

APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-072/90-01
50-407/90-01

Operating Licenses: R-25
R-126

Dockets: 50-072
50-407

Licensee: University of Utah (UofU)
Salt Lake City, Utah 84112

Facility Name: Nuclear Engineering Laboratory (NEL)

Inspection At: University of Utah, Merrill Engineering Building,
Salt Lake City, Salt Lake County, Utah

Inspection Conducted: September 24-28, 1990

Inspectors:

J. Blair Nicholas

J. B. Nicholas, Senior Radiation Specialist
Radiological Protection and Emergency
Preparedness Section

11/2/90

Date

for *J. Blair Nicholas*

M. M. Mendonca

M. M. Mendonca, Senior Project Manager
Non-Power Reactor Decommissioning and
Environmental Project Directorate
Office of Nuclear Reactor Regulation (NRR)

11/5/90

Date

B. Murray

B. Murray, Chief, Radiological Protection and
Emergency Preparedness Section

11/5/90

Date

Approved:

L A Yandell

A. B. Beach, Director, Division of Radiation
Safety and Safeguards

11/16/90

Date

Inspection Summary

Inspection Conducted September 24-28, 1990 (Report 50-072/90-01 and 50-407/90-01)

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Areas Inspected: Routine, announced inspection of the licensee's organization and management controls, training and qualifications, reactor operations, procedures, experiments, surveillances, radiological controls, emergency preparedness, physical security and safeguards, and notifications and reports.

Results: Within the areas inspected, one apparent violation, (failure to quantify the amount of byproduct material to be transferred to another license - paragraph 14) was identified. One unresolved item was identified (see paragraph 10), and 4 open items were identified. No deviations were identified.

The UofU TRIGA reactor facility appeared to be well managed and adequately staffed to handle the present experiment irradiation workload. The NEL had demonstrated good improvements in reactor operation and maintenance since the previous NRC inspection in February 1988. The cleanliness and order of the reactor facility was greatly improved. Reactor operators were qualified and training requirements had been met. Reactor operations were being performed in accordance with Technical Specification (TS) requirements. Audits were performed by the reactor safety committee (RSC) and included the information required by TS. Surveillance and reporting requirements had been met.

The radiation protection program at the NEL was considered adequate; however, several items for program improvement were identified for the licensee's evaluation. Confirmatory measurements performed by the inspectors did not identify any significant contamination or radiation levels. Personnel radiation exposures were generally minimal and were not in excess of 100 millirems per year. Radioactive effluent releases were minimal and were well within TS limits.

The licensee was implementing the physical security program and emergency response activities concerning emergency training and drills in accordance with the licensee's approved physical security plan (PSP) and emergency plan (EP).

DETAILS

1. Persons Contacted

Licensee

*J. J. Brophy, Vice President of Research, UofU
*J. S. Bennion, Senior Reactor Operator (SRO)
*K. C. Crawford, Reactor Supervisor
T. C. Gansauge, SRO
*D. K. Gehmlich, Reactor Administrator
G. C. Gilbert, Lieutenant, Campus Security
*B. L. Hardy, Health Physicist, Radiological Health Department (RHD)
L. D. Larsen, Associate Administrator, General Services
S. C. Palacios, Sergeant, Campus Security
J. W. Richins, Acting Supervisor, Building Maintenance Key Shop
*G. M. Sandquist, Director, NEL
*K. J. Schiager, Radiation Safety Officer (RSO), RHD
W. D. Shepherd, Chief, University Police
J. Unsuh, Dispatcher, University Police

*Denotes those present at the exit meeting on September 27, 1990.

2. Licensee's Actions on Previously Identified Inspection Findings

(Closed) Open Item (407/8801-013): Current Reactor Modification Training - This item was previously discussed in NRC Inspection Report 50-407/88-01 and involved the NRC concern regarding training of current reactor operators on the modifications to the TRIGA reactor involving computerization of rod control functions and reactor parameter displays. The inspectors examined the licensee's actions committed to in their August 4, 1988, response to the open item. The inspectors reviewed the current TRIGA reactor operator's requalification training program and requalification examination given in 1989 and verified that TRIGA reactor modifications were included in the biennial operator requalification training program. The licensee's completed requalification training of the current TRIGA reactor operators appeared to be adequate to resolve the NRC's concerns in this area.

(Closed) Open Item (407/8801-016): Timeliness of Response to Reactor Safety Committee Audit Findings - This item was previously discussed in NRC Inspection Report 50-407/88-01 and involved the apparent excessive time taken to resolve RSC audit findings. The inspectors examined the licensee's implementation of the steps committed to in their August 4, 1988, response to the open item. The RSC had developed an audit-finding tracking system and all audit findings have been included as part of the quarterly RSC meeting agenda. The audit findings are discussed at each RSC meeting and remain on the tracking list until resolved and closed during a RSC meeting. The licensee's RSC audit finding monitoring and

tracking system appeared to be adequate to resolve the NRC's concerns in this area.

(Closed) Open Item (407/8801-020): Leaking Fuel Element Identification - This item was previously discussed in NRC Inspection Report 50-407/88-01 and involved the licensee's investigation and testing of fuel elements for leaks. The inspectors reviewed the licensee's investigation and testing of TRIGA fuel elements for leaks. TRIGA operations logs indicated that the licensee identified the fuel elements which were indicating possible leakage. The licensee had replaced these fuel elements in the TRIGA reactor core. Since operation has resumed with the TRIGA reactor, the licensee has monitored reactor water for further indication of fuel leakage and no indication of fuel leakage has been detected. The licensee's replacement of defective fuel in the TRIGA core and the negative analysis results from monitoring the reactor water following the replacement of the leaking fuel elements was adequate to resolve the NRC's concerns in this area.

