive an input signal from the detector assembly for a specified time period (approximately one minute). This failure will de-energize relays 2K1A and 2K1B, thus preventing reactor operation with a failed radiation monitor.

The reactor containment building supply (SF-2) and return (RF-2) fans are interlocked such that securing SF-2 will automatically secure RF-2, thus preventing a negative overpressure condition from occurring within the containment building. However, operation of SF-2 with RF-2 is completely independent of reactor operation.

The CAS is included in TS 3.3 and 4.3, respectively. The supply and return fan follow on interlock is operational in nature only. MURR feels that no additional TSs are required for this interlock.

7.8.3 Anti-Siphon Actuation System

The Anti-Siphon Actuation System is automatically actuated upon detection of primary coolant system low pressure. System pressure is monitored by two electronic pressure transmitters (PT 944A and PT 944B) located on the 12-inch primary coolant piping between the reactor pressure vessel and primary coolant isolation valve V507A. Should primary coolant system pressure decrease below a predetermined value, PT 944A and PT 944B will de-energize relays 2K13 and 2K28, respectively, either of which will cause the following actions to occur:

1. Reactor will scram - 2K13 will open a contact in the process input string to E4A and 2K28 will open a contact in the process string to E3B of the Reactor Safety System NCLUs;
2. Primary Coolant Circulation Pumps 501A and 501B will stop;
3. Primary Coolant Isolation Valves 507A and 507B will close; and
4. Anti-Siphon System Isolation Valves 543A and 543B will open.

Redundancy is incorporated into the Anti-Siphon Actuation System to ensure that no single component or circuit failure will render any portion of the system inoperative. System reliability is achieved through instrumentation and equipment which fail-safe when de-energized. Characteristics of this system which provide the redundancy and reliability are:

(a) All relays which de-energize to perform their intended function are assumed to be fail-safe;
(b) Redundant primary coolant system pressure monitors PT 944A and PT 944B, either of which will initiate operation of this system are provided; and
(c) Redundant relays 2K13 and 2K28, either of which will initiate operation of this system are provided.

At least two major failures must occur before the Anti-Siphon Actuation System would be unable to perform its intended function. This is not a credible assumption.

The operation of the Anti-Siphon Actuation System is included under TS 3.9 and the associated surveillances are discussed in the answer to RAI A.46. MURR feels that no additional TS should be required.

7.9 Radiation Monitoring Systems

Interlocks within the Radiation Monitoring Systems are included in the above discussion of Engineered Safety Features. MURR feels that no additional TS should be required.

MURR feels that the interlocks discussed above have either been included in other requirements in the TSs or provide secondary enhancement to other systems and should not be required by additional specifications.

A.35 *TS 3.9, Reactor Coolant System. ANS 15.1 Section 3.3 suggests TS limits on water chemistry requirements. Please propose TSs on primary and pool water chemistry or justify why they are not needed (See RAIs 5.2 a and 5.4 b).*

See answers to 5.2.a and 5.4.b.

A.53 *TS 6.1, Organization. ANS 15.1, Section 6.1, Organization and Section 6.1.2, Responsibility, recommends TSs contain information on functions, assignments, and responsibilities of key organization staff. The standard also recommends that TSs contain information that individuals at the various management levels, in addition to having responsibility for the policies and operation of the reactor facility, shall be responsible for safeguarding the public and facility personnel from undue radiation exposures and for adhering to all requirements of the operating* *license and technical specifications. In all instances, responsibilities of one level may be assumed by designated alternates or by higher levels, conditional upon appropriate qualifications. Please include requirements similar to these in the TSs or justify why they are not needed.*

The primary staff members with direct responsibility in implementing the Technical Specifications (TSs) at MURR are the Reactor Facility Director, Reactor Manager, and Reactor Health Physics Manager. MURR proposes revising TS 6.1 to read:

6.1 **Organization**

a. The organizational structure of the University of Missouri-Columbia (MU) relating to the Missouri University Research Reactor (MURR) shall be as shown in Figure 6.0.

b. The following positions shall have direct responsibility in implementing Technical Specifications as designated throughout this document:

(1) Reactor Facility Director: Responsible for establishing the policies that minimize radiation exposure to the public and to radiation workers, and that ensures that the requirements of the license and Technical Specifications are met.

(2) Reactor Manager: To safeguard the public and facility personnel from undue radiation exposure, the Reactor Manager is responsible for:

i. Compliance with Technical Specifications and license requirements regarding reactor operation, maintenance and surveillance.

ii. Oversight of the experiment review process.

(3) Reactor Health Physics Manager: To safeguard the public and facility personnel from undue radiation exposure, the Reactor Health Physics Manager is responsible for:

i. Compliance with Technical Specifications and license requirements regarding radiation safety, byproduct material handling and the shipment of byproduct material.

ii. Implementation of the Radiation Protection Program.

c. At a minimum during reactor operation, there shall be two facility staff personnel at the facility. One of these individuals shall be a Reactor Operator or a Senior Reactor Operator licensed pursuant to 10 CFR 55. The other individual must be knowledgeable of the facility.

d. A senior reactor operator licensed pursuant to 10 CFR 55 shall be present at the facility or readily available on call at all times during operation, and shall be present at the facility during all start-ups and approaches to power, recovery from an unplanned or unscheduled shutdown or non-emergency power reduction, and refueling activities.

Note: TS 6.1.d above was added to the relicensing TSs as TS 6.1.c in response to RAI 12.2.b. This specification will now become TS 6.1.d.

A.55 *TS 6.0, Administrative Controls. ANS 15.1, Section 6.3, Radiation Safety, recommends TSs for the implementation of radiation safety. Propose appropriate TS wording to include requirements similar to these in the TSs or justify why they are not needed.*

The wording proposed in the response to RAI A.53 assigns responsibility for implementation of radiation safety to the Reactor Health Physics Manager.

ATTACHMENT 1