February 7, 2008

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. 50-297/2008-201

Dear Mr. Cook:

This letter refers to the inspection conducted on January 28 to February 1, 2008, 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 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 Nuclear Regulatory Commission (NRC) requirements was identified. No response to this letter is required.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," 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 (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) <u>http://www.nrc.gov/reading-rm/adams.html</u>.

Should you have any questions concerning this inspection, please contact Marcus Voth at 301-415-1210.

Sincerely,

### /RA/

Johnny H. Eads, Branch 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: NRC Inspection Report No. 50-297/2008-201

cc w/ enclosure: Please see next page

North Carolina State University

CC:

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

Gerald Wicks, Reactor Health Physicist Nuclear Reactor Program Department of Nuclear Engineering North Carolina State University Campus Box 7909 Raleigh, NC 27695

Test, Research, and Training Reactor Newsletter University of Florida 202 Nuclear Sciences Center Gainesville, FL 32611

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Docket No. 50-297 License No. R-120 Enclosure: NRC Inspection Report No. 50-297/2008-201 cc w/ enclosure: Please see next page <u>DISTRIBUTION:</u> PUBLIC PRTB/rf RidsNrrDprPrtb RidsOgcMailCenter MVoth DHughes BDavis (Ltr only O13-E19)

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#### TEMPLATE #: NRR-106

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

| Docket No:   | 50-297   |
|--------------|--|
| License No:  | R-120  |
| Report No:   | 50-297/2008-201  |
| Licensee:    | North Carolina State University  |
| Facility:    | PULSTAR Reactor  |
| Location:    | Raleigh, North Carolina  |
| Dates:       | January 28 to February 1, 2008   |
| Inspector:   | Marcus H. Voth   |
| Approved by: | Johnny H. Eads, Branch Chief<br>Research and Test Reactors Branch B<br>Division of Policy and Rulemaking<br>Office of Nuclear Reactor Regulation |

# EXECUTIVE SUMMARY

### North Carolina State University PULSTAR Reactor Facility NRC Inspection Report No. 50-297/2008-201

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 requalification training; experiments; health physics; effluents and environmental monitoring; and transportation. The licensee's programs were acceptably directed toward the protection of public health and safety, and were in compliance with NRC requirements.

### **Requalification Training**

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

### **Experiments**

• Experiments appeared to be reviewed and performed in accordance with Technical Specification requirements and the licensee's written procedures. However, documentation of the review will be re-inspected.

### 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.

### Effluents and Environmental Monitoring

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

### Emergency Planning

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

### **Transportation**

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

## **REPORT DETAILS**

### **Summary of Facility Status**

The North Carolina State University (NCSU) Nuclear Reactor Facility (NRF) 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 started up, shut down, and operated in support of these activities.

### 1. Requalification Training

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

The inspector 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:

- Special Procedure 2.6, PULSTAR Operator Requalification Program, January 19, 1995
- On-The-Job-Training Log File (Current Senior Reactor Operator Requalification Checklists)
- NCSU Simulated In House License Examination, Administered November 14, 2006
- PULSTAR Reactor Operational Examination, Administered December 2007
- Senior Reactor Operator (SRO) files for each of the five SROs holding licenses

### b. Observations and Findings

The licensee maintained a written reactor operator requalification program that conformed to requirements of 10 CFR Part 55.

The licensee's reactor operator staff consisted of five NRC-licensed SROs, all held by full time staff members. Three reactor operator (RO) licenses that had been issued for the licensee's reactor were terminated at the time of the inspection; new RO candidates were in training, preparing for license examinations in the future.

The licensee's requalification program included the regulatory requirement for an annual operating test and a biennial written examination. The inspector 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 inspector reviewed the files of the five SROs, specifically checking NRC Form 396, Certification of Medical Examination by Facility Licensee, and supporting medical files. Acceptance criteria used by the physician for assessing the candidate's physical condition was Section 7, Medical Certification and Monitoring of Certified Personnel, of the American Nuclear Society and the American National Standards Institute Standard ANSI/ANS 15.4-1988, Selection and Training of Personnel for Research Reactors.

The inspector reviewed documentation indicating that each of the SROs 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 10 CFR Part 55.