(Closed) Open Item (407/8801-025): Hiring of a Reactor Supervisor - This item was previously discussed in NRC Inspection Report 50-407/88-01 and involved the licensee hiring an additional full-time faculty member at the NEL to serve as reactor supervisor. The licensee hired an additional full-time faculty member qualified as a SRO on the UofU TRIGA reactor to oversee the reactor facility operation and assume the duties and responsibilities of the reactor supervisor. The new reactor supervisor assumed his duties at the NEL on October 1, 1988. The licensee's hiring of a full-time faculty member to serve as the reactor supervisor resolved the NRC's concerns in this area.

(Closed) Violation (407/8601-03): Failure to Fully Implement the Operator Requalification Program - This violation was previously discussed in NRC Inspection Reports 50-407/86-01 and 50-407/87-01 and involved the licensee's failure to fully implement the NRC-approved TRIGA reactor operator requalification program. The inspectors reviewed the TRIGA operator requalification records for the four current TRIGA reactor operators. It was verified that all the requirements of the NRC-approved requalification program were being documented satisfactorily including the completion of an annual requalification examination, issuance of an annual evaluation, and the completion of a biennial operator training program record which documented the completion of all the operator training program requirements for each individual TRIGA reactor operator. The licensee's corrective actions appeared to be adequate to resolve the NRC's concerns in this area.

(Closed) Violation (407/8801-007): Decreasing the Effectiveness of the Physical Security Plan Without NRC Approval - This violation was previously discussed in NRC Inspection Report 50-407/88-01 and involved the licensee's implementation of Revision 2 to the NEL PSP without prior NRC approval per 10 CFR Part 50.54(p)(1). The licensee submitted Revision 2 to the NEL PSP, dated January 10, 1989, to the NRC for approval. The inspectors reviewed the NRC's response to the licensee's

submittal of the PSP and determined that the licensee's PSP was approved by the NRC in a letter dated July 10, 1989. The licensee's corrective actions were satisfactory to resolve the NRC's concerns in this area.

3. Open Items Identified During This Inspection

An open item is a matter that requires further review and evaluation by the inspectors. Open items are used to document, track, and ensure adequate followup on matters of concern to the inspectors. The following open items were identified:

<u>Open Item</u>	<u>Title</u>	<u>Paragraph</u>
407/9001-01	Training Issues	6
407/9001-03	Argon-41 Ventilation Monitor	11
407/9001-04	Area Radiation Monitor Calibration	12
407/9001-05	Emergency Plan Training	17

4. Unresolved Item

An unresolved item is a matter about which more information is required to ascertain whether it is an acceptable item, a deviation, or a violation. The following unresolved item was identified:

<u>Unresolved Item</u>	<u>Title</u>	<u>Paragraph</u>
407/9001-02	Thermal Power Calibration Calculation	10

5. Organization and Management Controls

The inspectors reviewed the licensee's organization and staffing to determine compliance with Sections 6.1, 6.2, 6.5.1, 6.5.2, and 6.5.3 of the TRIGA TS and agreement with the commitments in the TRIGA Safety Evaluation Report (SER), NUREG-1096.

The inspectors verified that the organizational structure of the NEL for the TRIGA reactor operations was as defined in the SER and TS. The NEL staff assignments of responsibilities were described in the NEL Operations Manual. All organizational positions were filled with qualified personnel. There had been one NEL staff change in October 1988 since the previous NRC inspection of the UofU NEL facility. The licensee had hired an additional full-time faculty member to fill the position of reactor supervisor and oversee the daily operations of the reactor facility. The inspectors determined that the NEL director devoted approximately 25 percent of his time to TRIGA reactor activities and the reactor supervisor devoted about 75 percent of his time to directly overseeing TRIGA reactor activities. The reactor supervisor was supported by two SRO graduate students in conducting the TRIGA reactor program. The inspectors

verified that the supervisory control and reactor program implementing responsibilities specified in the SER and TS were being implemented.

The RSC's charter and membership were reviewed. The RSC membership was in accordance with the charter and TS requirements. The inspectors reviewed selected RSC meeting minutes and determined that the RSC meetings were being conducted at least quarterly during the period October 1988 through September 1990 in accordance with the charter and TS requirements. Additionally, the inspectors observed the conduct of a quarterly RS meeting on September 26, 1990, and noted that the meeting met the TS requirements and dealt with reactor safety issues in a comprehensive manner. The RSC meeting agendas, minutes, and conduct indicated that the RSC was performing the required reviews.

No violations or deviations were identified.

6. Qualification and Training

The inspectors reviewed the licensee's training program for NEL personnel and experimenters working in the NEL to determine compliance with the requirements of TRIGA TS 6.3, 6.4, and 6.5.2; 10 CFR Parts 19.12 and 55; and agreement with the Industry Standard ANSI/ANSI 15.4-1988 and Regulatory Guides 8.13, 8.27, and 8.29.

The inspectors reviewed the education and experience of the present NEL staff and RSC members and determined that all of the NEL staff and RSC members met the qualifications required in TS and ANSI/ANSI 15.4-1985.

The inspectors reviewed the licensee's TRIGA operator requalification program dated January 31, 1983. It was noted that the TRIGA operator requalification program had been approved by the NRC and it conformed to the requirements of 10 CFR Part 55, Appendix A. The TRIGA operator requalification training procedure was reviewed and found to be satisfactory to implement the operator requalification program. The reactor operator requalification examinations for 1988 and 1989 were reviewed and the completed examinations had been included in the training records for the SROs. The requalification training records for the four TRIGA SROs were reviewed and found to contain all the documentation required by the approved TRIGA operator requalification program. During the review of the TRIGA operator requalification training program, the inspectors were concerned with the formality of conducting and documenting the on-the-job training aspects of the requalification training program to assure operator familiarity with the annual maintenance shutdown program, control rod worth measurements, fuel inspection, and fuel temperature measurement system calibration. Therefore, the inspectors discussed these areas with the licensed operators. The operators who were interviewed demonstrated acceptable familiarity with the four items listed above; although, one SRO had to refer to the appropriate procedure to assure an accurate description of the fuel temperature measurement system calibration. These discussions indicated that the formality and content of the TRIGA operator requalification training program had been

significantly improved since the previous NRC inspection. However, the inspectors could not readily determine from review of the individual operator training program records as to how and when the on-the-job training of the four above listed items was conducted and completed. This item was discussed with the reactor supervisor. The licensee agreed to evaluate the inspectors' concerns and revise the biennial operator training program record as necessary to thoroughly document the completion of the on-the-job requirements listed in the TRIGA operator requalification training program.

