February 19, 2014

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

SUBJECT: NORTH CAROLINA STATE UNIVERSITY - NRC ROUTINE INSPECTION REPORT NO. 50-297/2014-201

Dear Dr. Hawari:

The U.S. Nuclear Regulatory Commission (NRC) conducted an inspection from January 21–23, 2014, at your North Carolina State University Nuclear Reactor Facility. The inspection included a review of activities authorized for your facility. The enclosed report presents the results of that inspection.

Areas examined during the inspection are identified in the enclosed report. Within these areas the inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observations of activities in progress. 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 Section 2.390, "Public inspections, exemptions, and requests for withholding," of Title 10 of the *Code of Federal* Regulations, a copy of this letter and its enclosure 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 Document Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) http://www.nrc.gov/reading-rm/adams.html.

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/

Gregory T. Bowman, 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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Test, Research, and Training
Reactor Newsletter
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U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No:	50-297
License No:	R-120
Report No:	50-297/2014-201
Licensee:	North Carolina State University
Facility:	PULSTAR Nuclear Reactor Facility
Location:	Raleigh, NC
Dates:	January 21–23, 2014
Inspector:	Johnny Eads
Approved by:	Gregory T. Bowman, Chief Research and Test Reactors Oversight Branch Division of Policy and Rulemaking Office of Nuclear Reactor Regulation

EXECUTIVE SUMMARY

North Carolina State University
PULSTAR Reactor Facility
NRC Inspection Report No. 50-297/2014-201

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 organization and staffing, operations logs and records, experiments, health physics, and 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 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 Technical Specification requirements.

Experiments

- Experiments were reviewed and performed in accordance with Technical Specification 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.

- One inspector follow-up item was identified associated with reporting of thermoluminescent dosimeter exposure data as part of the licensee's environmental monitoring program.

- One unresolved item was identified associated with the location of thermoluminescent dosimeters used as part of the licensee's environmental monitoring program.

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 the following regarding the licensee's organization and staffing to ensure that the requirements of Section 6.1 of Technical Specifications (TS), Amendment No. 17, dated September 8, 2008, were being met:

- Organizational structure
- Management responsibilities
- Staffing requirements for safe operation of the research reactor facility
- PULSTAR Reactor Logbook, January 2012 through present
- Procedure NRP-OP-103, "Reactor Operation," 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. 50-297/2012-201). The minimum staffing required when the reactor is not secured is specified in TS 6.1.3. The inspector reviewed the console records for the period covering January 2012 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 Section 6. 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 Section 6.8, "Retention of Records," were being met:

- Procedure NRP-OP-103, “Reactor Operation,” Rev. 3, dated July 3, 2013
- NCSU PULSTAR Reactor Logbook, January 2012 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)

The inspector reviewed the following to verify compliance with TS Sections 3.7, “Limitations on Experiments;” 3.8, “Operation with Fueled Experiments;” and 6.4, “Review of Experiments;” requirements:

- Experiment Logbook
- Procedure NRP-OP-104, “Reactor Experiments,” Rev. 3, dated January 10, 2011
- Experiment Records, 2012 and 2013

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 Section 6.2, "Review and Audit." The approvals were written and approved pursuant to TS Section 6.4, "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 6.4.

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)

The inspector reviewed the following to verify compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 and TS Sections 3.5 and 4.4, "Radiation Monitoring Equipment," requirements:

- PULSTAR Nuclear Reactor Annual Report for 2012
- Procedure Health Physics (HP) 1, "Radiation Protection Program," Rev. 8, dated October 7, 2013
- Procedure HP 3, "Radiological Surveys," Rev. 2, dated April 17, 2009
- PULSTAR Nuclear Reactor Radiation Protection Program 2012 Annual Self-Assessment, dated March 29, 2013
- Procedure HP 5, "Access Control and Training," Rev. 0, dated October 14, 2013
- Procedure HP 8, "Radiation Work Permits," dated November 8, 2004
- Procedure HP 10, "Calibration, Operation, and Maintenance of Radiation Surveys and Chemistry Controls," dated July 1, 2004
- Landauer Personnel Dosimetry Reports for 2012 and November 2013
- File of Radiation Work Permits (per Procedure HP 8) for 2012 and 2013
- File of Weekly Contamination Surveys (HP 3, Rev. 2, Attachment 1) for 2013
- File of Monthly Radiation Surveys (HP 3, Rev. 2, Attachment 1) for 2012 and 2013
- File of Weekly Stack Monitor Particulate Analysis, (HP 3, Rev. 2, Attachment 2) for 2013
- PULSTAR Reactor Environmental Radiation Surveillance Report for 2012
- Sampling, Analysis, and Assessment of Liquid Effluent and Airborne

Effluent data, for 2012 and 2013

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 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 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 2012, 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.

Based on a review of the PULSTAR Reactor Environmental Radiation Surveillance Report for 2012, the inspector noted that for the third and fourth quarters of 2012, the licensee did not report any data for environmental TLD

exposures for any of the environmental monitoring locations. The licensee stated that data from that time period was reported by the TLD processing vendor to be invalid. However, the reported values from the vendor for the first three quarters of 2013 for these locations appeared to be consistent with the 2012 values that had been identified as invalid. The licensee indicated that they are continuing to coordinate with their TLD vendor to assess the reason for these results. The inspector opened an inspector follow-up item to review the licensee's analysis and ensure environmental monitoring results are properly reported. This issue has been identified as Inspector Follow-Up Item 50-297/2014-201-1.

While reviewing the environmental TLD exposures reported in 2012 and 2013 through the third quarter, the inspector noted that the readings reported for the D.H. Hill Library location were not as expected, based on a comparison of the readings there to those taken at the reactor stack. The readings at the library location were also not consistent with the readings that would be expected based on reactor operating history. Through interviews with licensee staff, the inspector determined that the physical location of these environmental monitoring TLDs had been moved by the University from the roof of the library to an interior location for personnel safety reasons, where they may not be as effective at measuring releases from the facility. The licensee indicated that they would further review the appropriateness of the new TLD monitoring location. The inspector determined that additional information is needed to confirm the adequacy of these new environmental monitoring locations, and ensure the licensee's environmental monitoring program continues to comply with NRC requirements with these TLDs located in the interior of the library. This issue has been identified as Unresolved Item 50-297/2014-201-2.

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

- File of Radioactivity Material Shipments for 2012 and 2013
- 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 2012 and 2013

b. Observations and Findings

The inspector reviewed documentation for shipments of radioactive material made in 2013. 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 January 23, 2014. 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
G. Gibson	Senior Reactor Operator
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

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

Closed

None

PARTIAL LIST OF ACRONYMS USED

10 CFR	Title 10 of the *Code of Federal Regulations*
ADAMS	Agencywide Document Access and Management System
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 Specifications
URI	Unresolved Item