

July 28, 2011

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 SPECIAL INSPECTION
REPORT NO. 50-297/2010-202

Dear Dr. Hawari:

The U. S. Nuclear Regulatory Commission (NRC) conducted a Special Inspection on December 20-22, 2010 and July 13, 2011, at the North Carolina State University (NCSU) (Inspection Report No. 50-297/2010-202). A Special Inspection Team (SIT) was assigned to review the event due to the unplanned high dose rates in excess of 30 rem/hr in the area where a radiography technician was present.

The special inspection included an examination of activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations. Pursuant to your report dated December 23, 2010 (Agencywide Documents Access and Management System Accession No. ML103620450), describing the causes of the event and your corrective actions, the inspections included selected examinations of procedures and representative records, interviews with personnel, and observations of re-enacted activities. The exit meeting was conducted by telephone on July 13, 2011.

The enclosed report documents the inspections findings, which were discussed in a preliminary debriefing and a final exit meeting with you, Professor Yousry Azmy, Head Nuclear Engineering Department; James Albright, North Carolina Radioactive Material Branch Manager; Lee Cox, North Carolina Radiation Protection Section (Branch Chief); Ken Kretchman, NCSU Director Environmental Health and Safety; Amy Orders, NCSU, Radiation Safety Officer; and Gerald Wicks, NCSU Certified Health Physicist.

The event that led to the conduct of this Special Inspection can be summarized as follows:

On December 13, 2010, a radiography technician opened the Neutron Imaging Facility (NIF) beam cave door and entered. After realizing that the beam port shutter was still open, the technician exited the NIF. Entering the NIF with the shutter open created a beam of radiation at 30 rem/hr. The technician traversed the beam when entering and leaving the cave. Actual time in the NIF was 18 seconds as documented by time stamps on security cameras. Additionally, the technician had failed to wear his dosimeter and no finger dosimetry had been issued for the technician.

Based on the results of this inspection, the NRC has determined that two Severity Level IV violations of NRC requirements have occurred. These violations are being treated as Non-Cited Violations (NCVs), consistent with Section 2.3.2.b of the Enforcement Policy. These NCVs are

A. Hawari

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described in the subject inspection report. If you contest the violations or significance of these NCVs, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington DC 20555-0001, with copies to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

In accordance with 10 CFR 2.390 "Exemptions, inspections, requests for withholding," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at <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 by electronic mail at Jack.Donohue@nrc.gov

Sincerely,

/RA/

Johnny H. Eads, Jr., Chief
Research and Test Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

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

Enclosure: NRC Special Inspection Report No. 50-297/2010-202

cc w/encl: See next page

North Carolina State University
cc:

Docket No. 50-297

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ACCESSION NO.:ML110190024

TEMPLATE #: NRC-002

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DATE	7/13/2011	7/25/2011	7/28/11

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

Docket No: 50-297

License No: R-120

Report No: 50-297/2010-202

Licensee: North Carolina State University PULSTAR

Facility: North Carolina State University

Location: Raleigh, North Carolina

Dates: December 20-22, 2010

Inspectors: Jack Donohue
Greg Schoenebeck

Accompanied by: Johnny H. Eads, Jr., Chief

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
NRC Inspection Report No. 50-297-2010-202

The primary focus of this non-routine, announced special inspection was the on-site review by a Special Inspection Team (SIT) of unplanned high dose rate in an area where a radiography technician was present. This inspection covered a period of three days of on-site inspection by two inspectors. The inspection included a review of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20, Standards for the Protection against Radiation including Subpart B, Radiation Protection Programs. A SIT was established in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program." The SIT charter did not require the team to address compliance or assess significance of findings and observations.

Special Inspection

- The inspectors reviewed the licensee's proposed corrective action and those currently in place and found them acceptable.
- The inspectors reviewed the Radiation Protection Program (RPP) and determined that the licensee failed to implement control access to a high radiation area commensurate with provision of 10 CFR 20.1601(a), and failed to monitor exposure to radiation and radioactive material at levels sufficient to demonstrate compliance with the dose limits with provision of 10 CFR 20.1502.

REPORT DETAILS

Summary of Facility Status

The North Carolina State University (NCSU, the licensee) Nuclear Reactor Program (NRP) PULSTAR research reactor had 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 not operated in support of follow-up items from the unplanned exposure event.