The inspectors reviewed the NEL orientation training given to nonoperators, experimenters, and students who work in the NEL. It was noted that the licensee did not have a procedure which addressed the NEL access requirements for personnel working in the NEL. The orientation training material and examination were reviewed. The results of the examinations taken by four people in 1989 and nine people in 1990 were reviewed. Occasional workers in the NEL were only receiving the abbreviated orientation training conducted by the NEL staff. Students who worked routinely in the NEL as experimenters had received radiation protection training offered each academic quarter by the UofU RHD. The training conducted by the UofU RHD appeared to meet the requirements of 10 CFR Part 19.12 and included the material in Regulatory Guides 8.13 and 8.29. However, the abbreviated orientation training conducted by the NEL staff to occasional workers in the NEL did not include the material presented in the two above listed Regulatory Guides. This concern was discussed with the reactor supervisor. The licensee agreed to review and evaluate the NEL orientation training program relative to including the information contained in Regulatory Guides 8.13 and 8.29. These training issues are considered an open item pending review of the licensee's evaluations (407/9001-01).

No violations or deviations were identified.

7. License Conditions and Special Nuclear Material (SNM) Control and Accountability

The licensee's SNM control and accountability program was reviewed to determine compliance with 10 CFR Part 70 and TRIGA Operating License R-126.

The inspectors reviewed SNM storage and inventory for agreement with TRIGA Operating License R-126, Amendment 5, dated April 17, 1985. License Condition 2.B(2) authorizes the possession of a 5 curie sealed plutonium-beryllium neutron startup source and up to 4.9 kilograms of uranium-235. The inspectors determined that the licensee possessed 105 grams of Pu-239 which is equivalent to approximately 6.43 curies. This amount of Pu-239 is divided between a 5 curie sealed plutonium-beryllium neutron startup source stored in the TRIGA reactor tank and a Pu-239 foil of approximately 1.5 curies stored in the NEL Room 1205-B. The Pu-239 sources are licensed under the UofU's license from the State of Utah. The inspectors performed an inventory of the

TRIGA fuel the licensee had on site. The inspectors determined that the licensee had 5 spent TRIGA fuel elements in the spent fuel storage wells, 53 fuel elements in the fuel storage racks at the bottom and on the inside perimeter of the reactor tank, and 77 fuel elements in the TRIGA core. These values agreed with the licensee's inventory of 135 TRIGA fuel elements. Based on approximately 34 grams of U-235 per fuel element, the licensee's TRIGA fuel contains approximately 4.59 kilograms of U-235 which is less than the 4.9 kilograms of U-235 allowed by the TRIGA Operating License R-126.

No violations or deviations were identified.

8. Reviews and Audits

The inspectors reviewed the licensee's review and audit programs conducted by the RSC to determine agreement with commitments in paragraph 13.4 of the TRIGA SER and compliance with the requirements in Sections 6.5.4 and 6.5.5 of the TRIGA TS.

The inspectors determined that the RSC audits of operations and maintenance activities and radiation safety were being performed semiannually as required by the TRIGA TS. Audit reports generated during the period January 1988 through July 1990 were reviewed for scope to ensure thoroughness of program evaluation. The RSC audits included reviews of the TRIGA maintenance and operations logs, NEL procedures for reactor operations and maintenance, instrument calibration procedures, TRIGA operating records for TS compliance, unusual or abnormal events, and radiation safety. The inspectors determined that the RSC audits were meeting the TRIGA TS audit requirements. Minutes of the RSC meetings for the period January 1989 through July 1990 were reviewed. The RSC meeting minutes indicated that the required RSC reviews listed in the TRIGA TS 6.5.4 were being completed. During the RSC meeting held on September 26, 1990, and attended by the inspectors, it was noted that the RSC discussed the development of a review and audit checklist to ensure that all required RSC reviews and audits will be performed at the required frequencies. The licensee had developed a calendar to schedule and track all the required training, administration, and operations required activities including reviews, audits, reports, and instrument calibrations. The inspectors reviewed the 1990 calendar and determined that the NEL and RSC required activities were scheduled in accordance with TRIGA TS requirements. The RSC had developed an audit-finding tracking system which required all audit findings to be listed on the RSC meeting agenda. The audit findings were discussed at each RSC meeting and remained on the RSC tracking list until resolved and closed during a RSC meeting and so documented in the RSC meeting minutes.

No violations or deviations were identified.

9. Logs and Records

The inspectors reviewed the licensee's program for documentation of the TRIGA reactor operations and maintenance activities to determine compliance with Sections 4.35, 6.5.6, and 6.9 of the TRIGA TS.

The inspectors reviewed the documentation of reactor operations and maintenance for the TRIGA reactor for the period March 1988 through August 1990. The AGN-201 reactor was not operated during this period. The logs and records documenting TRIGA reactor maintenance, routine operation, fuel inventory and storage, fuel inspection, experiments, startup checklists, instrument checks and calibrations, radiation surveys, and personnel exposure were reviewed. The inspectors determined that the TRIGA reactor annual reports and operations and maintenance history logs adequately documented reactor operations and maintenance activities.

The inspectors reviewed the facility maintenance logs. Major modifications which were reviewed included the addition of a fast flux irradiation unit and a nonsafety-related computer monitoring system for monitoring certain reactor core parameters. The licensee had performed safety evaluations for these modifications in accordance with 10 CFR Part 50.59 requirements. Their safety analyses were found acceptable and met the 10 CFR Part 50.59 requirements.

During discussions with the licensee, the inspectors were informed that the licensee had plans to replace the current TRIGA reactor control console. The inspectors emphasized to the licensee the requirement to perform a thorough safety evaluation per 10 CFR Part 50.59 requirements prior to replacing the current TRIGA control console with emphasis on assuring that the probability of an accident had been thoroughly considered.