### 2. Experiments

### a. Inspection Scope (IP 69001-02.06)

The inspector reviewed the following to verify compliance with Technical Specification (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, January 1, 2005
- Approved Reactor Utilization Request #015, Isotope Production

### 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 12 approved experiments for miscellaneous reactor utilization and 11 experiments for neutron activation analysis, neutron irradiation, and neutron flux mapping. These 23 experiments had been approved throughout the life of the Nuclear Reactor Program (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. While the ROM and RHP indicated that they reviewed each tried experiment prior to giving their approval to place it in the reactor, it was not clear to the inspector that in every case the combined review of the original untried experiment, the umbrella defined in that review, and the review of the ROM/RHP addressed each of the TS 3.7 and 3.8 considerations.

Most experiments performed were of a routine nature and clearly within the originally reviewed and analyzed envelope. On occasion, the ROM/RHP review of a new request as a tried experiment resulted in a new authorization, indicating that safety concerns were elevated. The licensee indicated that they would review their method of documenting the fact that all TS requirements were considered for each experiment. This matter will be reviewed in a future inspection and tracked as an unresolved item (URI), "Clarify and document the fact that every unique experiment is reviewed and found to meet TS requirements prior to insertion into the reactor." (URI 50-297/2008-201-01)

### c. Conclusions

Experiments appeared to be reviewed and performed in accordance with Technical Specification requirements and the licensee's written procedures. However, documentation of the review will be re-inspected.

### 3. Health Physics

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

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:

- Procedure HP 1, Radiation Protection Program, April 13, 2007
- PULSTAR Nuclear Reactor Radiation Protection Program 2006 Self-Assessment, G. Wicks, March 31, 2007
- File of Monthly Health Physics Trends for 2007
- File of Radiation Work Permits (per Procedure HP 3) for 2007
- PULSTAR Nuclear Reactor Annual Report for 2006, February 26, 2007
- Draft PULSTAR Nuclear Reactor Annual Report for 2007, undated
- Procedure HP 9, Respirator Use and Bioassay, November 8, 2004
- File of Medical Examinations for Respiratory Device Use for 2006 and 2007
- Landauer Personnel Dosimetry Reports for 2006 and first three quarters of 2007
- Procedure HP 3, Radiological Surveys, July 1, 2004
- File of Monthly Contamination Surveys (HP 3 Attachment 1) for 2006 and 2007
- File of Monthly Radiation Surveys (HP 3 Attachment 1) for 2006 and 2007
- File of Monthly Reactor Bay Continuous Air Monitor Particulate Filter Measurements for 2006 and 2007
- File of Monthly Reactor Bay Continuous Air Monitor Iodine Cartridge Measurements for 2006 and 2007
- Surveillance Procedure PS 6-17-1:A1, Area Radiation Monitor Calibration, June 17, 2002, and surveillance files for 2006 and 2007
- Surveillance Procedure PS 6-17-2:A1, Process Radiation Monitor Channel Calibration, April 6, 2005, and surveillance files for 2006 and 2007
- File of 2006 and 2007 PULSTAR Nuclear Reactor Examination Answer Sheets for HP Training

## 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 NRF, performed by a Health Physics 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 NRF occupants to be minimal. The maximum exposure was received by an experimenter who received a shallow dose of approximately 40 millirem per quarter as measured on whole body dosimeters and 100 millirem to the extremities as measured on a finger dosimeter. There was no indicated deep dose equivalent above background for this individual.

The licensee maintained a respiratory protection program. The inspector reviewed face mask fit measurement records and medical examination records for individuals in the program.

Radiation monitoring devices were found to be calibrated on 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 and given access until the training was completed and participants received a passing grade upon examination.

#### c. Conclusions

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.

### 4. Effluent and Environmental Monitoring

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

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 2006, February 26, 2007
- Draft PULSTAR Nuclear Reactor Annual Report for 2007, undated
- File of Monthly Reactor Stack Particulate Filter Measurements for 2006 and 2007
- Surveillance Procedure PS 6-17-2:A1, Process Radiation Monitor Channel Calibration, April 6, 2005, and surveillance files for 2006 and 2007

#### b. Observation and Findings

The annual report referenced above describes the gaseous, liquid and solid waste generated at the NRF during the year 2006, Argon-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 Argon-41 emissions. The inspector reviewed this information and concurred with the reported results. A total of 1.2 millicurie of liquid waste, primarily tritium, was released to the sanitary sewer. Solid waste from the reactor, consisting of 0.51 millicurie of radioactivity in 84 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. While only the first three quarters of the 2007 environmental data had been compiled at the time of the inspection, the Environmental Health Physicist performing the analysis noted that results available from 2007 show no significant difference from those of 2006.

