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Docket No. 50-116 Ref: 10 CFR 50.71 (a)

July 28, 1997

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

To Whom it May Concern:

Please find enclosed the Annual Operations Report for the Iowa State University UTR-10 reactor. The period covered by this report is from July 1, 1996 to June 30, 1997.

Sincerely,

Scott E. Wendt

Scott E. Wendt, Reactor Manager
Mechanical Engineering Department

Enclosure

c: American Nuclear Insurers
D.B. Bullen, Facility Director
A.F. Rohach, Reactor Use Committee
E.E. Sobottka, Dir., Environmental Health & Safety
R.A. Jacobson, Chm., Radiation Safety Committee
W.R. DeVries, Chm., Mechanical Engineering Department
U.S. NRC, Region III

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Annual Operations Report
Iowa State University's
UTR-10 Reactor

Docket No. 50-116

July 1, 1996 to June 30, 1997

This is a routine operations report to the Nuclear Regulatory Commission in accordance with the requirements of Section 6.6 of the Technical Specifications, Appendix A to Operating License R-59.

**1. Summary of reactor operating experience including the energy produced by the reactor:**

The reactor is operated in support of the teaching and research efforts of the university faculty. During this reporting period, laboratory courses for both the Physics and Mechanical Engineering departments were conducted. The purpose of one laboratory experiment was to demonstrate radioactive decay using activated silver dimes and copper pennies. The purpose of the second was to demonstrate the procedure for calculating the reactor's thermal power. The reactor was also used to support the training of reactor operations personnel.

During the period July 1, 1996, to June 30, 1997, a total of 56.7 kW-hr of energy production and 126.5 hours of operation were recorded. Last year's numbers were 9.2 kW-hr and 105.9 hours of operation. Since the initial criticality of the LEU core in August of 1991, the cumulative kilowatt-hours are 260.1 kW-hr and the cumulative hours of operation are 796.5 hours. The total energy produced during the life of the facility (both HEU and LEU cores) is 7584.1 kW-hr with a cumulative operation time of 9467.8 hours. A percentage breakdown by operational categories for the years 96-97 and 95-96 is shown below.

**Table 1. Allocation of energy production and operation time, in percent.**

| Year | Research | Teaching Undergrad. | Teaching Graduate | Maintenance | Operator Training | Service |
|---|---|---|---|---|---|---|
| Energy % | | | | | | |
| 96-97 | 0.0 | 49.8 | 0.0 | 47.5 | 2.7 | 0.0 |
| 95-96 | 0.0 | 0.0 | 0.0 | 33.1 | 66.8 | 0.1 |
| Time % | | | | | | |
| 96-97 | 0.0 | 38.6 | 0.0 | 30.0 | 31.4 | 0.0 |
| 95-96 | 0.0 | 0.0 | 0.0 | 18.1 | 76.7 | 5.2 |

**2. Unscheduled shutdowns including, where applicable, corrective action taken to preclude recurrence:**

During this reporting period, there were four unscheduled shutdowns; three occurred while the reactor was critical at various power levels and one occurred while at 'normal operating level' prior to the withdrawal of any control rods.

The first unscheduled shutdown occurred on 7/31/96. The reactor was critical at a power of approximately 14 W when an SRO trainee (performing duties independent of the reactor operations) was instructed to open the primary coolant sample line to draw a one liter sample of the primary coolant. Opening the sample line caused a momentary spike in the pressure measured by the differential pressure cell causing an automatic scram due to an indicated high moderator level. After assessing the situation, the SRO at the reactor control console cleared the reactor for restart. All SROs were informed of this incident and instructed not to draw samples while the reactor is operating.

The second unscheduled shutdown occurred on 11/14/96. The reactor was critical at 10 kW during calibration of the wide range log power channels. While measuring voltages in the channel in accordance with the calibration procedure, an automatic scram occurred due to loss of high voltage. It was determined that the voltage fluctuation was caused by the use of the digital multi-meter measuring probes and reactor operations were resumed. The reactor operations staff was informed of this and cautioned to use extra care when performing this procedure. Subsequent calibrations were performed using different measuring probes with NO recurrence of the loss of high voltage scram.

