February 28, 2012

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 ANNOUNCED ROUTINE INSPECTION REPORT NO. 50-297/2012-201

Dear Dr Hawari:

The U.S. Nuclear Regulatory Commission (NRC) conducted an inspection on February 13 to 17, 2012, 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 concern or noncompliance of requirements was 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, and requests for withholding" a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) 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 Jack Donohue at 301-452-1950 or electronic mail at Jack.Donohue@nrc.gov.

Sincerely,

/RA/
Johnny H. Eads, Jr., 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:	50-297/2010-201
Licensee:	North Carolina State University
Facility:	PULSTAR Nuclear Reactor Facility
Location:	Raleigh, NC
Dates:	February 13 to 16, 2012
Inspector:	Jack Donohue
Accompaniment:	Jon Fiske, General Engineer
Approved by:	Johnny H. Eads, Jr., 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. 50-297/2012-201

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; committees, audits and reviews 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 record keeping program conformed to Technical Specification requirements.

Experiments

- Experiments appeared to be reviewed and performed in accordance with Technical Specification requirements and the licensee's written procedures.

Health Physics

- 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.

Effluent and Environmental Monitoring

- Effluent releases, effluent monitoring, and environmental monitoring satisfied license and regulatory requirements.

Committees, Audits, and Reviews

- The Radiation Safety Committee and Reactor Safety and Audit Committee provided the oversight required by the Technical Specifications.

Transportation

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

REPORT DETAILS

Summary of Facility Status

The North Carolina State University (NCSU, 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) 69001-02.01)

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, February 2010 to February 2012
- Procedure NRP-OP-103, Reactor Operation, Rev. 2, dated April 15, 2009

b. Observations and Findings

NCSU functional organization had not changed since the last U. S. Nuclear Regulatory Commission (NRC) inspection (refer to Inspection Report No. 50-297/2011-201). 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 February 2010 to February 2012 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 69001-02.02)

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. 2, dated April 15, 2009
- NCSU PULSTAR Reactor Logbook, March 30, 2010 thru 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) enhances the subsequent reviews by management. Hourly readings from operating equipment are 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. A rubber stamp was used to document all of the factors used to calculate the Estimated Critical Position (ECP) of the control rods when the reactor was critical. For the records included in this review, the licensee’s administrative requirements were met.

c. Conclusion

Within the scope of this review, the licensee’s record keeping program conformed to TS requirements.

3. Experiments

a. Inspection Scope (IP 69001-02.06)

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:

- Experiment Logbook
- Procedure NRP-OP-104, Reactor Experiments, Rev. 3,dated, January 10, 2011
- Experiment Records, 2010 thru 2012

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 (RSC) or the Reactor Safety and Audit Committee (RSAC) 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. 7800 hours of reactor operation was utilized for experimental performance during 2011.

c. Conclusion

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

4. Health Physics

a. Inspection Scope (IP 69001-02.07.a-d & g-p)

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:

- Procedure Health Physics (HP) 1, Radiation Protection Program, dated May 1, 2009
- Procedure HP 3, Radiological Surveys, dated July 1, 2004
- PULSTAR Nuclear Reactor Radiation Protection Program Review 2010
- Self-Assessment, G. Wicks, dated March 31, 2011
- File of Monthly HP Trends for 2010
- File of Radiation Work Permits (per Procedure HP 8) for 2010 and 2011
- PULSTAR Nuclear Reactor Annual Report for 2009 and 2010
- Procedure HP 8, Radiation Work Permits, dated November 8, 2004
- Procedure HP 9, Respirator Use and Bioassay, dated November 8, 2004

- Procedure HP 10, Calibration, Operation, and Maintenance of Radiation Surveys and Chemistry Controls, dated July 4, 2004
- File of Medical Examinations for Respiratory Device Use for 2010 and 2011
- Landauer Personnel Dosimetry Reports for 2011 and to date in 2012
- File of Monthly Contamination Surveys (HP 3, Rev. 2, Attachment 1) for 2010 and 2011
- File of Monthly Radiation Surveys (HP 3, Rev. 2, Attachment 1) for 2010 and 2011
- Surveillance Procedure PS 6-17-1:A1, Area Radiation Monitor Calibration, dated June 17, 2002, and surveillance files for 2010 and 2011
- File of 2010 and 2011 PULSTAR Nuclear Reactor Examination Answer Sheets for HP Training
- File of Weekly Stack Monitor Particulate Analysis, (HP 3, Rev. 2, Attachment 2) for 2010 and 2011

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 in assuring effective implementation of As Low As Reasonably Achievable (ALARA) practices.

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 Title 10 of the *Code of Federal Regulations* (10 CFR) Part 19 was posted at the entrance to the Control Room and Reactor Bay.

The inspector reviewed respiratory training records and bioassay data for NRF personnel. Medical records indicate a clinical evaluation was completed on Reactor Operations Personnel.

Dosimetry results were reviewed by the inspector, indicating doses to most NRF occupants to be minimal. The inspector noted that the dosimetry records for an individual for 2010 were >500 millirem. The total yearly dose was < 1 rem (<20percent of the limit) and the ALARA limit is 10 percent of the regulatory limit, the RHP/EHS personnel determined that the high exposure was due to excessive work load at the imaging facility. A second technician is now qualified to perform neutron radiography, resulting in overall individual exposure reduction. As a continued part of an ALARA reduction effort, electronic dosimeters were placed in service.

