

February 12, 2009

Mr. Andrew Cook, Associate Director  
Nuclear Reactor Program  
Department of Nuclear Engineering  
North Carolina State University  
P. O. Box 7909  
Raleigh, NC 27695-7909

SUBJECT: NRC INSPECTION REPORT NO. 50-297/2009-201

Dear Mr. Cook:

The U.S. Nuclear Regulatory Commission (NRC) conducted an inspection on January 12 to 15, 2009, 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* Part 2.390 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>.

A. Cook

- 2 -

Should you have any questions concerning this inspection, please contact Marcus Voth at 301-415-1210 or by electronic mail at [Marcus.Voth@nrc.gov](mailto:Marcus.Voth@nrc.gov).

Sincerely,

**/RA/**

Johnny H. Eads, Chief  
Research and Test Reactors Branch B  
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

North Carolina State University

Docket No.: 50-297

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A. Cook

- 2 -

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

Docket No: 50-297

License No: R-120

Report No: 50-297/2009-201

Licensee: North Carolina State University

Facility: PULSTAR Nuclear Reactor Facility

Location: Raleigh, NC

Dates: January 12 to 15, 2009

Inspectors: Marcus H. Voth, Lead  
Patrick J. Isaac

Approved by: Johnny H. Eads, Chief  
Research and Test Reactors Branch B  
Division of Policy and Rulemaking  
Office of Nuclear Reactor Regulation

## EXECUTIVE SUMMARY

North Carolina State University  
PULSTAR Reactor Facility  
NRC Inspection Report No. 50-297/2009-201

The primary focus of this routine, announced inspection was the onsite review of selected aspects of the North Carolina State University Class II research reactor facility safety programs including organization and staffing; operations logs and records; procedures; requalification training; surveillance and LCO; design changes; committees, audits and reviews; emergency planning; maintenance logs and records; fuel handling logs and records; and follow up on previously identified items. The licensee's programs were acceptably directed toward the protection of public health and safety, and were in compliance with NRC 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 recordkeeping program conformed to Technical Specification requirements.

### Procedures

- Facility procedural review, revision, and implementation satisfied Technical Specification requirements.

### Requalification Training

- Operator requalification was conducted as required by the Requalification Program and 10 CFR Part 55.

### Surveillance and LCO

- Limiting conditions for operation and surveillances required by Technical Specification were being properly implemented.

### Design Changes

- Changes at the facility were acceptably reviewed in accordance with 10 CFR 50.59 and applicable licensee administrative controls.

Committees, Audits, and Reviews

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

Emergency Planning

- The emergency preparedness program was conducted in accordance with the Emergency Plan and implementing procedures.

Maintenance Logs and Records

- Maintenance was performed and logs and records maintained consistent with Technical Specification and licensee procedure requirements.

Fuel Handling Logs and Records

- Fuel handling logs or activities satisfied the Technical Specification requirements and facility procedural requirements.

Follow-up of Previously Identified Items

- An unresolved item related to review of experiments from a previous inspection was closed.

## 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 remained shut down to replace the primary coolant pump.

### 1. Organization and Staffing

#### a. Inspection Scope (Inspection Procedure (IP) 69001-02.01)

The inspectors 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, March 7, 2008 – January 14, 2009
- Procedure NRP-OP-103, Reactor Operation, Rev. 1, July 13, 2005

#### b. Observations and Findings

The Head of the Department of Nuclear Engineering at North Carolina State University had changed since the last inspection. There appeared to be no impact on the reactor or nuclear educational programs.

The minimum staffing required when the reactor is not secured is specified in TS 6.1.3. The inspectors reviewed the console records for the period covering March 2008 to January 2009 and determined that staffing requirements were met.

#### c. Conclusions

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 inspectors 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. 1, July 13, 2005
- NCSU PULSTAR Reactor Logbook, March 7, 2008 to January 14, 2009

### b. Observations and Findings

The licensee's administrative procedure for recordkeeping specifies the use of black, red, and green pens for certain data. This 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 just critical. For the records included in this review, the licensee's administrative requirements were met.

### c. Conclusions

Within the scope of this review, the licensee's recordkeeping program conformed to TS requirements.

