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

Report No.: 50-160/94-01

Licensee: Georgia Institute of Technology
225 North Avenue
Atlanta, GA 30332

Docket Nos.: 50-160 License No.: R-97

Facility Name: Georgia Institute of Technology Research Reactor

Inspection Conducted: March 9 and 10, 1994

Inspector: C Bassett 3/30/94
Craig H. Bassett, Senior Radiation Specialist Date Signed

Approved by: E J McAlpine 3/30/94
Edward J. McAlpine, Chief Date Signed
Radiation Safety Projects Section
Nuclear Materials Safety and Safeguards Branch
Division of Radiation Safety and Safeguards

SUMMARY

Scope:

This reactive, announced inspection involved review of an event which occurred February 15, 1994. This inspection also included review of a concern about the structural stability of the administrative/laboratory building which is adjacent to the reactor building.

Results:

The February 15, 1994 event occurred when a licensed Senior Reactor Operator failed to follow procedures during reactor startup. This resulted in operation of the reactor for one hour at a power level of 500 kilowatts with two disabled scram functions. The scram functions were associated with high thermal shield temperature and high bismuth block temperature and were not required to be operational by the Technical Specifications. During the licensee's investigation, an additional example of failure to follow procedures was identified as having occurred the previous week during reactor shutdown.

Documentation dealing with the construction of the reactor and the administrative/laboratory building and information provided by the licensee confirmed that the building was constructed on a firm foundation of weathered rock, and that reactor safety would not be jeopardized by potential problems with the sewer line that runs under one corner of the building.

Within the areas inspected, two examples of a non-cited violation for failure to follow procedures were noted. One example involved failure to reinstall a fuse in a temperature recorder during reactor startup on February 15, 1994 (paragraph 2), and the other involved failure to remove three jumpers from the jumper panel during reactor shutdown on February 11, 1994 (paragraph 3).

REPORT DETAILS

1. Persons Contacted

Licensee Employees

R. Ice, Manager, Office of Radiation Safety
*R. Karam, Director Neely Nuclear Research Center
D. Parker, Senior Reactor Operator
B. Statham, Manager of Reactor Operations

Other licensee employees contacted included office personnel.

NRC Personnel

*E. McAlpine, Chief, Radiation Safety Projects Section

*Attended the exit interview on March 10, 1994.

2. Licensee Event Followup - Inoperable Scrams (92700)

a. February 15 Incident

Technical Specification 6.4.b.(1) requires that written procedures be provided and utilized for the following: normal startup, operation, and shutdown of the reactor and of all systems and components involving nuclear safety of the system.

Procedure 2002, "Reactor Operations - Precritical Startup Checklist and Shift Supervisor Approval", Revision (Rev) 10 dated January 13, 1994, Step 5.2.1.1 requires that a Control Room Precritical Checklist (Appendix A) be completed daily before the first reactor startup. Appendix A requires that, during the High Shield Temperature check, the fuse be removed from the TR-2 recorder. Following check out of the High Shield Temperature scram and the High Bismuth Temperature scram, Appendix A requires that the fuse be replaced in the TR-2 recorder.

During a management meeting at the Georgia Institute of Technology (Georgia Tech) on February 16, 1994, the licensee reported that there had been a problem at the facility on Tuesday, February 15, 1994 which occurred when a SRO failed to replace a fuse in the TR-2 recorder following a check-out of the recorder during a training session on reactor operation. The TR-2 recorder, therefore, was not functioning during a portion of the period when the reactor was operating. The recorder prints out the temperature of the thermal shield and the bismuth block and produces a scram signal on indication of high temperature. These scrams are not listed in the Technical Specifications as being required for reactor operation but the licensee considers them part of the reactor safety system and safety related instrumentation.