The third unscheduled shutdown occurred on 1/28/97. The reactor operator was in the process of recovering from Hot Standby and attempting to level power at 1 W. The blue pen which indicates reactor power level from the multi-range linear channel and compensated ion chamber (tracing the power on the chart recorder) began to trend upwards. All other indications showed a continued decrease in reactor power. The SRO initiated a manual scram and secured the reactor. Follow-up investigations indicated that a resistor in the channel's pico-ammeter had failed. Further reactor operations were suspended until the old channel (and accompanying chart recorder) were replaced by a functionally equivalent unit purchased previously from Gamma Metrics. See page 4, paragraph 4 for further details.

The fourth unscheduled shutdown occurred on 6/24/97. A reactor start up was underway in order to perform measurement of control rod worths. While at normal operating level, prior to pulling control rods, a low flow alarm was received. Upon investigation, the moderator flow rate indication was found to be 0.0 gpm even though the primary coolant pump could be heard clearly by the operators and was apparently operating normally. This was confirmed by checking the pump discharge pressure which was found to be normal. The initial cause was suspected to be an entrained bubble in the pressure sensing line. The SRO cycled the primary coolant pump on and off in an effort to clear the suspected bubble. While doing this, an automatic high moderator level scram occurred.

The scram was determined to have occurred due to a pressure spike across the DP cell and restart was approved and shortly thereafter the flow indication returned to normal. It was later determined that the low flow indication was due to the process instrumentation test switch not being fully in the operate position. The electrical contacts on the process instrumentation switch were cleaned and no subsequent problems have occurred.

**3. Major preventive and corrective maintenance operations having safety significance:**

Three surveillance activities required by Technical Specifications were NOT completed within the specified time intervals. Although it is not included in the Technical Specifications, for many years it was incorrectly assumed that a 'grace' period of approximately 10% existed for the surveillance intervals. (Thus, the assumed grace periods were 3 days for monthly surveillances, 12 days for quarterly surveillances, and 30 days for annual surveillances.) In absence of the assumed grace period, the frequencies of the monthly area radiation monitor tests, the quarterly battery tests and the three year battery discharge test have all exceeded the specified time frames at least once during this reporting period. To preclude this from happening in the future, the individual elapsed intervals of each surveillance will be monitored and the surveillances will be performed in advance of its coming due.

Several annual maintenance procedures required for normal reactor operations were NOT completed within the allowed time period. Normal operations were suspended during this period until the required maintenance procedures could be completed. Before this could be accomplished, a component failure occurred with the linear power channel. The subsequent installation of a new channel and chart recorder kept the reactor staff from completing the required surveillance of the control rod reactivity worths. Normal reactor operations were suspended from January 28 through the end of this reporting period. The installation of the new instrumentation was completed in May. It is expected that the reactor will be cleared for normal operations after the control rod worth procedure is completed satisfactorily in late July, 1997.

In July of 1996, the facility's south area radiation monitor was temporarily relocated to accommodate the installation of larger access doors. In order to return it to its normal position the detector unit was disconnected so new conduit could be installed. When the detector unit was reconnected to the power module it was found to be inoperable. Since the south area radiation monitor is a required safety feature, normal reactor operations were suspended and the north area radiation monitor cable was used in conjunction with an extension cable to connect the south monitor with its module. Technical Specifications allow reactor operations without the north area radiation monitor as long as radiation readings are taken periodically using a hand held detector. Replacement parts needed to repair the south area radiation monitor were ordered from the manufacturer. During the four weeks that the parts were on order, the reactor was operated six times (at a maximum power of 10 W). Upon completion of repairs on August 9, all elements of the radiation protection system were tested and found to be operating satisfactorily.

Throughout the reporting period, monitoring of the "in core" cladding samples has continued. The samples do not appear to be changing. Also, fission product analysis using the high purity germanium detector (HPGe) has continued. No fission products have been detected in the primary coolant.

