May 25, 2016

Dr. Ayman I. Hawari, Director
Nuclear Reactor Program
Department of Nuclear Engineering
North Carolina State University
Campus Box 7909
Raleigh, NC 27695-7909

SUBJECT: NORTH CAROLINA STATE UNIVERSITY – U.S. NUCLEAR REGULATORY COMMISSION ROUTINE INSPECTION REPORT NO. 50-297/2016-201

Dear Dr. Hawari:

From April 25–27, 2016, the U.S. Nuclear Regulatory Commission (NRC or the Commission) conducted an inspection at the North Carolina State University Nuclear Reactor Facility. The inspection included a review of activities authorized for your facility. The enclosed report documents the inspection results, which were discussed on April 27, 2016, with you and members of your staff.

The inspection examined activities conducted under your license as they relate to the conduct of operations, and compliance with the Commission's rules and regulations and with the conditions of your license. The inspector reviewed selected procedures and records, observed activities, and interviewed personnel. Based on the results of this inspection, no safety concerns or violations of NRC requirements were identified. No response to this letter is required.

In accordance with Title 10 of the *Code of Federal* Regulations Section 2.390, "Public inspections, exemptions, requests for withholding," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC's Public Document Room or from the Publicly Available Records component of NRC's document system (Agencywide Documents Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, please contact Johnny Eads at 301-415-0136 or by electronic mail at Johnny.Eads@nrc.gov.

Sincerely,

/RA/

Anthony J. Mendiola, Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-297
License No. R-120

Enclosure:
As stated

cc: w/encl: See next page

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U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No.	50-297
License No.	R-120
Report No.	50-297/2016-201
Licensee:	North Carolina State University
Facility:	PULSTAR Nuclear Reactor Facility
Location:	Raleigh, NC
Dates:	April 25 -27, 2016
Inspector:	Johnny Eads
Approved by:	Anthony J. Mendiola, Chief Research and Test Reactors Oversight Branch Division of Policy and Rulemaking Office of Nuclear Reactor Regulation

Enclosure

EXECUTIVE SUMMARY

North Carolina State University
PULSTAR Reactor Facility
NRC Inspection Report No. 50-297/2016-201

The primary focus of this routine, announced inspection was the onsite review of selected aspects of the North Carolina State University (the licensee) Class II research reactor facility safety programs including: (1) organization and staffing, (2) operations logs and records, (3) experiments, (4) health physics, and (5) transportation. The licensee's programs were acceptably directed toward the protection of public health and safety and were in compliance with U.S. Nuclear Regulatory Commission requirements.

Organization and Staffing

- Organizational structure and responsibilities were consistent with Technical Specification (TS) requirements. Shift staffing met the minimum requirements for current operations.

Operations Logs and Records

- Operation logs and the licensee's record keeping program conformed to TS requirements.

Experiments

- Experiments were reviewed and performed in accordance with TS requirements and the licensee's written procedures.

Health Physics

- The licensee's radiation protection program was effective in minimizing radiation doses to individuals through training, notices to workers, radiation monitoring and surveys, and calibrated equipment.

Transportation

- Radioactive material shipments were made according to procedures and regulatory requirements.

REPORT DETAILS

Summary of Facility Status

The North Carolina State University (NCSU or the licensee) Nuclear Reactor Program (NRP) PULSTAR research reactor continued to be operated in support of graduate and undergraduate research and laboratory instruction, service irradiations, reactor operator training, and periodic surveillance. During the inspection, the reactor was operated in support of ongoing work and research.

1. Organization and Staffing

a. Inspection Scope (Inspection Procedure (IP) 69001)

The inspector reviewed selected aspects regarding the licensee's organization and staffing to ensure that the requirements of Technical Specification (TS) 6.1, "Organization," implemented through License Amendment No. 17 to the Facility License No. R-120, dated September 8, 2008, were being met the inspector reviewed the following:

- Organizational structure
- Management responsibilities
- Staffing requirements for safe operation of the research reactor facility
- PULSTAR Reactor Logbook, January 2015 through present
- Procedure NRP-OP-103, "Reactor Operation," Revision (Rev.) 3, dated July 3, 2013

b. Observations and Findings

The licensee's functional organization had not changed since the last U.S. Nuclear Regulatory Commission (NRC) inspection in this area (refer to Inspection Report No. 50-297/2014-201). The minimum staffing required when the reactor is not secured is specified in TS 6.1.3, "Minimum Staffing." The inspector reviewed the console records for the period covering January 2015 through present and determined that staffing requirements were met.

c. Conclusion

The licensee's organization and staffing were in compliance with the requirements specified in TS 6.0, "Administrative Controls." The operations log and associated records confirmed that shift staffing met the minimum requirements for duty and on call personnel.