No violations or deviations were identified.

10. Procedures

The inspectors reviewed the licensee's NEL Operations Manual and TRIGA reactor operating procedures to determine agreement with commitments in paragraph 4.7 of the TRIGA SER and compliance with the requirements in Section 6.8 of the TRIGA TS.

The licensee had written and approved procedures, checklists, and data forms for safety-related and operational activities that included reactor startup, operation, and shutdown; maintenance; and calibration of equipment and instrumentation. A review of selected procedures and data sheets, revised and approved since the previous NRC inspection in February 1988, indicated that the licensee had made progress in developing programmatic procedures to meet the requirements of the TRIGA SER and TRIGA TS. The licensee's procedures were reviewed by the RSC and their reviews were documented in the quarterly RSC meeting minutes.

The inspectors reviewed the licensee's semiannual thermal power calibration data/calculation sheet, Form NEL-012, which was approved by the RSC on May 25, 1988. The inspectors' review identified three potential discrepancies. The first potential discrepancy involved the calculation of the water volume in the TRIGA reactor tank for use in the calorimetric calculation. Specifically, the licensee used for this calculation a circular cross-sectional area for the tank of 42,895 square centimeters; however, for a nominal reactor tank diameter of 8 feet minus piping and equipment volume, that reduces the cross-sectional area, the inspectors calculated a cross-sectional area for the reactor tank of about 46,500 square centimeters. This difference in reactor tank cross-sectional area could result in a nonconservative-calculational error in thermal power of greater than 8 percent. The second potential discrepancy involved the use of a constant specific heat value in the thermal power calculation rather than a temperature dependent specific heat value. The licensee used a specific heat value that corresponded to a temperature of about 17°C. The inspectors noted that the TRIGA reactor water temperatures ranged between 10°C and 23°C during three recent thermal power calibrations. The use of a constant specific heat value corresponding to a reactor water temperature of about 17°C was estimated to result in a possible error of approximately 0.2 percent in thermal power when compared to the thermal power result calculated using a temperature dependent specific heat value corresponding to the 10 - 23°C temperature range. The third potential discrepancy was the licensee's use of a constant value of 2003 joules per gram for the latent heat of vaporization when calculating the thermal power calibration as compared to a thermal power calibration calculated using a temperature dependent latent heat of vaporization value. The inspectors estimated that the use of a constant value for the latent heat of vaporization rather than a temperature dependent value could result in an error of approximately 0.5 percent in the thermal power calibration. These potential discrepancies in the TRIGA reactor thermal power calibration calculation were discussed with the licensee during the inspection and at the exit meeting on September 27, 1990. The licensee stated that the thermal power calibration methodology would be evaluated and action taken to resolve these potential discrepancies. This item is considered to be an unresolved item pending further assessment of the adequacy of the licensee's TRIGA reactor thermal power calibration methodology (407/9001-02).

In conjunction with the potential problem with the reactor thermal power calibration calculation, the inspectors noted that the reactor power level had generally been limited during routine operation to a maximum of about 90 percent to assure that the licensed power level of 100 kilowatts thermal power had not been exceeded. However, the inspectors also noted an entry in the TRIGA reactor operations log, dated February 22, 1989, that indicated that the reactor power monitoring instrumentation had been nonconservatively calibrated by approximately 5 - 8 percent. This type of nonconservative reactor thermal power instrument calibration has the potential for causing the licensee to exceed their licensed power level; however, the safety concern of this condition is not significant in that

the basis for TRIGA TS 3.1 indicates that TRIGA fuel can be safely operated up to power levels of at least 2.0 megawatts with natural convection cooling.

No violations or deviations were identified.

11. Reactor Operations

The inspectors observed reactor operations and reviewed logs and records to determine compliance with Sections 2.0, 3.0, and 5.0 of the TRIGA TS.

AGN-201

The AGN-201 reactor is being decommissioned. The reactor has not been operated since February 1985. The licensee had removed the bricks which surrounded the reactor as a radiation shield and a physical security barrier for the AGN fuel. The bricks were surveyed for radioactive contamination. No radioactive contamination was found on the bricks and they were released by the licensee for unrestricted use and were removed from the NEL reactor facility. The licensee had removed the AGN fuel from the reactor and had stored the fuel in the NEL facility spent fuel storage wells waiting approval for shipment of the AGN fuel to the Oak Ridge National Laboratory. The inspectors verified the SNM accountability of the AGN fuel and its safe storage and control until it can be shipped from the UofU reactor facility. The licensee had submitted a decommissioning plan for the AGN-201 reactor to the NRC for review and approval.

TRIGA

The inspectors inspected the licensee's facilities, operations and maintenance logs and records, RSC meeting minutes, annual reports, and experiments; interviewed TRIGA reactor operators; and observed the licensee startup and operate the TRIGA reactor at low power levels to verify reactor protection systems operation. The licensee indicated that the TRIGA reactor was routinely operated approximately 12 hours per week for the purpose of laboratory teaching, reactor system tests, reactor surveillances, and sample irradiations. The licensee initiated startup of the TRIGA reactor on September 26, 1990, and operated the reactor for approximately 30 minutes at 10 kilowatts steady-state power to demonstrate to the inspectors the operation of the reactor protective systems, the computer monitoring capability of several reactor parameters, and the computer capability to maintain steady-state power level.

