TEXAS A&M ENGINEERING EXPERIMENT STATION
NUCLEAR SCIENCE CENTER

TEXAS A&M UNIVERSITY

Dr. Sean M. McDeavitt
Director, TEES Nuclear Science Center
Texas A&M University
Texas A&M Engineering Experiment Station
1095 Nuclear Science Road, M/S 3575
College Station, TX 77843-3575

November 18, 2015

2015-0064
Docket Number 50-128 / License No. R-83

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

SUBJECT: RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION FROM THE NRC, DATED NOVEMBER 9, 2015 REGARDING THE RECEIPT OF SPECIAL NUCLEAR MATERIAL AT THE NUCLEAR SCIENCE CENTER FROM THE AGN-201M REACTOR

Attn: Mr. Alexander Adams, Jr., Chief
Research and Test Reactors Branch
Office of Nuclear Reactor Regulation

Mr. Patrick Boyle, Project Manager
Research and Test Reactors Branch
Office of Nuclear Reactor Regulation

The purpose of this letter is to respond to the NRC Request for Additional Information, dated November 9, 2015. Attached is the response to the questions received from the NRC Staff following their review of the License Amendment Request to receive and store Special Nuclear Material and reactor components from the AGN-201M, dated October 14, 2015, (ADAMS Accession No. ML 15287A). While the Texas A&M staff believe the response is very thorough, there were a few instances in which specific data could not be obtained and thus we used conservative, bounding assumptions and this is presented in the attached responses. In addition, two Technical Specifications changes were made in the definition section and those pages are also attached.

Should you have any questions, please contact me or Mr. Jerry Newhouse at 979-845-7551 or via email at mcdeavitt@tamu.edu or newhouse@tamu.edu.

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. [979] 845-7551

Oath of Affirmation
I declare under penalty of perjury that the foregoing is true and correct. Executed on November 18, 2015.

Sincerely,

Sean M. McDeavitt

Sean M. McDeavitt, PhD.
Director, TEES Nuclear Science Center

Attachments: TAMU Responses to RAIs received on November 09, 2015
Recommended TS replacement pages incorporating new definitions

Debra Greer
Notary Public,
State of Texas
Expires: 06/01/2019

Debra Greer
11-18-15

Nuclear Science Center
1095 Nuclear Science Road, 3575 TAMU
College Station, TX 77843-3575
Tel. [979] 845-7551

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Responses to Request for Additional Information

Questions 1, 2, and 3

RAI-1: *"NUREG-1537, Section 9.2, "Handling and Storage of Reactor Fuel," provides guidance for the margin to criticality in a fuel storage location. The existing Safety Analysis Report for the NSC TRIGA reactor contains an analysis, for the storage vault, indicating a maximum k-effective (k_{eff}) of 0.45526 for the LEU 30/20 fuel in flooded conditions and a k_{eff} of 0.12994 in air. In your amendment request Section 4.0, "Storage," the following assertion is made regarding the safety analysis of the fuel storage vault:*

> *... these 4 storage tubes were modeled as containing up to 2.39 kilograms of 235U in low-enriched NSC reactor fuel [i.e., a 4-element bundle], or approximately 3.5 times the quantity of AGN-201M fissile material to be stored.*

The Uranium-235 (U-235) contained in the AGN fuel is in a different chemical form and physical geometry than the TRIGA fuel as only about 0.7 kilograms (kg) of U-235 is required to obtain criticality for the AGN fuel versus the nearly 8.8 kg of U-235 required for the TRIGA fuel to achieve criticality. The 30/20 TRIGA fuel also contains Erbium, a burnable poison, which is not present in the AGN fuel and further reduces the k_{eff} of the fuel in the storage location. Provide an analysis for this storage location specific to the AGN fuel type or provide a justification, considering the differences in material design, that this is not required. The analysis needs to include optimal moderation effects for flooding in the room and the storage of fuel or other materials near the AGN fuel, as allowed, unless otherwise restricted."

Response to RAI-1

SCALE/KENO-VI modeling software was used to examine the reactivity of approximately 50% the AGN-201M fuel discs (312 fissile grams) in the package configuration proposed for storage, and under a variety of conditions. A multi-region cell model was used for the evaluations. Absorbers and reflectors were configured as concentric cylinders around the 5-gallon fuel package. Use of a borated aluminum absorber (nominally 14% boron used for commercial reactor high density fuel racks) was also evaluated. The results are tabulated below. Given the design of the AGN-201M fuel in which the moderator (polyethylene) is intimately mixed with the 20%-enriched uranium fuel, the presence of water or concrete around the package provides only an incremental increase in reactivity. As a test of the model, the final case is an evaluation of the entire AGN-201M core, simplified by excluding penetrations and non-fuel materials in the actual core (e.g., experiment tube and control rod drive mechanisms). Results for the test case were as expected, with a k_{eff} of 1.0724.