**4. Major changes in the reactor facility, procedures, and new tests or experiments, or both, that are significantly different from those performed previously and are not described in the Safety Analysis Report, including conclusions that no un-reviewed safety questions were involved:**

An electrical relay was added to the high radiation evacuation alarm system that will cause the building fire alarms to activate when the high radiation alarms are activated. This was done as a precaution to ensure that the evacuation alarm could be heard in all rooms in the Nuclear Engineering Laboratory. The fire alarm system has its own separate back up power supply consisting of a diesel generator located in the basement of an adjacent building. The standby battery power supply, which provides back up power to the area radiation monitors and high radiation evacuation alarms, was not altered and was satisfactorily tested per Technical Specification requirements in January 1997.

Fire code modifications to the Nuclear Engineering Laboratory, completed during the previous reporting period, necessitated amendments to the facility's Technical Specifications, Emergency Plan, and Security Plan. In addition, the proposed use of the BMI-1 shipping cask for HEU fuel shipments to Savannah River necessitated further amendments to the facility's Security Plan. The amendments were submitted and approved during this reporting period.

A new channel and chart recorder were installed in the reactor control console after an equipment malfunction (see Section 2 page 2). The new channel and chart recorder were on hand having been obtained from Gamma Metrics in 1993 as part of the DOE reactor upgrade program. A safety review was performed by the Reactor Use Committee (RUC) prior to installation and initial reactor operations with the new equipment. To avoid any problems similar to those experienced by North Carolina State University (NRC Information Notice 97-44), the equipment will be operated in 'manual mode' only. In addition, the reactors servo-auto power controller will NOT be used. Documents pertaining to the safety evaluation are included as an attachment.

There were no major changes in facility tests or experiments.

**5. Summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the University as determined at or before the point of such release or discharge. (Included, to the extent practical, are estimates of individual radio-nuclides present in the effluent.):**

Argon-41: The operating records show that less than 0.0021% of the concentration allowed by 10 CFR 20, Appendix B, Table II were released to the environs. This estimate is based on 56.7 kW-hr of energy production.

Note: Due to an editorial error, the Ar-41 concentrations reported for the last two reporting periods were not as accurate as they could have been. For the reporting periods 1994-95 and 1995-96, the Ar-41 concentrations were reported, respectively, as less than 0.09% and less than 0.04% of the concentration allowed by 10 CFR 20, Appendix B, Table II. The more accurate estimates for those reporting periods, respectively, are less than 0.0009% and less than 0.0004% of the concentration allowed by 10 CFR 20, Appendix B, Table II. The 'editorial' error was due to confusion in whether these very small numbers were already reported as a percentage or not.

Others: No measurable amounts of other radioactive effluents were released to the environs.

**6. Summarized results of any environmental surveys performed outside the facility:**

No environmental surveys outside the facility were required to be performed since the trigger level, based on surveys inside the facility, was not exceeded.

**7. Summary of exposure received by facility personnel and visitors:**

No facility personnel or visitors had exposures greater than 25% of that allowed or recommended. The only recorded exposure during the reporting period was 40 mrem to the finger badge of one SRO.

**8. Summary of items or events of significance which are NOT required to be reported to the NRC by Technical Specifications (courtesy notification):**

The required annual audit of the Quality Assurance Program for the Packaging and Shipment of Radioactive Materials from the Iowa State University Nuclear Engineering Laboratory has been overlooked since the program was developed and approved in 1995. In that time, the two annual audits which were conducted by the Reactor Use Committee (RUC) did not include an audit of the QA Program. A special audit of the QA program was performed by the RUC on July 17, shortly after the oversight was discovered. To prevent further omissions, the QA Program was added to the list of areas to be audited by the committee each year.

The special RUC audit revealed the need for a checklist with signature blocks to ensure better implementation of the QA Program.

The operating license of one SRO was inadvertently allowed to expire (on 9/6/96) before the application for renewal was submitted on 9/16/97. The SRO in question was not a regular employee and did not operate the reactor during the period that his license was expired. The renewal application was filed and his license was renewed effective 9/23/96. To help prevent a recurrence of this, an item requiring annual verification the SRO's license expiration date was added to the Operator Requalification Cards.

