July 19, 2010

Colonel Mark A. Melanson, Ph.D.
Director
Armed Forces Radiobiology Research Institute
8901 Wisconsin Avenue
Bethesda, Maryland 20889-5603

SUBJECT: ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE —REQUEST FOR ADDITIONAL INFORMATION REGARDING THE APPLICATION FOR LICENSE RENEWAL (TAC NO. ME1587)

Dear Colonel Melanson:

The U.S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-84 for the Armed Forces Radiobiology Research Institute (AFRRI) TRIGA reactor, dated June 24, 2004 and supplemented by letter dated March 4, 2010. Our review conformed to the Interim Staff Guidance for the Streamlined Review Process for Research Reactors.

We require additional information and clarification on questions that have arisen during our review. Please provide responses to the enclosed request for additional information within 45 days of the date of this letter. In accordance with Title 10 of the *Code of Federal Regulations* Section 50.30(b), you must execute your response in a signed original document under oath or affirmation.

If you have any questions about this review or if you need additional time to respond to this request please contact Walter Meyer by telephone at 301-415-0897 or by electronic mail at Walter.Meyer@nrc.gov.

Sincerely,

/RA LTran for/

Alexander Adams Jr., Senior Project Manager
Research and Test Reactors Licensing Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-170

Enclosure:
As stated

cc w/encl: See next page

Docket No. 50-170

Armed Forces Radiobiology Research

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Test, Research, and Training
Reactor Newsletter
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202 Nuclear Sciences Center
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REQUEST FOR ADDITIONAL INFORMATION

LICENSE RENEWAL FOR ARMED FORCES RADIOLOGICAL RESEARCH INSTITUTE

LICENSE NO. R-84

DOCKET NO. 50-170

The U. S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-84 for the Armed Forces Radiobiology Research Institute (AFRRI) TRIGA reactor, dated June 24, 2004 and supplemented by letter dated March 4, 2010.

Please address and provide the requested information to the following:

1. NUREG 1537, Part 1, Section 4.3, Reactor Tank or Pool recommends that the applicant present all information about the pool necessary to ensure its integrity and should assess the possibility of uncontrolled leakage of contaminated primary coolant and should discuss preventive and protective features. Chapter 4, Section 4.3 of the Safety Evaluation Report (SAR) does not provide this information.

    a) Please discuss the reactor pool water level monitoring system, alarm levels and required responses from operator and/or university personnel, if remote alarm signal is present.
    b) Discuss the steps taken to monitor pool and heat exchanger integrity.
    c) Please provide an estimate of the minimum detectable amount of leakage and an estimate of how long such a leak could exist before detection.
    d) Please discuss potential release pathways of reactor pool water leakage to the environment and the radiological impact of a release.

2. NUREG-1537, Part 1, Section 4.5 recommends analyses of planned core configurations. The AFRRI core can be positioned at numerous locations within the reactor tank and reflector conditions change as the core is repositioned. Specify how these conditions are accounted for in the neutronic calculations presented in Section 4 of the SAR. What effect does moving the core to the North, the South, or the middle have on the reactivity values? What are the measured values of the excess reactivity at all three positions? At what location was the excess reactivity presented in Table 4-9 of the SAR measured?

3. NUREG-1537, Part 1, Section 4.6 recommends that an applicant should justify the assumptions and methods, and validate the results. Discuss the BLOOST code transient analysis in additional detail including the quantitative values of the major parameters that enter the analysis. This should include the flux peaking factors used to represent the hottest fuel rod.

ENCLOSURE

4. NUREG-1537, Part 1, Section 13.1.1 provides guidance identifying as an acceptable Maximum Hypothetical Accident (MHA) for TRIGA reactors, the failure of one fuel element in air. The potential consequences of the postulated MHA scenario exceed and bound all credible accidents. Section 13.2.3 of the SAR discusses the Design Basis Accidents (DBA) providing dose consequences to members of the public. The SAR does not specifically present an MHA analysis. Instead two DBA analyses are presented, which incorporate assumptions that result in doses that appear to not be bounding. Identify an MHA scenario whose potential consequences bound all credible accidents.

   The analysis results should include delineation of locations, dose rates and accumulated doses to reactor operating staff, maximum exposed members of the public, at the nearest resident and at any other location of interest. Dose calculations should consider shine from the radioactive material plume and direct exposure from the radiation source within the reactor room. The results should meet the requirements of Title10 of the Code of Federal Regulations (10 CFR) Part 20.

5. NUREG-1537, Part 1, Section 13.1.2 provides guidance to the licensee to identify all potential methods whereby excess reactivity could be accidentally inserted into the reactor to cause an excursion. Please discuss these potential methods and evaluate those found to be credible. At a minimum, analyze a ramp insertion of reactivity of the most reactive control rod (not the transient rod) at its maximum insertion rate, starting from the most limiting power level. Evaluations should include discussion of the model, assumptions and calculation results.

