



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION II  
101 MARIETTA STREET, N.W., SUITE 2900  
ATLANTA, GEORGIA 30323-0199

Report No.: 50-297/95-02

Licensee: North Carolina State University  
Raleigh, NC 27695-7909

Docket No.: 50-297

License No.: R-120

Facility Name: North Carolina State University PULSTAR Reactor

Inspection Conducted: December 5-6, 1995

Inspector: *EJM Alpine*  
C. H. Bassett, Senior Radiation Specialist

1/4/96  
Date Signed

Approved by: *EJM Alpine*  
E. J. McAlpine, Chief  
Fuel Facilities Branch  
Division of Nuclear Materials Safety

1/4/96  
Date Signed

SUMMARY

Scope:

This reactive, announced inspection involved on site review of the licensee's followup and corrective actions following a problem noted with a recently installed linear channel in the research reactor console.

Results:

The licensee discovered that the auto ranging capability of the recently installed linear channel had malfunctioned on November 6 and 15, 1995. The reactor was shutdown on November 15 and corrective actions were initiated. The corrective actions identified by the licensee included performing a review of the problem, changing/revising the operating procedures for the reactor, holding a training session for the reactor operators concerning the problem, and notifying the NRC.

Three non-cited violations were identified for: 1) failure to follow procedure, 2) failure to have an adequate procedure, and 3) failure to perform an adequate 10 CFR 50.59 Safety Evaluation.

Enclosure

## REPORT DETAILS

### 1. Persons Contacted

#### Licensee Employees

- \*S. Bilyj, Manager, Reactor Operations
- \*V. Brown, Assistant, Nuclear Reactor Program
- \*D. Dudziak, Department Head, Nuclear Engineering
- M. Harrison, Radiation Protection Officer
- \*K. Kincaid, Chief of Reactor Maintenance
- \*C. Mayo, Director, Nuclear Reactor Program
- W. Morgan, Manager, Radiation Projects
- \*P. Perez, Associate Director, Nuclear Reactor Program
- \*C. Plavney, Chief Reactor Operator
- \*G. Wicks, Reactor Health Physicist

\*Attended the exit interview on December 6, 1995.

### 2. Class II Operations - Linear Channel Malfunction (40750)

Following a malfunction of a new linear channel, the licensee notified the NRC of the problem by a letter dated November 29, 1995. The letter outlined the licensee's review of the circumstances surrounding the linear channel malfunction and their determination of the possible procedural non-compliances involved. Subsequently, an NRC inspection was performed to review the event.

As outlined in the licensee's letter, the inspector confirmed that during September and October 1995, the licensee had initiated a project to upgrade their nuclear instrumentation channels under the provisions of 10 CFR 50.59 and after receiving the approval of their Reactor Safety and Audit Committee (RSAC). As part of this project they replaced their source range, intermediate, linear, and safety channels. The instruments were installed following a sequential schedule which allowed the new instruments to be cross-checked with the remaining nuclear channels.

On November 6, the reactor was being operated to perform post maintenance testing of the safety channel using the form, "Request for Reactor Operation" (runsheets). The runsheet stipulated the project as, "PULSTAR Project #P-30," the Experiment Number as 05028-1, and the purpose as "safety channel testing." No mention was made on the runsheet of post maintenance testing or evaluation of the linear channel. At one point in the operation, reactor power was increased but the Gamma Metrics (G-M) linear channel failed to automatically up-range. When that happened, the operator placed the channel in the "manual" mode, which was not addressed by the operating procedure, and manually up-ranged the linear channel. Reactor power was then decreased and the linear channel automatically down-ranged as expected. Reactor power was then increased and the linear channel automatically up-ranged. These evolutions were repeated and the auto ranging mode responded as expected. No further anomalies were observed during reactor operations on that date.

On November 15, the reactor was started and operations were begun using a properly completed "Request for Reactor Operation" (runsheets). The runsheet indicated that the project was PULSTAR Project #P-40, the Experiment Number was 05034-1, and stipulated that the purpose of the reactor run was "Boron Analysis In Support of BNCT." This was to be a standard operation using the Project #P-40 criteria which did not include any testing or troubleshooting of the reactor instrumentation. During this operation the linear channel again failed to automatically up-range. Reactor power was then decreased and the channel down-ranged as expected. Power was increased again and the channel failed a second time to automatically up-range. At that point, the channel was placed in "manual" and was successfully up-ranged and down-ranged with the reactor at a constant power level. The reactor was then shut down and the licensee began investigating the problem using the maintenance procedure. The linear channel card was determined to be defective and was subsequently sent to Gamma Metrics for repair. The reactor remained shutdown following the second failure of the linear channel and a review of the problem was begun.