As a result of the fuse not being replaced in the TR-2 recorder, the reactor was operated for approximately one hour at a power level of 500 kilowatts (kW) without the two scrams being operable. (The reactor is licensed for power operations up to 5000 kW.) The SRO realized that there had been a problem and informed facility management on February 16. Following the incident, the facility director suspended the SRO's operating privileges while the incident was investigated. A panel was convened by the management of Georgia Tech to investigate the incident and review what actions should be taken, if any, with regard to the SRO involved.

b. Review of Operations Documentation

The inspector reviewed the logbook, the Appendix A Precritical Startup Checklist, the TR-2 recorder strip chart relating to the incident, and Procedure 2002. The inspector verified that appropriate entries were made in the logbook for reactor startup, changes in reactor status, and reactor shutdown. No entry was made of any problems. The Precritical Startup Checklist had been completed and all the applicable steps checked, including the step that verified that the fuse had been replaced in the TR-2 recorder. A review of the TR-2 recorder strip chart for February 15 indicated that the recorder had been operating for a period of time during preparations to begin initial startup of the reactor but that it had not been operational for approximately one hour. As noted above, the procedure directed the operator to remove the fuse from the TR-2 recorder for checkout of the recorder and then to replace the fuse in the recorder prior to reactor startup. The procedure and associated checklist appeared to be complete and provided adequate guidance.

The licensee was informed that failure to replace the fuse in the TR-2 recorder as required by procedure was a violation of TS 6.4.b. This violation, however, will not be subject to enforcement action because the licensee's efforts in identifying and correcting the violation meet the criteria specified in Section VII.B of the Enforcement Policy (50-160/94-01-01).

c. Safety Significance

The inspector reviewed the Technical Specifications (TS) and the Safety Analysis Report pertaining to the facility and interviewed reactor operations staff in order to determine the safety significance of operating the reactor without these two scrams being operable.

TS 3.2 specifies the minimum number of acceptable components for the reactor safety system and other safety related instrumentation. The required safety channels include, among others, the period scram, the power scram, and coolant low flow, coolant high temperature, and coolant low level scrams. The list of required safety channels does not include the high temperature thermal shield scram nor the high temperature bismuth block scram.

Section 4.4.5 of the Safety Analysis Report indicates that the thermal shield is composed of a 3½-inch thick layer of lead containing copper tubes of the shield cooling system and is located in the annular space between the external surface of the steel shield tank and an outer steel retainer. Its major function is to reduce heating in the concrete portions of the biological shield as a consequence of absorption of radiation from the core. Section 4.4.6 describes the bismuth block. The section indicates that there is a shielded room for bio-medical research located on the side of the reactor. This room is designed to allow accurate exposures of biological specimens to a wide-angle beam of thermal neutrons with a relatively low background of fast neutrons and gamma rays. Consequently, at one end of the this bio-medical facility there is an opening into the reactor. Within this opening is located the bismuth block to provide shielding for gamma radiation, water tanks for neutron attenuation, a collimator, and a shutter.

As a result of exposure to and absorption of radiation, both the thermal shield and the bismuth block were designed to have cooling systems. The scrams associated with these systems are designated in Table 4.3 of the Safety Analysis Report as being delayed scrams. The licensee indicated that a delayed scram has a 10-second delay built into the scram circuitry before the scram activates. If a problem develops in the portion of the system controlled by a delayed scram, the delay provides the operator with 10 seconds in which to take corrective action. The seven delayed scrams are not included with the others as being required for operation of the reactor. Table 4.3 also shows that there is a low thermal shield coolant flow delayed scram and a low bismuth block coolant flow delayed scram. These were both operational during the February 15 event and provided additional assurance through redundant, diverse means that the bismuth block and thermal shield cooling systems were monitored to ensure cooling functions and were protected during reactor operations.

Through discussions with the reactor operations staff, the inspector also noted that bismuth melts at approximately 530°F and lead at approximately 615°F. The set points associated with these two scrams, that were inoperable on February 15, were set at 120°F for each. Therefore, the set points were very conservative relative to the temperatures at which there could be a problem with the bismuth or the lead beginning to soften or melt. The licensee indicated that the thermal shield and the bismuth block may not need to be cooled and they plan to perform an experiment to prove that theory.

Based on the above, the inspector determined that, although operating a research reactor without the thermal shield high temperature scram and the bismuth block high temperature scram was not correct, there was little safety significance involved. The inoperable scrams were not required to be operational by the Technical Specifications. These scrams are not part of the accident safety analyses and were apparently added to provide additional equipment protective functions. The low coolant flow scrams associated with the thermal shield and the bismuth block were operational and provided a backup indication and shutdown function if there were a problem with the cooling system flow. Additionally, adequate coolant flow was maintained during the one hour period when the high temperature scrams were inoperable.

One non-cited violation was identified.

3. Licensee Event Followup - Jumpers Not Removed (92700)

a. February 11 Incident

Technical Specification 6.4.b.(1) requires that written procedures be provided and utilized for the following: normal startup, operation, and shutdown of the reactor and of all systems and components involving nuclear safety of the system.