# Iowa State University
**OF SCIENCE AND TECHNOLOGY**

## Interoffice Communication

Date: June 30, 1997

To: E. B. Bartlett, Chairman
Reactor Use Committee

From: S. E. Wendt, Reactor Manager
Mechanical Engineering Department

Re: Safety Evaluation of the Installation and Calibration of the new Wide Range Linear Flux Channel in the UTR-10 Reactor

The purpose of this memo is to inform the committee that a safety evaluation, required by 10 CFR 50.59, was conducted by the RUC on 5/8/97 and 6/12/97 prior to reactor operations following a reactor instrumentation upgrade.

The upgrade involved a new wide range linear flux channel and accompanying chart recorder which was installed in the UTR-10 Reactor's control console. Prior to the installation and initial startup, respectively, the RUC reviewed and approved an outline of the installation plan, the initial post-installation startup procedure as well as the calibration procedure for the new instruments.

The purpose of the evaluation was to determine if there were any un-reviewed safety questions involved with these changes. It was determined that the instrumentation upgrade involved equipment that was functionally equivalent and did not involve any unreviewed safety questions.

A description of the review and supporting material is attached.

Safety Evaluation of the Installation of the
Gamma Metrics Wide Range Linear Flux Channel
for the UTR-10 Reactor

The following is a safety evaluation of the new wide range linear flux channel, chart recorder and the associated check-out and calibration procedures.

**Installation**

A safety evaluation of the proposed equipment installation was performed with regards to 10 CFR 50.59 to determine whether the proposed change would create any un-reviewed safety questions. The seven questions from the Nuclear Safety Analysis Center's (NSAC) "Guidelines for 10 CFR 50.59 Safety Evaluations" were discussed. The answers to these questions are shown below, the questions are included as an attachment.

The first two questions deal with accidents which were previously evaluated in the Safety Analysis Report (SAR). There are three types of accidents which were evaluated in the most recent SAR which was completed in August 1981. The types of accidents evaluated were 1) a decrease in heat removal, 2) a reactivity insertion and 3) the design basis accident (dropped/damaged fuel assembly). The committee determined that the replacement of the wide range linear channel and chart recorder with a functionally equivalent channel and recorder would have no affect on any of these accidents.

The third, fourth and sixth questions deal with changes to safety related equipment. For the UTR-10, all safety functions are located in the left-hand and right-hand wide range logarithmic channels. The wide range linear channel is used by the operator to monitor power and has NO safety related functions. The committee determined, therefore, that the replacement of the linear channel and chart recorder with a functionally equivalent channel and recorder does not adversely affect any safety related equipment.

The fifth question deals with the creation of the possibility of an accident of a different type than any previously evaluated in the SAR. The committee determined that the replacement of the wide range linear channel and chart recorder with a functionally equivalent channel and chart recorder does not create a new type of accident.

The last of the seven questions deals with the reduction in any of the margins of safety as described in the Technical Specifications. The margins of safety that are defined in the Technical Specifications are shown in Table 1. The committee determined that the replacement of the linear channel and chart recorder with a functionally equivalent channel and recorder does not reduce any of these margins of safety.

Table 1. Margins of Safety from the Technical Specifications

| Parameter | Safety Limit | Limiting Safety System Setting | Margin of Safety |
|---|---|---|---|
| Reactor Power | 15 kW | 12.5 kW | 2.5 kW |
| Coolant Flow Rate | 3.5 gpm | 5 gpm | 1.5 gpm |
| Coolant Outlet Temperature | 180 F | 170 F | 10 F |
| Core Excess Reactivity | — | — | 0.65 $ |
| Minimum Shutdown Margin | — | — | 0.46 $ |

Based on the above discussion, the RUC determined that the installation of the new channel and chart recorder did not involve an un-reviewed safety question. Permission was therefore granted for proceeding with the installation.

It was agreed that the committee would meet at a later date to review procedures covering the initial startup of the reactor and calibration of the new equipment. After review and approval of these procedures, the reactor would be made critical for the purpose of completing the calibration of the new equipment.