## 3. Procedures

### a. Inspection Scope (IP 69001-02.03)

The inspectors reviewed the following to ensure that the requirements of TS Section 6.4, Operating Procedures, were being met:

- PULSTAR Operations Manual, specifically procedures:
  - NRP-OP-101, Reactor Startup and Shutdown, Rev. 4, April 2, 2008
  - NRP-OP-103, Reactor Operations, Rev. 1, July 13, 2005
  - NRP-OP-104, Reactor Experiments, Rev. 2, December 15, 2008
  - NRP-OP-105, Response to SCRAMS, Alarms and Abnormal Conditions, Rev. 1, January 1, 2009
  - NRP-OP-201, Primary Demineralizer, Rev 0, September 13, 2004
  - NRP-OP-202, Service Water, Rev 1, January 1, 2009
  - NRP-OP-301, Reactor Fuel Handling, Rev. 0, September 13, 2004

- Special Procedure Manual, specifically procedures:  
SP 2.1, Review and Approval of Documents, Rev. 8,  
September 15, 2008  
SP 2.6, Operator Requalification Program, Rev. 6,  
January 19, 1995
- PULSTAR Emergency Procedures, specifically procedures:  
EP-1, Emergency Plan Activation, Response, and Actions,  
October 13, 2008  
EP-4, Emergency Classification, October 13, 2004
- PULSTAR Nuclear Reactor Emergency Plan, September 19, 2008

b. Observations and Findings

The inspectors observed that the licensee maintained written procedures covering the areas specified in TS Section 6.4. A systematic approach was being used to update and reissue procedures. New procedures and major changes were reviewed and approved by the Reactor Safety Audit Committee (RSAC) and the Radiation Safety Committee (RSC) in accordance with a written procedure on document control. Minor changes did not require committee approval but were reviewed by the committees; the reviews and approvals were documented in the minutes of the respective committee meetings.

c. Conclusions

The licensee was maintaining and implementing written procedures in accordance with TS requirements.

#### 4. **Requalification Training**

a. Inspection Scope (Inspection Procedure (IP) 69001-02.04)

The inspectors reviewed the following to verify that the requirements of 10 CFR Part 55, Operators' Licenses, and the licensee's Operator Requalification Program were being met:

- Requalification Written Examination administered December 12, 2008
- Special Procedure 2.6, PULSTAR Operator Requalification Program, January 19, 1995
- On-The-Job Training Log File, 2007 - 2008

b. Observations and Findings

The licensee's reactor operator staff consisted of five NRC licensed Senior Reactor Operators (SRO), all held by full time staff members, and four Reactor Operators (RO).

The licensee's requalification program included the regulatory requirement for an annual operating test and a biennial written examination. The inspectors verified that both examinations were administered at the specified frequency and that the level of difficulty was comparable to that of NRC-administered examinations.

The inspectors reviewed the content of the written and oral examinations used for the 2007-2008 requalification cycle and found them adequate. The inspectors selected one SRO licensee and one RO licensee and reviewed their training and medical records in detail. The inspectors reviewed documentation indicating that all operators had performed the required number of reactor manipulations at the frequency specified in the requalification program.

c. Conclusions

Operator requalification was conducted as required by the Requalification Program and NRC regulations.

**5. Surveillance and Limiting Conditions for Operation**

a. Inspection Scope (IP 69001-02.05)

The inspectors reviewed the following to determine if limiting conditions for operation specified in TS Section 3.0 were being effectively implemented and if the periodic surveillance tests on safety systems were being performed in accordance with TS Section 4.0:

- Procedure NRP-OP-101, Reactor Startup and Shutdown, Appendix A, Startup Checklist, Rev. 5, January 8, 2009
- Procedure PS-1-08-4A, Nitrogen N-16 Calibration, March 24, 1993
- Procedure PS-2-03:S1, Flow Channel Calibration, October 1, 1990
- Procedure PS-4-07-1:B1, Fuel Inspection, October 1, 1990
- Procedure PS-4-01-2, Safety No. 1, Control Rod Calibration, July 9, 1993
- Procedure SP-2.5, PULSTAR Reactor Surveillance, Rev. 1, February 1, 1989
- NRP-SP-101, Appendix A, Controlled Access Area Lock-up Checklist, February 23, 2006
- PULSTAR Surveillance and Maintenance File
- PULSTAR 2008 Surveillance Master Schedule
- NCSU PULSTAR Reactor Logbook, March 7, 2008 to January 14, 2009

b. Observations and Findings

Surveillances were completed on schedule and in accordance with licensee procedures. The protocols and techniques were effective in verifying the performance of the safety equipment. All the recorded results were within the TS and procedurally prescribed parameters. The records and logs were complete

and were being maintained as required. Checks and calibrations were completed as required by TS.

c. Conclusions

The limiting conditions for operation and surveillances required by TS were being properly implemented.