Scenario	Configuration	k_{eff}	+/-
1	312 g fuel in can with no absorber, with 12-in air	0.5399	0.0018
2	312 g fuel in can with 1/8-in borated Al absorber, with 12-in air	0.5407	0.0018
3	312 g fuel in can with 1/8-in borated Al absorber, with 12-in water	0.5512	0.0019
4	312 g fuel in can with 1/8-in borated Al absorber, with 12-in concrete	0.5682	0.0017
5	312 g fuel in can, no absorber, with 12-in water +12-in concrete	0.6665	0.0024
6	312 g fuel in can with 1/8-in borated Al absorber, 12-in water + 12-in concrete	0.6356	0.0017
TEST	~665 g fuel in 0.7 mm Al core tank, 20 cm graphite reflector, 10 cm lead	1.0724	0.0019

As noted in the LAR, TEES proposes storing the two AGN-201M fuel storage drums, each containing nominally 50% of the fuel, on the floor in opposite corners of the NSC fuel storage vault placed under the existing NSC fuel storage tubes. The nominal 15 feet of separation effectively renders the two drums stand-alone items. The four AGN safety and control elements containing approximately 40 fissile grams of fuel will be stored in the existing NSC fuel storage tubes (1 per tube).

There is no fresh (unirradiated) NSC fuel currently stored in the NSC fuel storage vault, and given the very long expected operating life for the current NSC fuel, there is no anticipated need for refueling the NSC reactor in the foreseeable future. Accordingly, TEES will administratively restrict the receipt and storage of fresh (unirradiated) NSC fuel during the AGN-201M fuel storage interval, unless additional criticality safety analyses of the NSC fuel storage vault are developed to support it.

The 1 Ci (16 gram) PuBe source will present a very low fluence rate of approximately 14 n/cm^2s at a distance of 1 meter when in open air[1]. This source will be stored in the fuel storage vault and in an appropriate shield for personnel exposure management. Source shielding will result in an additional reduction in associated neutron fluence rate.

In summary, TEES concludes that further analysis of the proposed AGN-201M fuel storage supports the assertion that reactivity under the conditions described will be well under the 0.8 limit specified in Technical Specification 5.6.

RAI-2: *"In your amendment request, Enclosure 1a, "Proposed License Change for the NSC Facility," suggests a new Section B.5, to receive and possess, but not use the U-235 contained in the Aerojet General Nucleonics (AGN) fuel and the plutonium-239 (Pu-239) in the form of a Pu-239/Beryllium source. However, since the AGN fuel contains U-238 and has been operated for many years some Pu-239 will be present in the AGN fuel. Propose revised wording for Section B.5, license condition to address the presence of the Pu-239 in the AGN fuel or provide justification for why this is not necessary."*

[1] *Health Physics and Radiological Health Handbook, Johnson and Birky, pp. 56 and 340, Wolters Kluwer Lippincott Williams & Wilkins.*

Response to RAI-2

The estimated 239Pu mass in the AGN-201M reactor fuel is approximately 52 micrograms, equivalent to approximately 3.3 microcuries of activity. These values were derived as follows:

1. Annual power history data from 1972 to present yields a total energy production of 1.3E3 watt-hours.
2. Historical data for 1957 through 1971 is not as detailed and reactor operation has been estimated based upon the maximum annual operating hours in the latter time frame, and assuming operation at full authorized power (prior to 1972) of 100 milliwatts. This estimate yields an additional 170 watt-hours
3. The total lifetime energy produced is conservatively estimated to be a maximum of 1500 watt-hours.
4. Lamarsh & Baratta[2] estimate the relationship between energy produced (thermal) and fission rate to be 2.7E21 fissions per megawatt-day, or 1.1E14 fissions per watt-hour.
5. Assuming a conservative 0.8 neutrons per fission are utilized in 238U capture that leads to 239Pu yields 1.3E17 atoms of 239Pu.
6. Given the half-life of 239Pu is 24,100 years, there has been no significant decay in the 239Pu produced in the AGN-201 core over its operating history.
7. The resulting mass of 239Pu is approximately 52 micrograms:

$$\text{mass, g} = \left(1.3\text{E}17 \text{ atoms}\right) \times \left(239 \ {}^{amu}\!/_{atom}\right) \times \left(1.66\text{E}-24 \ {}^{g}\!/_{amu}\right)$$

Given the small quantity of 239Pu produced to date, and that successive neutron capture events are necessary to produce the heavier Pu isotopes, the presence of Pu is not a contributor to reactivity margin associated with the stored fuel and need not be further addressed in analysis of the proposed storage. Based on the documentation presented, TEES believes the wording in Section B.5 is adequate.