6. NUREG-1537, Part 1, Section 13 provides guidance to the licensee to discuss potential accident scenarios. Section 13.1.5 of the SAR presents the results of an analysis of a reactivity insertion of $0.51. Justify the magnitude of this assumed reactivity insertion in comparison with the maximum reactivity insertion associated with any single experiment.

7. NUREG-1537, Part 1, Section 13.1.4 provides guidance to the licensee to discuss scenarios of loss of coolant flow resulting from blocked fuel cooling channels. Discuss procedures for foreign material exclusion from entry to the reactor pool in order to prevent blockage of coolant channels. Include discussion of any other blockage-mitigating design features.

8. NUREG-1537, Part 1, Section 13.1.5 provides guidance to licensees to systematically analyze and discuss credible accidents in each accident category. Identify potential scenarios that could lead to accidents involving mishandling or malfunction of fuel. Analyze scenarios that are judged credible.

9. NUREG-1537, Part 1, Section 13.1.8 provides guidance to the licensee to demonstrate that the reactor can withstand external events and the potential associated accidents. Identify potential external events and demonstrate that the external event consequences show compliance with the regulations in 10 CFR Part 20.

10. NUREG-1537, Part 1, Section 13.1.7 provides guidance to the licensee to discuss events that could result from loss of normal electrical power. Demonstrate that the loss of power does not pose an unacceptable risk to the health and safety of the public.

11. NUREG-1537, Part 1, Section 13.1.9 provides guidance to the licensee to identify any initiating events that could fall under the category of equipment malfunction or mishandling. Identify any potential additional events under the category of mishandling or malfunction of equipment. Discuss the potential impact of malfunctions of the lead shield doors and identify any such malfunctions that have occurred during the operating history of the AFRRI.

12. NUREG-1537, Part 1, Section 13.1.6 provides guidance to the licensee to discuss events that could result from experiment malfunction. The licensee is requested to justify its assumption that the release of irradiated Argon accident scenario is the worst conceivable case for radiological consequences from an experiment. The licensee should present the range of experimental malfunction accidents considered. The Argon activation assumptions and calculations should be presented in more detail.

13. NUREG-1537, Part 1, Section 13.1.3 provides guidance to licensees to systematically analyze and discuss credible accidents in each accident category. Section 13.2.1.4 of the SAR describes the radiation levels in the reactor floor and the roof areas due to the unshielded reactor core after a postulated large loss-of-coolant accident event. The analysis also provides the consequent maximum dose rates at various locations on the reactor floor and the reactor building roof. Please provide accumulated doses to reactor building occupants and the maximally exposed member of the public considering any evacuation procedure and potential residence time for staff. The results should show compliance with the regulations in 10 CFR Part 20.

NUREG-1537, Part 1, Appendix 14.1 suggests that the format and content of the proposed Technical Specifications (TS) follow the recommendations of the standard ANSI/ANS-15.1, “The Development of Technical Specifications for Research Reactors.” The current version of the standard is ANSI/ANS-15.1-2007 and is the basis for the questions below.

14. TS 1.0, Definitions: ANSI/ANS-15.1-2007, Section 1 defines Reactor Secured and Reactor Shutdown. Please evaluate AFRRI TS 1.19 against the standard definition of Reactor Secured and TS 1.20 against the standard definition of Reactor Shutdown. Propose changes to meet ANSI/ANS-15.1-2007 or justify your definitions.

15. TS 1.0. Definitions: ANSI/ANS-15.1-2007, Section 1 provides a definition of Reference Core Condition. TS 1.5 defines Cold Critical at 40ºC with no specific condition for Xenon reactivity. Please evaluate the definition of Cold Critical against the ANSI/ANS-15.1-2007 standard definition for Reference Core Condition and propose and justify a definition that can be applied to the Limiting Conditions for Operations (LCO) for Excess Reactivity and Shutdown Margin in TS 3.1.3, or justify the current definition.

16. TS 1.0. Definitions: ANSI/ANS-15.1-2007, Section 1 provides definitions for key terminology utilized in technical specifications. Please include definitions of Excess Reactivity, Scram Time, Shall, Should and May, Secured Experiment, and Movable Experiment, in TS 1.0 Definitions, or provide a basis for not defining these terms.

17. TS 1.0. Definitions: ANSI/ANS-15.1-2007, Section 6.7.2 provides a schedule of events that require special reports. The Reportable Occurrence definition in TS 1.21(c) which addresses these special reports is not consistent with the guidance that specifies "malfunction caused by maintenance" instead of "malfunction discovered during tests." Please propose changes or justify not doing so.