2. Operations Logs and Records

a. Inspection Scope (IP 69001)

The inspector reviewed selected maintenance and reactor operations records to ensure that the requirements of TS 6.8, "Retention of Records," were being met the inspector reviewed the follow:

- Procedure NRP-OP-103, “Reactor Operation,” Rev. 3, dated July 3, 2013
- NCSU PULSTAR Reactor Logbook, January 2015 through present

b. Observations and Findings

Reactor operations were carried out following written procedures and TS requirements. The inspector conducted observations of the reactor staff performing pre-startup checks and a startup.

The reactor operations logbook, an official record of reactor operations, was used as a chronological account of operations. The use of multicolor pens, black (routine entries), red (unscheduled scrams/shutdowns), and green (for scram clearance and authorization for continued operations) facilitated subsequent reviews by management. Hourly readings from operating equipment were recorded in the Operating Parameters Log. This data was used for preemptive maintenance to prevent equipment failures during operation. In addition, equipment maintenance records contained detailed information regarding equipment failures, the failure mode, repairs, calibrations, and operational testing prior to return to service. The factors used to calculate the estimated critical position of the control rods during reactor startup were also recorded appropriately. For the records included in this review, the licensee’s administrative requirements were met.

c. Conclusion

The licensee’s record keeping program conformed to TS requirements.

3. Experiments

a. Inspection Scope (IP 69001)

To verify compliance with TS 3.7, “Limitations of Experiments,” TS 3.8, “Operations with Fueled Experiments,” and TS 6.5, “Review of Experiments,” the inspector reviewed selected aspects of the following:

- Experiment Logbook
- Procedure NRP-OP-104, “Reactor Experiments,” Rev. 4, dated August 1, 2015
- Experiment Records, 2015 and 2016

b. Observations and Findings

The licensee maintained an Experiment Logbook consisting of two sections. The first section consisted of completed forms entitled “Appendix A to Procedure NRP-OP-104, Reactor Utilization Request.” It contained approved experiments for miscellaneous reactor utilization and experiments for neutron activation analysis, neutron irradiation, and neutron flux mapping.
These experiments had been approved throughout the life of the NRP by the Radiation Safety Committee or the Reactor Safety and Audit Committee in accordance with TS 6.2, “Review and Audit.” The approvals were written and

approved pursuant to TS 6.5, "Review of Experiments," as new or untried experiments; they were written to provide an umbrella for subsequent applications, with minor variations, as tried experiments approved by the Reactor Operations Manager (ROM) and the Reactor Health Physicist (RHP) pursuant to TS 6.5.

The second section of the Experiment Logbook consisted of forms entitled "Appendix B to Procedure NRP-OP-104, Reactor Sample Irradiation History." Each time a tried experiment was performed, one line of data was added to this form, indicating the type of material irradiated, the quantity, the irradiation time, power level, etc. The ROM and RHP indicated that they reviewed each tried experiment prior to giving their approval to place it in the reactor.

c. Conclusion

Experiments were reviewed and performed in accordance with TS requirements and the licensee's written procedures.

4. Health Physics

a. Inspection Scope (IP 69001)

To verify compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 "Standards for Protection Against Radiation," TS 3.5, "Radiation Monitoring Equipment," and TS 4.4, "Radiation Monitoring Equipment," the inspector reviewed selected aspects of the following:

- PULSTAR Nuclear Reactor Annual Report for 2015
- PULSTAR Nuclear Reactor Radiation Protection Program 2015 Annual Self-Assessment
- Landauer Personnel Dosimetry Reports for 2015
- File of Radiation Work Permits for 2015
- File of Weekly Contamination Surveys for 2015
- File of Monthly Radiation Surveys for 2015
- PULSTAR Reactor Environmental Radiation Surveillance Report for 2015
- Sampling, Analysis, and Assessment of Liquid Effluent and Airborne Effluent data, for 2015

b. Observations and Findings

The inspector toured the facility, finding practices regarding the use of dosimetry, radiation monitoring equipment, placement of radiological signs and postings, use of protective clothing, and the handling and storing of radioactive material or contaminated equipment to be in accordance with regulations and the licensee's written Radiation Protection Program. The licensee had performed and documented annual self-assessments of the program as a tool for assuring radiation exposure was maintained as low as reasonably achievable.

The inspector reviewed records of radiation surveys of the nuclear reactor facility (NRF), performed by a Health Physics (HP) specialist from the Department of Environmental Health and Safety (EHS), and found them to be generally low and in line with facility postings and instrument readings. No unmarked radioactive material was found in the facility. A copy of the current NRC Form 3 notice to radiation workers required by 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," was posted at the entrance to the control room and reactor bay.

Dosimetry results were reviewed by the inspector, indicating doses to most NRF occupants to be minimal.