In reviewing these events, the licensee determined that the reactor operators had not followed the PULSTAR Operating Manual (POM) procedures when they placed the linear channel in "manual" mode and manually up-ranged and down-ranged the channel. Likewise, the operators had not adhered to the runsheet instructions when they performed post installation testing and evaluation of the linear channel during other operations of the reactor. The licensee also determined that the POM procedures did not provide the operators with instructions or guidance for an abnormal channel behavior such as those experienced on November 6 and 15.

After further review of the incident by the licensee, a letter was written to the RSAC, dated December 4, 1995, which outlined the incident as described above. The letter also indicated that a further 10 CFR 50.59 safety evaluation had been performed because questions had arisen concerning the configuration of the linear and safety channels and operating the linear channel in the auto ranging mode. The licensee found that the protective action set-points of both channels were configured as "percent of full power" rather than "percent of full (meter) scale" as had been anticipated. After performing a 10 CFR 50.59 safety evaluation of the linear channel configuration, the licensee concluded that the "percent of full power" set-point configuration did not involve a technical specification change or constitute an unreviewed safety question. The second 10 CFR 50.59 safety evaluation also confirmed that implementing the auto ranging mode of operation did not require a technical specification change or constitute an unreviewed safety question. The licensee also determined that deviations from the original 50.59 safety evaluation resulted from not comparing the as-built linear channel to the preliminary technical description and from not performing a post installation verification to demonstrate conformance with the 10 CFR 50.59 scope.

### 3. Corrective Actions by the Licensee (40750)

The licensee determined that various actions were needed to correct the problems noted during their review of the linear channel malfunction event. These corrective actions included the following:

- Revise the POM to allow for operation of the linear channel in the "manual" mode (scheduled for completion by January 31, 1996).
- Write a new procedure to address immediate operator action following abnormal instrumentation behavior (scheduled for completion by January 31, 1996).
- Provide training for the reactor operators to review adherence to approved runsheet specifications for reactor evolutions, and review reactor status, maintenance operations, and 10 CFR 50.59 design changes and evaluations (scheduled for completion by January 15, 1996).
- Write a new procedure to provide guidance on the performance of 10 CFR 50.59 safety evaluations (scheduled for completion by March 1, 1996).

By a letter to the NRC, dated December 15, 1995, the licensee indicated that the first three of the corrective actions mentioned above had been completed.

### 4. NRC Review of the Linear Channel Malfunction (40750)

10 CFR 50.59 requires the licensee to perform a safety evaluation of proposed changes to the facility which involve a change in the technical specifications (TS) incorporated in the license or an unreviewed safety question.

TS 6.3.a.1 and 7 require that operating procedures pertaining to normal startup, operation, and shutdown of the reactor and periodic surveillance activities be written, updated periodically, and followed.

POM, Section 3, Reactor Operating Procedures, Revision (Rev.) 15, dated November 6, 1995, stipulates in Step 3.2 that a properly completed and authorized "Request for Reactor Operations" is required for each reactor start.

POM, Section 3, Reactor Operating Procedures, Rev. 15, dated November 6, 1995, describes in Step 3.2.1.1 the sequence of events performed by the operator for normal reactor start-ups. Step 3 of the sequence instructs the operator to place the linear channel "Range Select Mode" to "AUTO." The procedure does not subsequently address operating the reactor with the linear channel "Range Select Mode" in manual mode.

The inspector reviewed various licensee documents relative to the malfunction of the linear channel. These documents included the technical specifications, reactor operating procedures, the operations log, runsheets, the maintenance log, the licensee's 10 CFR 50.59 Safety Evaluation of the instrumentation upgrade, and the strip charts which

recorded the linear channel operations. The inspector also discussed these events with various members of the licensee's operations staff and licensee management.

After review of this event by the inspector, it was determined that the reactor operators had operated the reactor contrary to the instructions outlined in the POM by placing the linear channel in "manual" mode of operation. The licensee was informed that operating the reactor in the "manual" mode was an apparent violation of TS 6.3 for failure to follow procedure (50-297/95-02-01). However, this licensee-identified and corrected violation is being treated as a Non-Cited Violation (NCV), consistent with Section VII.B.1 of the NRC Enforcement Policy.

Upon reviewing the actions of the operators during the period when the linear channel failed to up-range properly and before the reactor was shutdown, the inspector determined that the operators were performing troubleshooting activities under a "Request for Reactor Operation" authorization that did not allow such operation. The licensee was informed that this was another example of an apparent violation of TS 6.3 for failure to follow procedure (50-297/95-02-01). However, as noted above, this licensee-identified and corrected violation is being treated as a NCV, consistent with Section VII.B.1 of the NRC Enforcement Policy.