**Initial Operating Plan**

Following the installation of the new equipment, reviewed a summary of what had been done and inspected the equipment as installed. The post-installation check-out procedure and initial operating plan was also reviewed by the committee. The initial operating plan was approved prior to the first criticality. Using the same criteria as above, the committee determined that the checkout and operating plans did not involve an un-reviewed safety question. Copies of the installation summary and initial operating plan are attached.

**Wide Range Linear Channel Calibration Procedure**

Using the calibration procedure for the old chart recorder as a reference, the calibration procedure supplied by Gamma Metrics for the new wide range linear channel was modified for use with the UTR-10. The procedure was reviewed and approved by the committee. Using the same criteria as above, the committee determined that the new calibration procedure did not create an un-reviewed safety question.

**Operator Training Plan**

The reactor operations staff who were responsible for installing the new wide range linear channel and chart recorder developed a training plan for the remaining reactor operators. The plan was reviewed and approved by the committee prior to these individuals running the reactor. Completion of the above steps will be logged in the Nuclear Engineering Lab Training Log and on the individual operator's Qualification Card. Using the same criteria as above, the committee determined that the operator training plan did not create an un-reviewed safety question. A copy of the operator training plan is attached.

Conditions Involving an Un-reviewed Safety Question
Per NSAC-125 "Guidelines for 10 CFR 50.59 Safety Evaluations"

1. May the proposed activity increase the **probability of occurrence** of an accident previously evaluated in the SAR?

2. May the proposed activity increase the **consequences** of an accident previously evaluated in the SAR?

3. May the proposed activity increase the **probability of occurrence** of a malfunction of equipment important to safety previously evaluated in the SAR?

4. May the proposed activity increase the **consequences** of a malfunction of equipment important to safety previously evaluated in the SAR?

5. May the proposed activity create the possibility of an accident of a **different type** than any previously evaluated in the SAR?

6. May the proposed activity create the possibility of a **different type** of malfunction of equipment important to safety than any previously evaluated in the SAR?

7. Does the proposed activity **reduce the margin of safety** as defined in the basis for any technical specification?

Proposed outline for the installation of the new linear flux channel and chart recorder

Removal of old chart recorder
- physically remove the old chart recorder from the console

Disconnection of the old channel
- remove pico-ammeter and cover scale (eventually replace panel/cover)
- de-energize old HVPS in left wide range drawer
- disconnect CIC leads to old HVPS and chart recorder
- disconnect AUTO Power controller

Installation of the new channel
- complete pre-installation checks per Gamma-Metrics installation procedure
- physically install new channel instrumentation in upper center console compartment
- connect channel to AC power
- connect new channel to CIC
- do not connect AUTO Power functions
- perform pre-startup calibrations

Installation of the new chart recorder
- complete pre-installation checks per Gamma-Metrics installation procedure
- physically install new chart recorder in lower center console compartment
- connect recorder to AC power
- connect new channel to recorder
- connect log channels to recorder
- perform pre-startup calibrations

# Initial Startup Procedure
## following the Installation of the new Wide Range Linear Flux Channel & Chart Recorder

A. Prerequisites:
1. Inlet temperature calibration (12-M-2) completed satisfactorily.
2. Outlet temperature calibration (12-M-3) completed satisfactorily.
3. Preliminary pre-critical check-off completed.

B. Calibration Equipment needed:
1. Calibrated digital multi-meter.
2. Two-way switch box.
3. Four banana-to-insulated tip-plug cables; 2 red, 2 black.
4. COHU 324 voltage source (borrow from ERI).

C. Equipment Setup:
1. Set the switch of the two-way switch box to OFF. Using the banana-to insulated tip-plus cables (2 red, 2 black), connect the banana ends to the two-way switch box input jacks. Connect the two-way switch box to the digital multi-meter.
2. Pull out the left and right hand drawers, and connect the insulated tip-plugs to XA8-TP1 (+) and XA8-TP2 (-) of both drawers. NOTE: The digital multi-meter monitors fission counter/chamber voltage; thus the meter provides an indication of reactor power.
3. Connect the COHU 324 to the blue pin of the chart recorder.

D. Procedure (Day 1):
1. Perform a pre-critical check-off.
2. Perform flow rate calibration (12-M-4).
3. Perform moderator level calibration (12-M-5).
4. Perform a shutdown check-off and secure the reactor.