### c. Conclusions

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

## 5. Emergency Planning

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

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

- PULSTAR Nuclear Reactor Emergency Plan, July 19, 2006
- Emergency Procedures 1, Emergency Plan Activation, Response and Actions, July 19, 2006
- Emergency Procedures 2, Off-Site Notification, April 4, 2007
- Emergency Procedures 3, Release of Information, October 15, 1995
- Emergency Procedures 4, Emergency classification, July 19, 2006
- Emergency Procedures 5, Recovery, October 15, 1995
- Emergency Procedures 6, Training, July 19, 2006
- Emergency Procedures 7, Drills, February 23, 2001
- Emergency Procedures 9, Emergency Locker Inventory, February 16, 2006
- Emergency Procedures 10, Determination of Concentration, Release Rate, and Off-Site Dose from Airborne Effluent, July 19, 2006
- Training Records of Emergency Support Groups
- PULSTAR Nuclear Reactor, Emergency Drill Scenario, February 9, 2007
- PULSTAR Nuclear Reactor Drill Summary and Critique, April 4, 2007

### b. Observations and Findings

The inspector reviewed the licensee's emergency preparedness program as defined in the above-referenced emergency plan and implementing procedures. The inspector also reviewed the execution of the plan and procedures in the documentation of an annual drill conducted February 9, 2007. The last document referenced above, prepared two months after the drill, summarized the critique of the drill, lessons learned, action items identified in the critique, and disposition of action items.

The inspector found that letters of agreement with support agencies (Appendix A of the Emergency Plan) were available and current. Specifically, letters exist for Wake County Emergency Management; North Carolina Department of Crime Control and Public Safety, Division of Emergency Management; City of Raleigh Fire Department; and Rex Healthcare (hospital). Most of these same emergency agencies supported the Shearon Harris Nuclear Power Plant located approximately 20 miles from the campus.

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 inspector 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 detector was operable and in the specified calibration interval.

### c. Conclusions

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

### 6. 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 2007 and 2008
- File of Radioactivity Material Shipments for 2007 and 2008
- File of Licenses for recipients of Radioactive Material Shipments

### b. Observations and Findings

The inspector reviewed the papers for approximately 25 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. Conclusions

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

## 7. Exit Interview

The inspection scope and results were summarized on February 1, 2008, with members of licensee management. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee.

# PARTIAL LIST OF PERSONS CONTACTED

### <u>Licensee</u>

- 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
- M. Bourham, Nuclear Engineering Department Head
- G. Wicks, Reactor Health Physicist
- S. Lassell, Manager, Nuclear Services

### Other Personnel

R. Harris, Environmental Health Physicist, Department of Environmental Health and Safety

- K. Kretchman, Industrial Hygienist, Department of Environmental Health and Safety
- A. Orders, Radiation Safety Officer, Department of Environmental Health and Safety
- M. Smith, Electronic Technician, Department of Environmental Health and Safety

## **INSPECTION PROCEDURES USED**

- IP 69001 Class II Research and Test Reactors
- IP 86740 Transportation

# ITEMS OPENED, CLOSED, AND DISCUSSED

### Opened

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

<u>Closed</u> None

Discussed None

## PARTIAL LIST OF ACRONYMS USED

| ALARA | As Low As Reasonably Achievable                 |
|-------|---|
| CFR   | Code of Federal Regulations                     |
| EHS   | (Department of) Environmental Health and Safety |
| IP    | Inspection Procedure                            |
| NCSU  | North Carolina State University                 |
| NRC   | Nuclear Regulatory Commission                   |

| NRF  | Nuclear Reactor Facility              |  |
|------|---------------------------------------|--|
| NRP  | Nuclear Reactor Program               |  |
| PARS | Publicly Available Records            |  |
| Rev. | Revision                              |  |
| RHP  | Reactor Health Physicist              |  |
| RO   | Reactor Operator                      |  |
| ROM  | Reactor Operations Manager            |  |
| RSAC | Reactor Safety and Auditing Committee |  |
| RSC  | Radiation Safety Committee            |  |
| SRO  | Senior Reactor Operator               |  |
| TLD  | Thermoluminescent Dosimeter           |  |
| TS   | Technical Specifications              |  |
| URI  | Unresolved Item                       |  |
|      |                                       |  |