RAI-3: *"In your amendment request, Enclosure 2a, "Proposed Technical Specification Change," the terms "AGN-201M fuel" and "neutron start-up source" are not defined. Propose wording for the definition section of the technical specification (TS), propose wording that adds a material description to Section 5.6 TS, or explain why this is not required."*

Response to RAI-3

The following definitions are incorporated in the definition section of the Technical Specifications. Recommended replacement pages incorporating these definitions are attached.

- **AGN-201M neutron start up source:** A plutonium-beryllium (α,n) source used in the AGN-201M reactor to ensure the detectors are in their normal operating range and to verify operation of the low level interlock.

- **Fuel – AGN-201M:** UO_2 enriched to <20% 235U mixed with polyethylene and pressed into cylindrical discs and fueled control rod ends, and 0.4 grams of 235U mixed with polystyrene.

[2] *Lamarsh & Baratta, Introduction to Nuclear Engineering, 3rd edition, 2001, p. 90.*

TECHNICAL SPECIFICATIONS

1 Introduction

1.1 Scope

This document constitutes the Technical Specifications for the Facility License No. R-83 as required by 10 CFR 50.36 and supersedes all prior Technical Specifications. This document includes the “bases” to support the selection and significance of the specifications. Each basis is included for information purposes only. They are not part of the Technical Specifications, and they do not constitute limitations or requirements to which the licensee must adhere.

1.2 Format

These specifications are formatted to NUREG-1537 and ANSI/ANS 15.1-2007.

1.3 Definitions

AGN-201M neutron start up source

A plutonium-beryllium (α,n) source used in the AGN-201M reactor to ensure the detectors are in their normal operating range and to verify operation of the low level interlock.

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ALARA

The ALARA program (As Low as Reasonably Achievable) is a program for maintaining occupational exposures to radiation and release of radioactive effluents to the environs as low as reasonably achievable.

Audit

An audit is a quantitative examination of records, procedures, or other documents after implementation from which appropriate recommendations are made.

Channel

A channel is the combination of sensors, lines, amplifiers, and output devices that are connected for the purpose of measuring the value of a parameter.

Channel Test

A channel test is the introduction of a signal into the channel to verify that it is operable.

Channel Calibration

A channel calibration is an adjustment of the channel such that its output corresponds, with acceptable accuracy, to known values of the parameter that the channel measures. Calibration shall encompass the entire channel, including equipment actuation, alarm, or trip and shall be deemed to include a channel test.

Fuel Bundle

A fuel bundle is a cluster of two, three, or four fuel elements and/or non-fueled elements secured in a square array by a top handle and a bottom grid plate adapter. Non-fueled elements shall be fabricated from stainless steel, aluminum, boron, or graphite materials.

Fuel Element

A fuel element is a single TRIGA fuel rod of LEU 30/20 type.

Fuel – AGN-201M

UO_2 enriched to < 20% ^{235}U mixed with polyethylene and pressed into cylindrical discs and fueled control rod ends, and 0.4 grams of ^{235}U mixed with polystyrene.

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Instrumented Fuel Element (IFE)

An instrumented fuel element is a special fuel element in which one or more thermocouples are embedded for the purpose of measuring the fuel temperatures during operation.

License

The written authorization, by the U.S. NRC, for an individual or organization to carry out the duties and responsibilities associated with a personnel position, material, or facility requiring licensing.

Licensee

A licensee is an individual or organization holding a license.

LEU Core

An LEU core is an arrangement of TRIGA-LEU fuel in a reactor grid plate.

Limiting Safety System Setting (LSSS)

The limiting safety system setting is the fuel element temperature, which if exceeded, shall cause a reactor scram to be initiated, preventing the safety limit from being exceeded.

Measured Value

A measured value is the value of a parameter as it appears on the output of a channel.

Operable

Operable means a component or system is capable of performing its intended function.

Operating

Operating means a component or system is performing its required function.