Procedure 2006, "Reactor Shutdown Checklist", Rev 6 dated August 13, 1992, Step 5.2.2 requires that, when executing the shutdown, if it is the last day of the calendar week that the reactor will be operated, all items listed on the Checklist (Appendix A - Reactor Shutdown Checklist) shall be executed. On the first page of Appendix A it specifies that electrical jumpers be installed during completion of the shutdown checklist: TBA-29 to TBA-30, (Inhibit low D_2O flow scram channel 2), TBA-69 to TBA-82, (Allow automatic "D_2O Level" reset) and TBA-89 to TBA-98 (Inhibit Reactor Isolation valves not open scram). The next page of instructions of Appendix A contains the requirement to remove electrical jumpers TBA-69 to TBA-82 and TBA-89 to TBA-98. The third page in Appendix A requires that the electrical jumper be removed from TBA-29 to TBA-30.

During startup of the reactor on February 15, 1994, a group of three trainees were helping during the operation. One of the trainees was performing the startup under the guidance of an SRO. After startup, but prior to criticality, the trainee performing the startup noticed that three jumpers remained in the jumper panel. These were: TBA-29 to TBA-30, (Inhibit low D_2O flow scram channel 2), TBA-69 to TBA-82, (Allow automatic "D_2O Level" reset) and TBA-89 to TBA-98 (Inhibit Reactor Isolation valves not open scram). When this problem was noticed, the jumpers were immediately removed and the startup then proceeded. The other SRO on duty in the reactor building then informed the Manager of Reactor Operations.

When this problem was investigated, it was determined that the jumpers were apparently left in place after the shutdown the previous week, on February 11, 1994. Examination of the records showed that, although the checklist had been initialed signifying that the jumpers were removed, they had been left in place in the jumper panel.

This problem and the problem identified in Paragraph 2 above were reported to the NRC Region II in a letter from the licensee dated February 18, 1994. The letter reiterated the problems noted and the corrective actions taken to date. The letter and the Appendix A - Reactor Shutdown Checklist were reviewed by the inspector. They indicated that licensee staff members had noted the problem and had taken corrective actions, removing the jumpers prior to taking the reactor critical.

The licensee was informed that failure to remove the electrical jumpers as required by procedure was another example of a violation of TS 6.4.b. This violation, however, will not be subject to enforcement action because the licensee's efforts in identifying and correcting the violation meet the criteria specified in Section VII.B of the Enforcement Policy (50-160/94-01-01).

An additional example of a non-cited violation was identified.

4. Structural Stability of the Administrative/Laboratory Building

Following the problems that occurred with the main sewer system in the City of Atlanta (in the Orme Street Trunkline) during the heavy rains that occurred in the spring of 1993, there was a concern that some similar type of a problem could possibly develop on the Georgia Tech campus. In particular, it was thought that a sink hole, similar to the one that carried away a portion of a parking lot near a hotel and resulted in the deaths of two individuals, could develop near the reactor facility. This was a concern because there is a six-foot diameter branch line, leading from the main sewer line, that passes under a corner of the administrative/laboratory (admin/lab) building adjacent to the reactor building.

When this concern was brought up with the licensee, they contacted the City of Atlanta. The licensee was informed that the sewer line is inspected at least annually and that the last inspection, performed July 20, 1993, had indicated that there were no structural problems with the sewer line. The licensee also contacted the contractor who prepared the original building drawings and specifications for the reactor building and the admin/lab building and requested that the contractor provide a report on the structural stability of these two buildings. The contractor issued a report on October 4, 1993, indicating that the reactor and its foundation mat have gone through more than a quarter century's rigorous test and should remain structurally sound as long as the underlaying bearing rock remains unchanged. The contractor also recommended that a soils engineer be contacted to provide further information but added that the reactor structure should not be damaged, even if the building adjacent to it (the admin/lab building) should collapse since the two buildings are separated by an expansion joint and are not rigidly attached to each other.