A review of the POM, Section 3 indicated that the procedure lacked instructions or guidance for an abnormal channel behavior such as those noted on November 6 and 15. The licensee was informed that not providing adequate instructions for reactor operators during abnormal instrumentation behavior was an apparent violation of TS 6.3 for having an inadequate procedure for operation of the reactor (50-297/95-02-02). This licensee-identified and corrected violation is being treated as a NCV, consistent with Section VII.B.1 of the NRC Enforcement Policy.

The 50.59 Safety Evaluation was deemed to be inadequate because it had not reviewed the implementation of the auto ranging mode of operation of the linear channel and it did not require post installation verification of the new equipment to demonstrate conformance with expected conditions, characteristics, and performance. The licensee was informed that failure to perform an adequate Safety Evaluation was an apparent violation of 10 CFR 50.59 (50-297/95-02-03). This licensee-identified and corrected violation is also being treated as a NCV, consistent with Section VII.B.1 of the NRC Enforcement Policy.

Three NCVs were identified.

#### 5. Review of Research Reactor Terminated Licenses (40750)

On October 1, 1955, North Carolina State University was licensed to operate a homogeneous reactor up to a power level of 100 watts when the Atomic Energy Commission (AEC) issued License No. R-1. The facility was used for training and related activities. In December of 1962, the licensee wrote a letter to the AEC indicating that it was no longer economically feasible to continue operation of the reactor and that the space was needed for other projects. Subsequently, the AEC issued an Order to Authorize Dismantling of the reactor on August 12, 1963. The

reactor was dismantled and component parts, excluding the shielding blocks, some graphite blocks, and the radium-beryllium start-up source, were stored on site until a transfer was arranged to Mississippi State University. A Request for Termination of Facility License No. R-1 was submitted to AEC on August 23, 1965. The licensee indicated that the appropriate air samples, contamination surveys, and radiation surveys were performed during and after the dismantling of the reactor.

A review of this information by Oak Ridge Associated Universities (ORAU) in 1991 indicated that no survey data was available in the docket file concerning the dismantling of this reactor. A search of the available records at the licensee's facility did not reveal further information on this matter. Therefore, it was decided to perform whatever surveys were possible to determine the current status of the site where the reactor had been located; in Room 117 of the Bureau of Mines Building.

As a result, the inspector and a licensee representative visited the Bureau of Mines Building on December 6, 1995, to perform radiation and contamination surveys of Room 117 and the surrounding areas. The licensee performed the radiation measurements using a Ludlum MicroR meter, Model 19. The instrument had been calibrated on June 14, 1995. It was noted that the background was 5 microrem per hour ( $\mu\text{R/hr}$ ). The survey was initiated after entering the front door of the building. The front hallway was surveyed, as well as Room 117, surrounding offices, and the areas directly under and to each side of Room 117 in the "basement". The readings were in the range of 5-7  $\mu\text{R/hr}$  as indicated below:

<u>Area Surveyed</u>	<u>Survey Results in <math>\mu\text{R/hr}</math></u>
Front hallway of building	5.0 - 7.0
Room 117 - located against back wall	5.0 - 6.0
Areas on each side of Room 117	5.5 - 6.5
Area below Room 117 - basement	5.5 - 6.0
Areas on each side of Rm 117 - bsmt	5.0 - 6.0

Contamination surveys were contemplated until it was noted that the areas in question had been carpeted and a smear survey would not have provided any meaningful data. The walls had been painted and no survey could be taken there.

No violations or deviations were identified.

## 6. Exit Interview

The inspection scope and results were summarized on December 6, 1995, with those persons indicated in Paragraph 1. The licensee's procedures, Safety Review, and event review and initiation of corrective actions were reviewed. The licensee did not identify as proprietary any of the material provided to or reviewed by the inspector during this inspection. The following NCVs were identified:

<u>Type</u>	<u>Item Number</u>	<u>Status</u>	<u>Description and Reference</u>
NCV	50-297/95-02-01	Closed	Violation of TS 6.3 for failure to follow procedures (Paragraph 4).
NCV	50-297/95-02-02	Closed	Violation of TS 6.3 for failure to have an adequate procedure instructing operators in what to do in case of abnormal instrument behavior (Paragraph 4).
NCV	50-297/95-02-03	Closed	Violation of 10 CFR 50.59 for failure to perform an adequate Safety Evaluation of the instrumentation upgrade project (Paragraph 4).