**6. Design Changes**

a. Inspection Scope (IP 69001-02.08)

In order to verify that any modifications to the facility were consistent with 10 CFR 50.59, the inspectors reviewed selected aspects of:

- SP 2.1, Review and Approval of Documents, September 15, 2008
- Neutron Imaging Facility Hydrogen and Oxygen Gas System, Memo dated September 19, 2008
- PULSTAR Reactor Annual Report For Period January 01, 2007 to December 31, 2007

b. Observations and Findings

Through review of applicable records and interviews with licensee personnel, the inspectors determined that no changes requiring prior NRC approval had been initiated and/or completed at the facility since the last NRC operations inspection.

On December 8, 2008, the licensee initiated the replacement of the reactor primary pump which seized and failed after more than 30 years of operation. The new pump to be installed was not exactly the same as the one being replaced and required minor piping modification and a new mounting support. The licensee stated that the pump replacement will be a minor modification and they will perform a 10 CFR 50.59 review prior to completion.

The inspectors noticed that the review and approval of design changes and procedure changes did not have a consistent process for making sure that all operators were aware of such changes prior to performing licensed operator duties. Although covered in the requalification program, some changes could go unnoticed until covered in a requalification lecture. The licensee was made aware of this matter early in the inspection and began immediate discussions toward resolution. This was designated as an Inspection Follow-up Item (IFI) for consideration at a subsequent time. (IFI 50-297/2009-201-01)

c. Conclusions

Records showed that changes at the facility were acceptably reviewed in accordance with 10 CFR 50.59 and applicable licensee administrative controls.

## 7. Committees, Audits, and Reviews

### a. Inspection Scope (IP 69001-02.09)

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

- Reactor Safety and Audit Committee (RSAC) Membership, September 22, 2008
- RSAC Minutes of meeting held September 15, 2008
- 2007 RSAC Audit Summary, 27 May 2008
- RSC Minutes of meeting held September 19, 2008
- 2007 – 2008 RSC Annual Report

### 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. Conclusions

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

## 8. Emergency Planning

### a. Inspection Scope (IP 69001-02.10)

The inspectors reviewed the emergency preparedness program and its implementation through the following:

- PULSTAR Nuclear Reactor Emergency Plan, Rev. 9, September 19, 2008
- Emergency Procedures 1, Emergency Plan Activation, Response and Actions, October 13, 2008
- Emergency Procedures 2, Off-Site Notification, January 1, 2009
- Emergency Procedures 4, Emergency Classification, October 13, 2008
- Emergency Procedures 6, Training, July 19, 2006
- Emergency Procedures 7, Drills, April 2, 2001
- Emergency Procedures 9, Emergency Locker Inventory, February 16, 2006
- Training Records of Emergency Support Groups
- PULSTAR Nuclear Reactor, Emergency Drill Scenario, February 6, 2008
- PULSTAR Nuclear Reactor Drill Summary and Critique, March 25, 2008

- Letter of Agreement with City of Raleigh Fire Department, December 30, 2008
- Letter of Agreement with State of North Carolina Division of Emergency Management , November 5, 2008
- Letter of Agreement with Wake County Emergency Management, October 30, 2008
- Letter of Agreement with Rex Healthcare Hospital, October 30, 2008

b. Observations and Findings

The inspectors reviewed the licensee's emergency preparedness program as defined in the above-referenced emergency plan and implementing procedures. The inspectors also reviewed documentation related to an annual drill conducted February 6, 2008, the critique of the drill, lessons learned, action items identified in the critique, and disposition of action items.

The inspectors found that letters of agreement with support agencies were available and current. The inspectors toured the decontamination facility and conducted interviews with the Medical Director, the Clinical Emergency Preparedness Coordinator, and the Staff Educator of the Emergency Department at the Rex Healthcare Hospital.

Emergency Procedure 6, Training, specifies that training for support agency personnel be offered every two years. Training records indicated that it was offered annually on multiple days to accommodate shift workers' schedules.

Emergency Procedure 9, Emergency Locker Inventory, specified the inventory for emergency supply cabinets at various locations, calling for a quarterly inventory of each locker and also an inventory after each use. The inspectors checked the inventory of one locker and verified that the inventory was performed on the designated frequency, that the specified items were in the cabinet, and that the radiation detectors were operable and in the specified calibration interval.

c. Conclusions

The emergency preparedness program was conducted in accordance with the Emergency Plan and implementing procedures.