18. TS 3.1.2: ANSI/ANS-15.1-2007, Section 3.1(3) provides guidance for the LCO for pulse limits. In TS 3.1.2, the LCO for pulse mode operation specifies the maximum step insertion of reactivity shall be $4.00 in the pulse mode. Analyses performed by the licensee indicate that this magnitude pulse may achieve a peak fuel temperature that exceeds the fuel vendor's recently recommended peak temperature of 830°C during pulse mode operation. Please analyze and discuss how TS 3.2.1 should be revised to meet the fuel vendor recommendation.

19. TS 3.1.3.b: ANSI/ANS-15.1-2007, Section 3.1(4) indicated that limits shall be established for core configurations. NUREG-1537, Appendix.14.1, Section 3.1(4) specifies that a special core configuration should be included in the LCOs for the condition when control rods need to be removed from the core for maintenance or other purpose. How does AFRRI control the core configuration when removing a control rod from the core in order to maintain the shutdown margin as required by TS 3.1.3.b?

20. TS 3.2.1, Table 1: ANSI/ANS-15.1-2007, Section 3.2 provides guidance for the reactor control and safety systems. In Table 1 in TS 3.2.1 identifies a Pulse Energy Integrating Channel. This instrument is not described in the SAR. Please clarify.

21. TS 3.2.1: ANSI/ANS-15.1-2007, Section 3.2(1) provides guidance that the minimum number of operable control rods shall be specified for operation of the facility. Please indicate in TS 3.2.1 that the reactor shall not be operated unless the control rods specified in TS 5.2.2.b are operable or justify why this is not needed.

22. TS 3.2.2, Table 2: ANSI/ANS-15.1-2007, Section 3.2 provides guidance for the reactor control and safety systems. Table 2 in TS 3.2.2 specifies that a total of three Emergency Stop switches be provided, one at each exposure room and one in the main console. As stated in the TS, the purpose of these switches is to allow personnel in an exposure room or the reactor operator to stop actions through the interlock system. However, TS Table 2 appears to indicate that only one of the three switches is needed for reactor operation. It is not clear how the availability of only a single switch would be sufficient to satisfy the safety function of these switches. Please clarify.

23. TS 3.2.2, Table 3: ANSI/ANS-15.1-2007, Section 3.2 provides guidance for the reactor control and safety systems. Table 3 in TS 3.2.2 identifies an interlock to prevent pulse initiation at power levels greater than 1 kW. Can this interlock be manually overridden? Is there a written procedure to instruct the operator in the function and operation of this interlock? Is there periodic surveillance on this interlock?

24. TS 3.2.2, Table 3: ANSI/ANS-15.1-2007, Section 3.2 provides guidance for the reactor control and safety systems. Table 3 in TS 3.2.2 specifies the minimum reactor safety system interlocks that are required. However, three interlocks listed in the SAR are not included in Table 3, specifically the high voltage to fission detector, water temperature < 60ºC, and period > 3 s interlocks. Please propose the addition of these interlocks to the TSs or justify why these interlocks are not included in Table 3.

25. TS 3.5.2.b: 10 CFR 20.1101(d) specifies an ALARA constraint of 10-mrem TEDE for the public. Explain how the TS 3.5.2(b) exposure limit of 90 mrem complies with the 10-mrem ALARA constraint.

26. TS 3.6.c: Regulatory Guide 2.2, Section C.1.c(3) states that the “materials of construction and fabrication and assembly techniques should be so specified and used that assurance is provided that no stress failure can occur at stresses twice those anticipated in the experiment.” TS 3.6(c) allows explosive materials in quantities less than 25 mg to be irradiated in the reactor in a container “provided that the detonation pressure has been calculated and/or experimentally demonstrated to be less than the design pressure of the container.” Please discuss how AFRRI will ensure a safety factor of two in TS 3.6(c) for this type experiment and other experiments. In addition, please provide the reference used to determine if materials are explosive materials.

27. TS 3.6.e: ANSI/ANS-15.1-2007, Section 3.8.1(1) guidance includes establishing a LCO for the maximum absolute value of the reactivity worth of individual experiments. TS 3.6(e) establishes a limit for the sum of all experiments in the reactor, but no limit is specified for a single experiment. Please propose and justify LCOs regarding the reactivity of individual experiments in the reactor, both secured and moveable or justify why such LCOs are not needed.

28. TS 4.1: ANSI/ANS-15.1-2007, Section 4.2(8) recommends that a thermal power calibration be done at least annually. Please clarify that the surveillance in TS 4.2.2.c includes a thermal power calibration.