The inspectors reviewed TRIGA reactor operations logs and records to determine compliance with the reactor's license conditions and TS requirements. The licensee had operated the TRIGA reactor at thermal power levels not in excess of 100 kilowatts in accordance with License Condition 2.C(1). The reactor safety limits for fuel element temperature were verified to be in compliance with TS 2.1 and 2.2. The TRIGA TS limiting conditions for operation were reviewed. The reactor shutdown margin was verified to be \$0.93 on August 22, 1990, during the semiannual

control rod worth determination. This value was greater than \$0.50 and in compliance with TS 3.2(1). The excess reactivity in the reactor was also determined during the latest semiannual control rod worth determination to be \$1.98 which was less than \$2.80 and in compliance with TS 3.2(4). All other reactor reactivity limitations were verified to be in compliance with TS 3.2. The reactor scram times for the scramble control rods were determined to be in the range of 0.7 - 1.4 seconds which were less than 2 seconds as required by TS 3.3.1. The inspectors verified that all the required reactor control system instrument channels required in TS 3.3.2 were tested and operable and included on the TRIGA Preliminary Check Sheet, Form NEL-001, which had been completed prior to each startup of the reactor. The reactor safety systems listed in TS 3.3.3 were all verified to be operable and included on the TRIGA Preliminary Check Sheet. The annual reports for 1989 and 1990 were reviewed and the argon-41 discharge limit of 4.0E-08 microcuries/milliliter ($\mu\text{Ci}/\text{ml}$) averaged over 1 year per TS 3.4 was not exceeded. Operation records indicated that the ventilation system had operated as required per TS 3.5. A review of TRIGA reactor experiment authorization forms determined that TS 3.6 limitations on experiments were checked for each experiment configuration prior to issuing experiment performance authorization. Effluent releases from the reactor facility had been controlled and were minimal per TS 3.7 as described in the annual reports. The primary coolant chemistry conditions had been maintained in accordance with TS 3.8.

The TRIGA design features for reactor fuel, reactor core, control elements, radiation monitoring system, fuel storage, reactor building ventilation system, and reactor pool water systems per Section 5.0 of the TS were inspected and verified. The TRIGA reactor fuel was verified to be of the type and enrichment described in TS 5.1. The inspectors reviewed the current TRIGA reactor core configuration map and verified that the fuel elements were positioned in the reactor grid plate in accordance with the core map and in compliance with TS 5.2. The three TRIGA reactor control elements were verified to have the required scram capability and contained the materials specified for standard TRIGA control elements in compliance with TS 5.3. All fuel elements not positioned in the TRIGA reactor core were stored in the TRIGA reactor pool in storage racks or in the NEL spent fuel storage pits. The fuel elements were stored in storage racks at the bottom of the reactor pool in an arrangement where the K_{eff} had been calculated to be less than 0.8 as per TS 5.5. The minimum free volume of the reactor room calculated by the licensee was verified acceptable by the inspectors and satisfied the TS 5.6(1) requirement. The stack from the reactor facility appeared to be of adequate height to meet the TS 5.6(2) requirement of at least 40 feet above the ground. The inspectors verified that the reactor cooling water systems were adequate to meet the requirements specified in TS 5.7. A pool level alarm was provided to indicate a loss of reactor coolant if the reactor pool level should drop more than 2 feet below the normal level. A hole had been drilled in the circulating water piping approximately 3 feet below the normal level of the reactor pool to prevent inadvertent siphoning of the reactor pool to a level less than 18 feet of water above the top of the reactor core.

Area radiation monitors were installed in key locations throughout the reactor facility at the surface of the TRIGA reactor pool, on the ceiling directly over the reactor pool, and in the exhaust ventilation duct. These area radiation monitors were gamma-sensitive detectors which had been calibrated and alert and alarm setpoints had been calculated to initiate an alarm at activity concentrations below maximum permissible concentrations (MPC) and provided activity readout at the reactor control console per TS 5.4(1). These monitors were verified to be operational and provided the required alarm function at the reactor control console during the completion of the TRIGA Preliminary Check Sheet prior to the reactor startup witnessed by the inspectors on September 26, 1990. The continuous air radiation monitor was an end-window Geiger-Mueller tube detector positioned in the reactor facility exhaust ventilation duct to measure the concentration of radioactive particulate activity in the reactor pool room collected on a particulate filter assembly installed in the reactor facility exhaust ventilation duct. This monitor had been calibrated and an alarm setpoint had been calculated at 50 percent of the MPC value for any airborne radioactive material not containing alpha emitters. The monitor initiated an alarm and provided an activity readout at the reactor control console per TS 5.4(2). TS 5.4(3) requires an argon-41 stack monitor which is to monitor the concentration of radioactive gases including argon-41 in the building exhaust and provide an alarm and activity readout at the reactor console. The radiation monitor used for this TS requirement was the same end-window Geiger-Mueller tube detector installed in the facility exhaust ventilation duct and used as the continuous air particulate radiation monitor. The inspectors discussed the use of this type of monitoring system as a stack argon-41 monitor with the licensee during the inspection. The current monitor appeared to be serving a multipurpose function of monitoring all airborne activity in the reactor facility ventilation exhaust including argon-41. No monitor had been installed to specifically monitor argon-41 in the ventilation exhaust and the licensee agreed to evaluate this installation for acceptability. Not having a ventilation exhaust monitor specifically designed and calibrated to monitor argon-41 gaseous activity is considered an open item pending evaluation by the licensee of the current ventilation gaseous monitoring system for argon-41 (407/9001-03).

No violations or deviations were identified.

12. Technical Specification Surveillance Requirements

The inspectors reviewed surveillance results to determine compliance with Section 4.0 of the TRIGA TS.

The inspectors verified that the fuel element temperature measuring channel had been calibrated semiannually per TS 4.2(2) and documented on Form NEL-011. The calibration records were reviewed for 1988, 1989, and 1990. The channel check for the fuel element temperature measuring channel was made each time the reactor was operated per TS 4.2(3) and documented on the TRIGA Preliminary Check Sheet, Form NEL-001.

The inspectors verified that the reactor shutdown margin had been determined in conjunction with the semiannual control rod worth determinations and documented on Form NEL-003. The results of these determinations were reviewed to determine compliance with TS 4.3.1(1). Surveillance records indicated that the control rods were visually inspected per TS 4.3.1(2) and documented on Form NEL-002.