By letter dated October 22, 1993, the licensee forwarded the contractor's report to the NRC Region II. The licensee also made an evaluation of the data studied by the contractor and issued a separate memorandum on their findings. The licensee's letter and memorandum stated that the ground floor (the reactor basement) is at an elevation of 892.92 feet from "sea level". The floor itself is seven feet eight inches thick and made of concrete. The floor rests on a 1/4-inch thick steel plate. Below the steel plate is a two-inch thick layer of sand and asphalt and below this is a one-foot layer of concrete. The steel plate in the floor foundation is tied to the 7/16-inch thick cylindrical steel tank which forms the sealed containment structure. The total thickness of the floor foundation is 8.85 feet and at an elevation of 884.07 feet. The original boring log indicates that the containment building structure rests on partially decomposed rock which should support a pressure bearing of 10,000 pounds per square foot (psf). Also, the floor foundation rests on a concrete ring 1.5 feet thick, excavated 11.59 feet deep through the bedrock foundation. This concrete ring rests on hard Gray Gneiss rock at an elevation of 872.5 feet from sea level. The ring forms an upside down cup filled with rock formation so that motion in any direction is not possible.

The licensee also requested the Manager of Facilities Engineering at Georgia Tech to evaluate the potential impact of any sewer failure on the admin/lab building. This evaluation was performed and the results were forwarded to NRC Region II by letter from the licensee dated March 7, 1994. This Facilities Engineering Manager reviewed the construction documents and records such as earth bore testing reports, foundation details, and construction specifications, and visited the building to inspect for any cracks due to structural shifting over the last 30 years of the facility's life. He noted that the admin/lab building's footings were placed on weathered rock and that the foundation structure forms a bridge to support the building over the existing sewer line. He concluded that, if the earth were to erode from under the admin/lab building, the building would be supported by the weathered rock formations.

During the inspection, the inspector reviewed the documents noted above. Other NRC staff engineers also reviewed the letters and documents provided by the licensee and agreed with the licensee's conclusion. The inspector also toured the reactor bay, control room, and basement, and the various floors of the admin/lab building. The inspector toured outside the buildings and throughout the adjacent parking lot to observe whether or not there were any cracks in the buildings or the parking lot that might have resulted from shifting or settling of the earth. No obvious problems were noted.

From a review of the construction documentation, it appeared that the licensee's conclusion that the building should withstand problems caused by a leaking or collapsing sewer line was substantiated. The inspector did note, however, that the majority of the utility lines, (i.e. electrical, steam, water, and pneumatic) enter the reactor building from the admin/lab building in the basement. If there were a problem with the admin/lab building collapsing, this would cut off most of the utilities to the reactor building. A review of the Safety Analysis Report for the facility indicates that, the reactor was designed to automatically shutdown upon power failure. If the reactor was operating at power when the power failed, there is an emergency core cooling system designed to supply cooling water to the core for 30 minutes following such a problem. This would allow the licensee time to take actions to establish supplementary cooling for the core. The system is designed so that supplementary cooling water can be supplied via pump and hose from the adjacent water storage pit located in the admin/lab building or from the city water lines. The pump has a gasoline engine for power and is tested monthly for operation. This system provides redundant and diverse means, as required by Technical Specifications, to reasonably ensure that cooling water would be supplied to the reactor core in the unlikely event of a loss of coolant accident as analyzed in the Safety Analysis Report.

5. Exit Interview (30703)

The inspection scope and results were summarized on March 10, 1994, with the licensee representatives indicated in Paragraph 1 above. The inspector discussed the findings for each area reviewed. An event on February 15, 1994, involved failure to follow procedure which resulted in operating the research reactor for one hour at 500 kW without two scrams being operable. It was noted that, although the research reactor had been operated without the two scrams, they were not required by the licensee's Technical Specifications for operation of the reactor. Another example of failure to follow procedures had occurred on February 11, 1994, during shutdown of the reactor.

Through a review of the documentation dealing with the construction of the administrative/laboratory building and through discussions with the licensee, it was determined that the building is built on a firm foundation of weathered rock. This should enable the building to withstand possible difficulties created by potential problems with the sewer line that runs under one corner of the building.

No dissenting comments were received from the licensee. The licensee did not identify as proprietary any of the material provided to or reviewed by the inspectors during this inspection.

Within the areas inspected, two examples of a non-cited violation were noted.

Item Number	Status	Description (paragraph)
50-160/94-01-01	CLOSED	NCV - Two examples of failure to follow procedures: 1) for completing the actions required by the checklist for startup of the reactor on February 15, 1994 (Paragraph 2), and 2) for completing the actions required by the checklist during shutdown of the reactor on February 11, 1994 (Paragraph 3).