1. Special Inspection

a. Inspection Scope Inspection Procedure (IP) 98312)

The inspectors reviewed the licensee's investigation of the event with respect to Technical Specifications (TS) Sections 1.0, 5.0, 6.1, 6.2, 6.4, 6.5, 6.6 and 6.7; Title 10 of the *Code of Federal Regulations* (10 CFR) Section 20.1502 and 10 CFR 20.1601(a). In addition, the inspectors reviewed the procedures and documents listed in Attachments A.

b. Observations and Findings

By letter dated December 23, 2010 (Agencywide Documents Access and Management System Accession No. ML103620450), NCSU submitted a report describing the causes of the event and the corrective actions taken and planned. The inspection included a review of this report and selected examinations of procedures and representative records, interviews with personnel, and observations of re-enacted activities.

1) Sequence of Events

The sequence of events below is based on interviews with licensee staff and all the data accumulated by the licensee and the U.S. Nuclear Regulatory Commission (NRC) staff.

On December 13, 2010, a radiography technician opened the beam cave door to the NIF and entered. The reactor was at power to support the radiography. After realizing that the beam port shutter was still open, the radiography technician exited the beam cave. Entering the NIF with the shutter open created a beam of radiation at 30 rem/hr. The radiography technician traversed the beam when entering and leaving the cave. Actual time in the cave was 18 seconds as documented by time stamps on security cameras. Additionally, the radiography technician had failed to wear the dosimeter following a lunch break.

2) Cause of Occurrence

The cause of the occurrence was a mechanical failure of the beam shutter to close and inadequate controls on personnel entry into the

Neutron Imaging Facility (NIF) allowing a radiography technician to open the beam cave door and enter the NIF during reactor power operations with the shutter open.

3) Corrective Actions

The immediate action was to shutdown the reactor and to close the NIF shutter. Upon learning that the NIF was entered by the radiographer, a dose evaluation began. Based on the survey data and stay time determined from the surveillance video recording, a dose estimate of 150 mrem was made. Notifications were to the Director, Nuclear Reactor Program, Radiation Safety Officer, and the NRC Project Manager and NRC Headquarters Operations Officer.

Area radiation monitor readings for the new fuel storage area for December 13, 2010 and December 14, 2010 were reviewed and showed no abnormal readings. A radiation survey was re-performed on December 21, 2010 and indicated normal radiation levels for the new fuel storage area.

After the incident the surveillance video was reviewed to determine if the shutter failure to close was an isolated event or if there may have been other instances when the shutter failed to close. Operation of the NIF for radiography was viewed from November 29, 2010 to December 13, 2010 using the security surveillance video.

A total of 40 shutter openings on 5 days of NIF operation were observed. All NIF shutter openings on the day of the incident were observed. In all instances, the shutter close indication occurred before any personnel entered the NIF. The time of the incident is the only time that any personnel entered the NIF with a shutter open indication. Stay times inside the NIF by radiography personnel were determined from the observed 40 radiographs sequences to be 30 to 60 seconds. Based on a stay time of 60 seconds, the expected dose would be 500 mrem.

The inspectors reviewed the NCSU Event Report dated December 23, 2010 (Agencywide Documents Access and Management System Accession No. ML103620450) and verified the remaining items were scheduled to be completed. In addition, the inspectors determined that the situation was not fortuitous and that the resulting exposure did not represent a substantial potential for exposure in excess of regulatory limits. The violation was not repetitive and the licensee did not have a prior opportunity to identify the problem or take the action to correct the event.

The inspectors determined this was an isolated event due to: 1) the minimum time the radiographer was exposed was 18 seconds and 2) the distance the radiographer maintained from the source. The average time for the radiographer to perform his/her duties in the NIF radiography was

between 30 to 60 seconds. The exposure time required to exceed the regulatory dose limit would have been approximately ten minutes. The typical time to complete the radiography activities in the NIF for this evolution are approximately 60 seconds, far less than the 10 minutes which would have been required to exceed the dose limits.

The corrective actions include but not limited to: 1) NIF design changes including addition of mechanical and electronic interlocks; 2) visual control room indication and automatic protective actions (scram); 3) radiological and operations procedure changes to include additional dosimetry requirements and reactor operator controls; and 4) personnel training. The remaining action items were scheduled and will be reviewed during the next inspection

c. Conclusion

The licensee followed the immediate actions for placing the reactor and the NIF in a safe shutdown condition. The notification procedures and processes were reviewed and the licensee notified the NRC following the immediate actions and completed the event report on schedule.