The inspectors verified that the scram times were less than 1 second and measured at least annually in compliance with TS 4.3.2(1). The scram times were determined semiannually at the same time the control rod worth determinations were performed. Channel checks of each of the reactor safety system channels were performed before each day's operation per TS 4.3.2(2) and documented on the TRIGA Preliminary Check Sheet, Form NEL-001. Channel calibration of the power level monitoring channels was performed semiannually in compliance with TS 4.3.2(3) and documented on Form NEL-012. The inspectors reviewed the results of the reactor power level instrument calibrations for 1988, 1989, and 1990. The fuel temperature measuring channel was tested semiannually during 1988, 1989, and 1990 in compliance with TS 4.3.2(4).

The inspectors verified that the required radiation monitoring systems were installed and operational. The licensee's records indicated that the radiation monitoring systems were calibrated annually in compliance with TS 4.3.3 and documented on Form NEL-023. The inspectors reviewed the licensee's method of radiation monitor calibration for area radiation monitors, the exhaust stack particulate monitor, and the exhaust stack argon-41 monitor. The inspectors noted that the licensee was not using a certified calibration source traceable to the National Institute of Standards and Technology (NIST) to produce a specific monitor response when placed at a specific position from the monitor. Instead the licensee was placing a calibrated portable survey instrument next to the area radiation monitor, placing a noncertified cesium-137 source at various distances from the two detectors to produce varying dose rates at the detectors, and comparing the area radiation monitor reading to the calibrated portable survey instrument reading. If necessary, the area radiation monitor's zero and gain adjustments were changed to produce results within 10 percent of the calibrated portable survey instrument. This secondary standard method of calibration of the area radiation monitors, which does not directly use a certified calibration source, was discussed with the licensee during the inspection and at the exit meeting on September 26, 1990. The inspectors expressed their concern as to this unusual method of monitor calibration and the fact that a primary certified calibration source traceable to NIST was not being used. The licensee agreed to evaluate their area radiation monitor calibration method. This item is considered an open item pending further review by the inspectors (407/9001-04).

The inspectors reviewed the TRIGA Preliminary Check Sheet, NEL-001, for selected reactor startups during 1989 and 1990 and verified that the reactor room ventilation system was operational and that a negative air pressure was maintained in the reactor pool room during reactor operation.

The air pressure differential between the reactor pool room and the areas outside the reactor pool room was measured at 0.04 inches which was in compliance with TS 4.3.4.

The inspectors reviewed several of the licensee's completed TRIGA reactor experiment authorization forms and determined that an analysis of irradiation experiments had been performed by the reactor supervisor and approved by the RSC, if required, in compliance with TS 4.3.5.

The inspectors reviewed the results of the biennial fuel element inspection performed on January 29, 1990, and documented on Form NEL-004. The licensee had performed a visual inspection for damage or deterioration of all fuel elements in the TRIGA reactor core and in storage in compliance with TS 4.4. However, the licensee did not perform physical measurements on each of the fuel elements to determine any transverse bend or elongation of the fuel element. TS 4.4 implied that these measurements should be done during each inspection of each fuel element along with the visual inspection to determine fuel element damage severe enough to remove the fuel element from further use in the TRIGA reactor core. The licensee stated that they were of the understanding that the transverse bend and elongation measurements only had to be performed as confirmation of fuel element damage or deterioration if the visual inspection should so indicate. The licensee also stated that subjecting the fuel elements repeatedly to the transverse bend measuring device could produce physical damage to the aluminum clad fuel elements by scratching the cladding. The inspectors reviewed the licensee's TRIGA TS dated September 30, 1975, and compared the fuel inspection requirements to those in the licensee's TRIGA TS dated March 1985. The fuel inspection criteria expressed in the 1975 TS stated that any fuel element which appeared damaged by the visual inspection shall be measured for bend and length. This was the interpretation the licensee was also applying to their current fuel inspection TS. An interpretation of the current TS requirements was requested from the NRC staff in the Office of NRR and they stated that the licensee would not be required to measure each fuel element for transverse bend or elongation during each biennial inspection unless visual damage or deterioration was indicated. Therefore, it was suggested that the licensee apply for a TS amendment which would be similar to the 1975 TS requirement and clarify the specific requirements of the biennial fuel inspection.

The licensee's records indicated that primary coolant water conductivity and pH values were within TS 4.5 limits.

No violations or deviations were identified.

13. Experiments

The inspectors reviewed the licensee's program for control and conduct of reactor experiments including evaluations, conduct, and documentation of experiments to determine compliance with Sections 1.2, 3.2, 3.6, 4.3.5, and 6.5.4(1) of the TRIGA TS.

The inspectors reviewed selected TRIGA reactor experiment authorization forms which documented the licensee's requirements regarding the evaluation, review, and approval of reactor experiments. The inspectors determined that the licensee's experiment authorization form included the requirements in the TRIGA TS. It was noted that the reactor supervisor approved all experiments and the RSC reviewed all new and Class II experiments. The TRIGA reactor had been primarily used for the irradiation of ore samples, biological samples, and the production of isotopes for medical tracer applications.

No violations or deviations were identified.

14. Transportation of Radioactive Materials

The inspectors reviewed the licensee's program for the transportation of radioactive materials to determine compliance with the TRIGA reactor license condition requirements and the requirements of 10 CFR Parts 20.5 and 30.41.

The inspectors determined that the licensee had not made any shipments of SNM or reactor components offsite since the last NRC inspection in February 1988. However, the licensee had transferred byproduct material produced during the irradiation of samples in conducting experiments to other licensed personnel authorized to receive such byproduct material. The inspectors reviewed selected TRIGA reactor irradiation request and performance data sheets, Form NEL-027, which had been completed for each irradiation experiment. This form documents the sample and reactor data and material release survey data associated with each experiment. It was noted that the form did not include the quantity of byproduct material being transferred.

10 CFR Part 30.41(c) requires, in part, that "Before transferring byproduct material to a specific licensee of the Commission or an Agreement State . . . , the licensee transferring the material shall verify that the transferee's license authorizes the receipt of the type, form, and quantity of byproduct material to be transferred."