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.

c. Conclusion

The inspector verified that the licensee's radiation protection program (RPP) was effective in minimizing radiation doses to individuals through training, notices to workers, radiation monitoring and surveys, and calibrated equipment. The RPP met TS requirements.

5. Effluent and Environmental Monitoring

a. Inspection Scope (IP 69001-02.07.e, f, & g)

The inspector reviewed the following to verify compliance with 10 CFR Part 20 and TS Sections 3.5 and 4.4, Radiation Monitoring Equipment, requirements regarding effluents, and environmental monitoring:

- PULSTAR Nuclear Reactor Annual Report for 2010
- PULSTAR Reactor Environmental Radiation Surveillance Report for 2010 and 2011
- File of Monthly Reactor Stack Particulate Filter Measurements for 2010 and 2011
- Surveillance Procedure PS 6-17-2:A1, Process Radiation Monitor Channel Calibration, dated April 6, 2005, and surveillance files for 2010 and 2011
- Sampling, Analysis and Assessment of Liquid Effluent and Airborne Effluent data, for 2010 and 2011

b. Observation and Findings

The annual report referenced above describes the gaseous, liquid and solid waste generated at the NRF during the year 2011, Argon-41 (Ar-41) produced by the irradiation of atmospheric air being the only one of significance. The report presents the model, input data, assumptions, and summary of calculations for Ar-41 emissions. The inspector reviewed this information and concurred with the reported results. A total of 143 microcuries of liquid waste, primarily tritium, was released to the sanitary sewer. Solid waste from the reactor, consisting of 1.0 millicurie of radioactivity in 58 cubic feet of dry solid material, was transferred to

the broad byproduct material (state) license for disposal at a licensed waste facility along with other low level radioactive waste from the remainder of the campus.

The licensee also reported the results of thermoluminescent dosimeters (TLDs) placed at eight locations around the NRF as environmental radiation monitors. In all cases the TLDs indicated no significant difference from background radiation levels. Surface water and vegetables were analyzed for indications of environmental impacts and likewise showed no significant difference from background levels

c. Conclusion

Effluent releases, effluent monitoring, and environmental monitoring satisfied license and regulatory requirements.

6. Committees, Audits, and Reviews

a. Inspection Scope (IP 69001-02.09)

The inspector reviewed the following to ensure that the audits and reviews stipulated in TS Section 6.2 were being completed:

- RSAC Appointment, dated August 10, 2011
- RSAC Minutes of meeting held January 10, 2011, February 22, 2011, April 11, 2011, September 21, 2011and February 8, 2012 (unpublished)
- 2010 RSAC Audit Summary, dated April 17, 2011
- RSC Minutes of meeting held April 19,2011, February 23, 2011 and October 6, 2010
- Annual Report for 2010, dated March 31, 2011
- PULSTAR Nuclear Reactor Radiation Protection Program 2010 Annual
- Self Assessment, Gerald Wicks, CHP dated March 31, 2011

b. Observations and Findings

The composition of the RSC and RSAC were as specified in the TS. A review of records indicated that both committees met at the prescribed frequency and provided the oversight and reviews of the reactor programs as required by the TS.

c. Conclusion

The RSC and RSAC provided the oversight required by the TS.

7. 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 Receipts for 2010 and 2011
- File of Radioactivity Material Shipments for 2010 and 2011
- File of Licenses for recipients of Radioactive Material Shipments
- Procedure HP 6, Transportation of Radioactive and Hazardous Material, dated September 25, 2003
- Hazardous Material Transfer and Shipment Summary (HP 6, Rev1, Attachment 2) for material shipped 2010, 2011 and 2012

b. Observations and Findings

The inspector reviewed the papers for approximately 74 shipments of radioactive material. 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.

8. Exit Interview

The inspector presented the inspection results to licensee management at the conclusion of the inspection on February 16, 2012. The inspectors described the areas inspected and discussed in detail the inspection observations. No dissenting comments were received from the licensee. The licensee acknowledged the findings presented and did not identify as proprietary and 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
G. Wicks	Reactor Health Physicist

INSPECTION PROCEDURES USED

IP 69001	Class II Research and Test Reactors

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

None.

Closed

None

PARTIAL LIST OF ACRONYMS USED

10 CFR	Title 10 of the *Code of Federal Regulations*
ADAMS	Agencywide Document Access and Management System
ALARA	As Low As Reasonably Achievable
Ar-41	Argon-41
ECP	Estimated Critical Position
EHS	Department of Environmental Health and Safety
HP	Health Physics
IP	Inspection Procedure
NCSU	North Carolina State University
NRC	U. S. Nuclear Regulatory Commission
NRF	Nuclear Reactor Facility
NRP	Nuclear Reactor Program
PARS	Publicly Available Records
Rev.	Revision
RHP	Reactor Health Physicist
ROM	Reactor Operations Manager
RPP	Radiation Protection Program
RSAC	Reactor Safety and Auditing Committee
RSC	Radiation Safety Committee
SRO	Senior Reactor Operator
TLD	Thermoluminescent dosimeters
TS	Technical Specifications