Radiation monitoring devices were found to be calibrated within the frequencies specified in procedures. The NRF personnel calibrated in-line process instrumentation, while the EHS calibrated all portable instruments.

The inspector noted from records that training was provided for radiation workers assigned to the NRF and individuals were not issued dosimetry or given access until the training was successfully completed.

The annual report referenced above described the gaseous, liquid, and solid waste generated at the NRF during the year 2015, with Argon-41 produced by the irradiation of atmospheric air being the only one of significance. The report presented the model, input data, assumptions, and summary of calculations for Argon-41 emissions. The inspector reviewed this information and concurred with the reported results. The inspector confirmed that liquid and solid radioactive waste was disposed of properly and in accordance with NRC requirements.

The licensee also reported the results of thermoluminescent dosimeters (TLDs) placed at locations around the NRF as environmental radiation monitors. In all cases the TLDs indicated that the license continued to comply with NRC requirements associated with releases of radioactivity to the environment. Surface water and vegetables were analyzed for indications of environmental impacts and showed no significant difference from background levels.

The inspector reviewed a previously identified Inspector Follow-Up Item (IFI) 50-297/2014-201-1 related to missing environmental TLD exposure data for the third and fourth quarters of 2012. The licensee determined that data from that time period was reported by the TLD processing vendor to be invalid and as such not included in the report. The inspector determined that licensee's analysis was accurate and verified that environmental monitoring results were being properly reported. Based on this review, IFI 50-297/2014-201-1 is considered closed.

The inspector also reviewed a previously identified Unresolved Item (URI) 50-297/2014-201-2 related to the adequacy of new environmental monitoring locations. The previous inspection identified that the environmental TLD data for the D.H. Hill Library location was not as expected, based on a comparison of the readings there to those taken at the reactor stack. The University subsequently relocated the environmental monitoring location from the library to a new location on the roof of the nearby Daniels building. The inspector determined that the

licensee's environmental monitoring program continues to comply with NRC requirements with the new TLD location. Based on this review, URI 50-297/2014-201-2 is considered closed.

c. Conclusion

The inspector verified that the licensee's radiation protection program was effective in minimizing radiation doses to individuals through training, notices to workers, radiation monitoring and surveys, and calibrated equipment. The program met regulatory requirements. Effluent releases, effluent monitoring, and environmental monitoring satisfied license and regulatory requirements.

5. Transportation

a. Inspection Scope (IP 86740)

The inspector interviewed personnel to verify compliance with regulatory and procedural requirements for transferring licensed material and reviewed the following:

- File of Radioactivity Material Shipments for 2015
- Procedure HP 6, "Transportation of Radioactive and Hazardous Material," dated September 25, 2003
- Hazardous Material Transfer and Shipment Summary (HP 6, Rev. 1, Attachment 2) for material shipped in 2015

b. Observations and Findings

The inspector reviewed documentation for shipments of radioactive material made in 2015. All of the shipments were low quantities of radioactivity. Many contained fractional gram quantities of special nuclear material that had been irradiated; others were radionuclides produced at the reactor for on-campus and off-campus researchers. The licensee had reviewed licenses of receivers to verify that they held current licenses to receive the material being shipped. In all cases, the shipping papers were found in order.

c. Conclusion

Radioactive material shipments were made according to procedures and regulatory requirements.

6. Exit Interview

The inspector presented the inspection results to licensee management at the conclusion of the inspection on April 27, 2016. The inspector described the areas inspected and discussed in detail the inspection observations. The licensee acknowledged the findings presented and did not identify as proprietary any of the material provided to or reviewed by the inspector during the inspection.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

A. Cook	Manager, Nuclear Reactor Program and Reactor Operations Manager
A. Hawari	Director, Nuclear Reactor Program
K. Kincaid	Chief of Reactor Maintenance
A. Orders	Radiation Safety Officer
G. Wicks	Reactor Health Physicist

INSPECTION PROCEDURES USED

IP 69001	Class II Research and Test Reactors

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

None

Closed

50-297/2014-201-1	IFI	Missing TLD exposure data for environmental monitoring locations
50-297/2014-201-2	URI	Adequacy of physical location for environmental monitoring on the D.H. Hill Library

PARTIAL LIST OF ACRONYMS USED

10 CFR	Title 10 of the *Code of Federal Regulations*
EHS	Department of Environmental Health and Safety
HP	Health Physics
IFI	Inspector Follow-up Item
IP	Inspection Procedure
NCSU	North Carolina State University
NRC	U. S. Nuclear Regulatory Commission
NRF	Nuclear Reactor Facility
NRP	Nuclear Reactor Program
RHP	Reactor Health Physicist
ROM	Reactor Operations Manager
TLD	Thermoluminescent dosimeters
TS	Technical Specification
URI	Unresolved Item