10 CFR Part 20.5 requires, in part, that the quantity of radioactivity for purposes of the regulations shall be measured in terms of disintegrations per unit time or in curies. The inspectors determined on September 25, 1990, that the licensee was not determining the quantity (activity) of the byproduct material being transferred to another licensee and documenting this isotopic quantity on Form NEL-027; therefore, indicating that the licensee had not verified that the transferee's license was authorized to receive that quantity (activity) of byproduct material generated by the experiment and being transferred. The failure to determine the quantity of byproduct material being transferred and verifying that the transferee's license was authorized to receive that quantity of byproduct material is considered an apparent violation of 10 CFR 30.41(c). After discussing this matter, the licensee revised Form NEL-027 to specifically require the activity of each radionuclide in each sample be documented on the form. The revised Form NEL-027 also documents that the transferee's

license is authorized to receive that quantity of byproduct material. Therefore, in accordance with 10 CFR Part 2, Appendix C, Section V.A. of the NRC's Enforcement Policy, no Notice of Violation is being issued for this violation.

No deviations were identified.

15. Radiation Protection

The inspectors reviewed the licensee's radiation protection program to determine compliance with Sections 3.7, 4.3.3, and 5.4 of the TRIGA TS and 10 CFR Part 20 and agreement with the recommendations of Industry Standard ANSI/ANS-15.11-1977.

Radiation exposure records for NEL personnel were reviewed. It was noted that not everyone who worked in the reactor facility had been issued personal dosimetry. An example of this was that several students from Weber State College had worked on the new Berkley reactor console located in the reactor room without being issued personal dosimetry. The review of radiation survey data indicated that personnel working in the reactor area would not exceed 10 CFR Part 20.101 limits, but the licensee stated that they planned to review their personal dosimetry program to ensure that procedures clearly address workers that are required to wear dosimetry devices.

The inspectors also reviewed the licensee's program for issuance of self-reading pocket dosimeters (SRDs) to visitors or occasional students working in the reactor facility. The licensee had several 0-200 millirem (mR) SRDs stored on a rack behind the reactor control room door. These SRDs had not been calibrated nor drift checked and the licensee did not have a calibration and quality control program established for SRDs as recommended by Regulatory Guide 8.4. The licensee informed the inspectors that these SRDs were issued to students as educational tools and were not intended for documenting personnel exposure. Therefore, the licensee had no official means of issuing temporary personal dosimetry to occasional visitors or students in the reactor facility other than issuing a film badge from the RHD.

The inspectors reviewed selected monthly radiation and contamination survey records for 1989 and 1990 performed by both the UofU RHD and NEL personnel. The radiation surveys appeared thorough and indicated very little contamination. The inspectors performed independent radiation surveys throughout the NEL and reactor facility on September 27, 1990, and found very little indication of radiation or contamination greater than background levels. The only radiation level detected greater than background was in contact with the reactor water demineralizer resin tank which indicated approximately 2 mR per hour on contact.

The inspectors noted that the licensee had not established a personnel frisking station to identify possible contamination on individuals exiting the reactor room. The possibility of establishing a frisking station at the exit from the reactor room was discussed with the licensee.

The inspectors noted that the licensee does not routinely perform neutron surveys of the reactor facility during reactor operation. The licensee indicated that the last neutron survey was performed in 1985 but could not produce the results of that survey. Neutron surveys were discussed with the licensee by the inspectors who indicated that although the reactor is operated at low power levels, it might be prudent for the licensee to have documentation to support the potential for or lack of neutron exposure as a result of reactor operation.

During the review of the RSC radiation safety audit performed August 8, 1989, the inspectors noted that the director of the NEL, Dr. G. M. Sandquist, had received a neutron badge reading of 5.03 rem for November 1988 that had been investigated and determined to be erroneous. The inspectors reviewed the investigation report dated January 26, 1989, and concurred with the results of the investigation. The investigation of the high neutron badge reading was thorough and handled immediately upon notification from the film badge vendor. The investigation determined that the neutron exposure must have been erroneous since the TRIGA reactor was shut down, the neutron generator was not operational, and the 60 micrograms of californium-252 were stored in a 10-foot deep tank of shielding water. Since the potential overexposure was determined to be erroneous by the UofU RHD within 24 hours of being notified by the film badge vendor, no notification was required to be made to the NRC. This matter was discussed with the licensee. Even though no specific violation of 10 CFR Part 20.403 occurred, the licensee revised their personal exposure investigation procedure and reporting form to include notification of the NRC if a reported or potential dose exceeds 5 times the annual limit and is involved with the reactor operation.

No violations or deviations were identified.

16. Radiological Effluent and Environmental Monitoring

The inspectors reviewed the licensee's radiological environmental monitoring program to determine agreement with commitments in paragraphs 12.6 and 12.7 of the TRIGA SER and compliance with the requirements of Sections 3.4 and 3.7 of the TRIGA TS and 10 CFR Part 20.106.

The inspectors reviewed the licensee's annual reports for the periods July 1, 1988, through June 30, 1989, and July 1, 1989, through June 30, 1990, concerning effluent releases and environmental monitoring. During the period July 1988 through June 1989 the total liquid waste radioactivity released to the environment was estimated to be 2.84 μCi of cobalt-60. The average annual calculated concentration of argon-41 generated during operations was estimated to be 1.6.3E-10 $\mu\text{Ci}/\text{ml}$ which was 0.4 percent of the MPC for argon-41. The total amount of gaseous radioactivity released was estimated at 53.5 μCi . For the reporting period July 1989 through June 1990, the licensee reported no release of liquid radioactive effluent. The average annual calculated concentration of argon-41 generated during this reporting period was estimated at

1.93E-10 $\mu\text{Ci}/\text{ml}$ which was approximately 0.5 percent of the MPC for argon-41. The total amount of argon-41 released was estimated at 63.4 μCi . During 6 months of this reporting period, approximately 4.42 millicuries (mCi) of phosphorus-32 and other radionuclides were released from the UofU NEL as a result of processing sulfur foil dosimeters. The total amount of all gaseous radioactivity released between July 1989 and June 1990 was estimated to be 4.48 mCi.