10CFR20.1601, "Control of access to high radiation areas" requires that the licensee ensure that each entrance or access point to a high radiation area has one or more of the following features: (1) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates; (2) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or (3) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

Although the licensee had design features in each of these areas, the installed features were inadequate to control access to the high radiation area created by the shutter failure in the NIF beam tube.

10CFR20.1502, "Conditions requiring individual monitoring of external and internal occupational dose" requires that each licensee monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum each licensee shall monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in § 20.1201(a).

The radiography technician involved in this event self-identified that on the day of this event he removed his issued dosimetry while at lunch and failed to don his dosimetry upon return from lunch when he entered the NIF beam cave.

The inspection team concludes that two violations of NRC requirements occurred: (1) the licensee failed to implement control access to high radiation areas commensurate with provisions of 10 CFR 20.1601(a) and (2) the licensee failed to monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the dose limits commensurate with provisions of 10 CFR 20.1502. However, because the violations were identified by the licensee, were not repetitive, were not willful, and because various remedial actions were taken, these will be identified as Non-Cited Violations (NCVs) in accordance with Section 2.3.2.b of the NRC Enforcement Policy (NCV 50-297/2010-202-01 and NCV 50-297/2010-202-02).

2. Exit Interview

The inspector presented the inspection results to licensee management at the conclusion of the initial inspection on December 22, 2010 and during the exit meeting conducted by conference call with the Reactor Manager on July 13, 2011. 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 observations presented and did not identify as proprietary, any of the material provided to or reviewed by the inspectors during the inspection.

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel

A. Cook	Manager, Nuclear Reactor Program and Reactor Operations Manager
A. Hawari	Director, Nuclear Reactor Program
G. Wicks	Reactor Health Physicist
A. Orders	NCSU Radiation Safety Officer

Other Personnel

J. Albright	NC Radioactive Material Branch Manager
Y. Azmy	Department Head and Professor, Nuclear Engineering Department
L. Cox	NC Radiation Protection Section (Branch Chief)
K. Kretchman	NCSU Director, Environmental Health and Safety

INSPECTION PROCEDURES USED

IP 93812	Special Inspection
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ITEMS OPENED, CLOSED, AND DISCUSSED

OPENED

NCV 50-297/2010-202-01	NCV	The licensee failed to implement access control to High Radiation Areas commensurate with provisions of 10 CFR 20.1601(a).
NCV 50-297/2010-202-02	NCV	Failure of the licensee to monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the dose limits commensurate with provisions of 10 CFR 20.1502.

CLOSED

NCV 50-297/2010-202-01	NCV	The licensee failed to implement access control to High Radiation Areas commensurate with provisions of 10 CFR 20.1601(a).
NCV 50-297/2010-202-02	NCV	Failure of the licensee to monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the dose limits commensurate with provisions of 10 CFR 20.1502.

PARTIAL LIST OF ACRONYMS USED

10 CFR	Title 10 of the <i>Code of Federal Regulations</i>
ADAMS	Agency-wide Document Access Management System
ALARA	As Low As Reasonably Achievable
HRA	High Radiation Area
IP	Inspection Procedure
IR	Inspection Report
MEO	Manager Engineering and Operations
MW	Megawatts
NCSU	North Carolina State University
NIF	Neutron Imaging Facility
NRC	U. S. Nuclear Regulatory Commission
NRP	Nuclear Reactor Program
Rev.	Revision
RHP	Reactor Health Physicist
RO	Reactor Operator
RSAC	Reactor Safety and Audit Committee
RSC	Radiation Safety Committee
SIT	Special Inspection Team
SRO	Senior Reactor Operator
TS	Technical Specifications

ATTACHMENT A

Licensee Procedures Reviewed

- Reactor Experiment Procedure "NRP-OP-104" dated, January 1, 2005
- Procedure HP-1, Radiation Protection Program, April 13, 2007
- Procedure HP-3, Radiological Surveys, July 1, 2004
- File of Monthly Radiation Surveys (HP-3 Attachment 1) for 2010
- File of Monthly Contamination Surveys (HP-3 Attachment 1) for 2010
- Laundauer Personnel Dosimetry Reports for 2009 and 2010
- Neutron Imaging Facility Personnel Exposure Report, dated December 23, 2010
- NC State University, Ayman I. Hawari, Ph.D., Reportable Event 46484; Radiography Incident, dated December 23, 2010
- NIF Radiation Monitor Displays (Expanded Screenshot) for 2:50PM to 3:00PM on December 13, 2010