29. TS 4.2.1: ANSI/ANS-15.1-2007, Section 4.2 (4) specifies surveillance for scram times of control rods. The surveillance requirement for control rod drop times is in TS 4.2.1. TS 4.2.1 requires that control rod drop times be measured semiannually. This TS does not include "or after any work is done on rods or rod drive system" which is specified in the guidance. Please propose and justify TS to meet the guidance or justify why this is not needed.

30. TS 4.3: ANSI/ANS-15.1-2007, Section 4.3(4) recommends that the reactor coolant be analyzed for radioactivity annually, if necessary. Please propose and justify a specification to TS 4.3 for periodic analysis of the coolant for radioactivity or provide a basis for why such a surveillance specification should not be required.

31. TS 4.4: ANSI/ANS-15.1-2007, Section 4.5 provides guidance for surveillances on ventilation system filter efficiency measurements and an operability check of any emergency exhaust systems. Please discuss whether the TS 4.4 is consistent with the standard guidance.

32. TS 5.3: ANSI/ANS-15.1-2007, Section 5.4 provides guidance for the k_{eff} in the storage of fissionable material; however, TS 5.3 does not specify a value. Please specify the k_{eff} value to which the fuel storage racks are designed or justify why this is not needed.

33. TS 6.0: 10 CFR 20.1101(a) requires that each licensee develop, document, and implement a radiation protection program. NUREG-1537, Chapter 12.1 states that the organization should meet the non-power reactor standard ANSI/ANS-15.1-2007. ANSI/ANS-15.1-2007, Section 6.3 states that the facility shall implement a radiation protection program in accordance with the guidelines in ANSI/ANS-15.11. Please discuss whether the TS meets the criteria in 10 CFR 20.1101(a)-(c) and ANSI/ANS-15.1-2007, Section 6.3.

34. TS 6.1.3.2.b: ANSI/ANS-15.1-2007, Section 6.1.3.3 provides guidance for events requiring the presence at the facility of the senior reactor operator. TS 6.1.3(b) only specifies “maintenance activities that could affect the reactivity of the reactor.” The other items listed in ANSI/ANS-15.1-2007, Section 6.1.3.3 that require Senior Reactor Operator supervision, such as (1) initial startup and approach to power, (2) recovery from unplanned or unscheduled shutdown or significant power reduction, and (3) refueling should be specified in order to comply with the requirements of 10 CFR 50.54(m)(1).

35. TS 6.2.3.3: ANSI/ANS-15.1-2007, Section 6.2.2(2) provides guidance for establishing a quorum for a meeting of the Reactor and Radiation Facility Safety Committee (RRFSC). Please explain how the RRFSC quorum satisfies the ANSI 6.2.2 (2) criterion that quorums are “not less than one-half of the voting membership where the operating staff …does not constitute a majority.”

36. TS 6.3: ANSI/ANS-15.1-2007, Section 6.4 provides guidance requiring written procedures be approved by specified personnel prior to initiating activities listed in said Section. TS 6.3 states that the Reactor Facility Director can make substantive changes to procedures and the Reactor Operations Supervisor can make temporary changes to procedures. Please clarify that both types of changes are documented and subsequently reviewed with respect to 10 CFR 50.59 by the RRFSC.

37. TS 6.5.2: ANSI/ANS-15.1-2007, Section 6.7.2.1 provides guidance on licensee actions following a reportable occurrence. It is not specified in the TS who can authorize restart of the reactor after a reportable occurrence where the reactor was shut down.

38. TS 6.5.2: ANSI/ANS-15.1-2007, Section 6.7.2.1 provides guidance for a follow-up written report following a reportable occurrence. TS 6.5.2 should specify the 14-day time frame for the follow-up written report.

39. TS 6.6: ANSI/ANS-15.1-2007, Section 6.7.2.2 provides guidance for the requirement for a written report within 30 days to the NRC for permanent changes in the AFRRI organization involving Level I or II personnel and significant changes in transient or accident analyses as described in the SAR. This requirement does not appear in TS 6.6.

40. TS 6.7.3: ANSI/ANS-15.1-2007, Section 6.8.3 provides guidance for the requirement to retain records for the lifetime of the facility. Please add to records retained for the life of the facility the following: “Reviews and reports pertaining to a violation of a Safety Limit, Limiting Safety System Setting, or an LCO.”

41. 10 CFR 50.59(c)(5)(i) requires that the facility licensee shall retain operator requalification documentation records until the operator's license is renewed. In addition, Section 6.8.2 of ANSI/ANS 15.1-2007 contains the requirement that training records for reactor operators be maintained at all times the individual is employed or until the certification is renewed. TS 7.6.2 specifies that operator requalification records are maintained for a training cycle, which usually does not coincide with the operator license renewal cycle. Please discuss whether TS 6.7.2 meets the criteria in 10 CFR 55.59(c)(5)(i) and ANSI/ANS-15.1-2007, Section 6.8.2