**9. Maintenance Logs and Records**

a. Inspection Scope (IP 69001-02.11)

The inspectors reviewed the following selected maintenance and reactor operations records to ensure that the requirements of TS Sections 6.8 "Retention of Records" were being met:

- PULSTAR Maintenance Log and History Report

- PULSTAR Unscheduled Scram and Shutdown Log
- PULSTAR Reactor Logbook, March 7, 2008 to January 14, 2009

b. Observations and Findings

The inspectors reviewed the maintenance records related to scheduled and unscheduled preventive and corrective maintenance activities that had occurred during the inspection period. Routine and preventive maintenance was controlled and documented in the appropriate logs. These documents indicated that all maintenance activities were in accordance with the requirements in 10 CFR 50.59. The inspectors verified that all maintenance was conducted in accordance with the requirements of TS Section 4.0, and system operational checks were performed before returning them to service.

c. Conclusions

Maintenance was performed and logs and records maintained consistent with TS and licensee procedure requirements.

## 10. Fuel Handling Logs and Records

a. Inspection Scope (IP 69001-02.12)

The inspectors reviewed the following records to verify implementation of the requirements of TS Section 4.1:

- Procedure NRP-OP-301, Reactor Fuel Handling, Rev. 0, September 13, 2004, Appendix A, Data Sheet for Fuel Movements on August 5, 2008, October 7, 2008, and November 19, 2008
- Core Map Records of Fuel Element Locations
- PULSTAR Reactor Console Logbook entries on August 5, 2008, October 7, 2008, and November 19, 2008

b. Observations and Findings

The inspectors found the procedures used for fuel handling provide for the safe handling of fuel elements. The data sheets and the Core Map Records adequately documented the location of fuel elements at all times.

c. Conclusions

Fuel movements were performed safely in accordance with TS requirements and licensee procedural requirements.

## 11. Follow-up

a. Inspection Scope (IP 92701)

The inspectors reviewed the following to verify compliance with TS Sections 3.7, Limitations on Experiments, 3.8, Operation with Fueled Experiments, and 6.5, Review of Experiments:

- Experiment Logbook
- Procedure NRP-OP-104, Reactor Experiments, Rev. 2, December 15, 2008
- NRP Work Request Form
- File of completed Reactor Use Request Forms
- NRC Inspection Report IR 50-297/2008-201, Unresolved Item (URI) 50-297/2008-201-01

b. Observations and Findings

The referenced previous NRC inspection report identified URI 50-297/2008-201-01, "Clarify and document the fact that every unique experiment is reviewed and found to meet TS requirements prior to insertion into the reactor." In response, the license had made numerous changes to procedure NRP-OP-104, one being the creation of the NRP Work Request Form. This form asked if the desired sample composition, mass, power level, position (flux), and irradiation time was within the analyzed envelope of previous experiments. The form also specified the hazards to be considered for the specific sample irradiation as required by TS 3.7 and 3.8. This information documented the fact that the TS requirements were being considered in the review of each experiment, addressing the concern raised by the URI. (URI 50-297/2008-201-01 was closed.)

c. Conclusions

The inspectors closed out the unresolved item from a previous inspection based on changes the licensee had made in the documentation of how experiments met Technical Specification requirements.

## 12. **Exit Interview**

The inspection scope and results were summarized on January 15, 2009, with members of licensee management. The inspectors described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee.

## **PARTIAL LIST OF PERSONS CONTACTED**

### Licensee

L. Broussard, Chief Reactor Operator  
A. Cook, Associate Director, Nuclear Reactor Program and Reactor Operations Manager  
A. Hawari, Director, Nuclear Reactor Program  
K. Kincaid, Chief of Reactor Maintenance  
Y. Azmy, Nuclear Engineering Department Head  
G. Wicks, Reactor Health Physicist

### Other Personnel

B. Quigley, MD, Medical Director, Rex Critical Care Transport, Rex UNC Health Care  
A. Foster, Critical Emergency Preparedness Coordinator, Rex UNC Health Care  
Carol Foster, RN, Staff Educator, Emergency Department, Rex UNC Health Care

## **INSPECTION PROCEDURES USED**

IP 69001      Class II Research and Test Reactors  
IP 92701      Follow-up

## **ITEMS OPENED, CLOSED, AND DISCUSSED**

### Opened

50-297/2009-201-01    IFI      Review and approval of design changes and procedure changes does not have a consistent process for making sure that all operators are aware of such changes

### Closed

50-297/2008-201-01    URI      Clarify and document the fact that every unique experiment is reviewed and found to meet TS requirements prior to insertion into the reactor

### Discussed

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
ECP	Estimated Critical Position
IP	Inspection Procedure
NCSU	North Carolina State University
NRC	Nuclear Regulatory Commission
NRP	Nuclear Reactor Program
PARS	Publicly Available Records
Rev.	Revision
RO	Reactor Operator
RSAC	Reactor Safety and Auditing Committee
RSC	Radiation Safety Committee
SRO	Senior Reactor Operator
TS	Technical Specifications
IFI	Inspection Follow-up Item
URI	Unresolved Item