The licensee's environmental monitoring program is primarily conducted by operating and maintaining the air monitoring station located outside the reactor building for the U.S. Environmental Protection Agency. The measurement results from the air monitoring station for the period July 1, 1988, through June 30, 1990, indicated no unusual changes in radiation or radioactive material concentrations. The UofU RHD conducted quarterly environmental radiological surveys by positioning six thermoluminescent dosimeters in the areas surrounding the NEL located in the Merrill Engineering Building. No unusual dose rates were detected.

No violations or deviations were identified.

17. Emergency Planning and Preparedness

The inspectors reviewed the licensee's EP for the TRIGA reactor and the NEL facility to determine agreement with commitments in paragraph 13.3 of the TRIGA SER and compliance with the requirements of 10 CFR Parts 50.54(q) and (r) and the recommendations of Regulatory Guide 2.6 - 1983 and Industry Standard ANSI/ANS-15.16-1982.

The inspectors reviewed the assignment of responsibilities during an emergency and emergency facilities and equipment including medical facilities, communications, and rescue, fire, and radiation protection equipment. The inspectors verified that the inventories of emergency equipment and supplies agreed with the EP. The inspectors discussed with the Salt Lake City Fire Department and the UofU Medical Center their responsibilities in the event of a reactor accident or fire at the NEL.

The inspectors reviewed the UofU proposed EP submitted to the NRC for approval on June 1, 1990. The inspectors noted that Section 4 defined the emergency classifications as specified in ANSI/ANS-15.16-1982 and endorsed in Regulatory Guide 2.6-1983. Emergency classifications were defined according to potential radiation exposure and emergency response to each classification was detailed. Based on maximum hypothetical accident calculations, the external total body radiation dose would be much less than 1 mR and the thyroid dose would be less than 25 mR to the most exposed person offsite. Therefore, it had been concluded by the NEL staff that there were no accident scenarios that would lead to an emergency which would be classified more severe than an "Unusual Event."

The inspectors reviewed selected NEL emergency procedures and the training outline used in conducting training for emergency support personnel. Annual training had been conducted in June 1988, August 1989, and

August 1990. During discussions with campus emergency support personnel, it was noted that campus security play an active role in the emergency response to a reactor accident scenario since they control the keys and access to the NEL. However, they had not been specifically included in the annual training of campus personnel for emergency response and had not been consulted during the development of the annual emergency drill scenarios. This matter of including campus security personnel in the annual training and planning for the annual reactor emergency drill is considered an open item pending licensee evaluation (407/9001-05).

The licensee had conducted annual emergency drills on March 24, 1988, August 22, 1989, and September 17, 1990. The inspectors reviewed the critiques of the emergency drills conducted in 1989 and 1990 and found them to be detailed and complete.

No violations or deviations were identified.

18. Physical Security

The inspectors reviewed the licensee's physical security program to determine compliance with the requirements of the TRIGA Operating License Condition 2.C.(3) and 10 CFR Part 50.54(p) and the PSP, Revision 2, dated January 10, 1989.

The inspectors reviewed Revision 2 of the UofU PSP for the protection of SNM maintained at the NEL facility as submitted on January 10, 1989. This PSP was approved by the NRC in a letter dated July 10, 1989, and was currently being enforced. The inspectors verified that the site and facilities were consistent with the description given in the PSP. The inspectors examined the use and storage of SNM within the controlled access areas and verified that intrusion alarms functioned properly. An announced test of the UofU Police Department's response to an intrusion alarm was conducted. The appropriate intrusion alarms were observed on the campus police dispatcher's control panel and the campus police dispatcher followed established procedures in response to the reactor building intrusion alarm. The inspectors reviewed the security key control program and determined it to be adequate.

No violations or deviations were identified.

19. Reports and Notifications

The inspectors reviewed the licensee's submittal of reports and notifications to the NRC to determine compliance with the requirements of Section 6.10 of the TRIGA TS.

The inspectors reviewed the reactor facility annual reports for the period July 1, 1988, through June 30, 1990. It was determined that the annual reports met the TS requirements. No special reports had been issued to the NRC since the previous inspection of the UofU NEL facility conducted in February 1988.

No violations or deviations were identified.

20. Independent Inspection Effort

The inspectors observed a reactor startup, steady-state operation, and shutdown. The inspectors also performed independent radiation surveys and collected smear samples and a reactor pool water sample for the purpose of comparing analyses results with the licensee. The results of the smear analyses showed no detectable alpha contamination and only 91 disintegrations per minute beta-gamma activity on the smear taken on the reactor room floor near the reactor pool water demineralizer. All other smears indicated no detectable beta-gamma smearable contamination. Results of the reactor pool water sample taken at 12:30 p.m. on September 26, 1990, following reactor operation are given below:

<u>Sample Source</u>	<u>NRC Results</u> ($\mu\text{Ci}/\text{ml}$)	<u>Licensee's Results</u> ($\mu\text{Ci}/\text{ml}$)
Reactor Pool Water		
H-3	99.8E-05	3.80E-05
Cs-137	8.85E-08	1.00E-07
Co-58	1.84E-08	<MDA
Co-60	7.58E-09	<MDA

The discrepancies in the results were attributable to differences in counting times, instrumentation, analytical techniques, and sample geometry, but were found generally acceptable for this low level activity and for this type of facility. The tritium (H-3) activity was determined to be well below the 10 CFR Part 20, Appendix B, Table II, Column 2 release limit of 3.00E-03 $\mu\text{Ci}/\text{ml}$. Gamma spectral analysis of the reactor pool water indicated radionuclide activity concentrations well below the respective 10 CFR Part 20, Appendix B release limits.

No violations or deviations were identified.

21. Exit Meeting

The inspectors met with the licensee's representatives identified in paragraph 1 of this report at the conclusion of the inspection on September 27, 1990. The inspectors summarized the scope and the results of the inspection. The licensee stated that they would evaluate the open items concerning training, the argon-41 ventilation monitor, the calibration of the area radiation monitors, and EP training identified in the report. The PSP reviewed by the inspectors was identified as proprietary information.