E. Procedure (Day 2):
1. Conduct a normal reactor startup to 1 Watt as indicated on the most limiting indication of reactor power in accordance with the Operating Procedures.
2. Perform thermal power measurement (12-M-6).
3. Perform wide range linear channel and chart recorder calibration (12-M-8).
4. Conduct a normal reactor shutdown.
5. Perform a shutdown check-off and secure the reactor.

F. Procedure (Day 3):
1. Commence nuclear instrument calibration (12-M-11).
2. Perform a pre-critical check-off.
3. Conduct a normal reactor startup to 1 Watt as indicated on chart recorder in accordance with the Operating Procedures.
4. Complete nuclear instrument calibration (12-M-11).
5. Conduct a normal reactor shutdown and secure the reactor.

G. Post Calibration Tasks:
1. Disconnect the insulated tip-plugs from XA8-TP1(+) and XA8-TP2 (-) on the left and right nuclear instrument drawers.
2. Store all test equipment and make necessary log entries.

# Reactor Operator Training Plan following the Installation of the new Gamma Metrics WRL channel

Prior to being allowed to operate the reactor solo, the members of the reactor operations staff must complete the following steps.

1. Attend a lecture/discussion session covering the material on the attached pages.
2. Demonstrate to another SRO the ability to manipulate the controls on the new channel while in test mode.

Members of the operations staff involved with the installation of the new equipment shall be considered to be qualified after completing the steps 1 and 2.

Members of the operations staff NOT involved with the installation of the new equipment must, in addition, complete steps 3 and 4 to be considered to be qualified for solo operations.

3. Complete a pre-critical checklist under the observation of a qualified SRO.
4. Perform a normal startup under the observation of a qualified SRO.

Members of the operations staff NOT involved with the installation of the new equipment shall be considered to be qualified after completing the above steps.

Completion of the above steps will be logged in the Nuclear Engineering Lab Training Log and on the individual operator's Qualification Card.

# Use of the WRL Channel & Chart Recorder

I. WRL Channel will be continuous duty

II. Range of Power Indication

A. Possible Range - 300 µW - 100KW

B. Applicable Range - 3mW - 10KW

C. All power can be read from the upper scale. Power is read as a percent of the present scale. The lower scale has been shown to be in error a few percent from the upper scale.

D. The operator will manually change range up or down by using the "UP" or "DOWN" pushbuttons, respectively.

E. The operation mode of the channel will remain in MAN.

F. Full Power Gain Adjust is used during annual maintenance and will be set at that time. Do Not Adjust.

III. Test and Calibrate

A. A three position momentary switch

1. Ramp - introduces a signal which is additive to the power signal. The expected response when this feature is activated is for the indication of power to increase at a constant rate.

2. Test - removes the power signal, generating a non-operate condition, and places in its stead a signal proportional to the position of the locking potentiometer.

IV. Non-Operate Light

A. Conditions generating non-operate condition

1. Compensating Voltage High (200V)

2. High Voltage to CIC High (1000V)

3. High Voltage to CIC Low (adjustable 0-1000V)

4. Test Mode Activated

5. 5V power supply for ciruict cards and picoammeter

6. ± 15 V low power supply for ciruict cards and picoammeter

7. 1.25 V low

8. Remote Control not connected (overridden)

9. Isolated 5V power low

6/6/97 GW

B. The non-operate light and condition will not activate any of the safety systems within the reactor control system, but it will serve as a warning to the operator that the WRL signal may be erroneous.

V. Chart Recorder

A. Red Pen indicates Log Power and should be read from the red scale provided. Note: The indication provided by the red pen has not changed with the installation of the new chart recorder.

B. Blue Pen indicates wide range linear power. The input is now a 0-10V signal, formerly 0-100mV, and the output is 0-125% of scale, formerly 0-100% of scale.

VI. Paper Drive

A. Panel On - Chart Recorder Energized

B. Keyswitch On - Paper Drive Energized

C. The ▼▲ switch sets the direction as forward or reverse, respectively. The operator will not need to adjust the direction

D. The paper speed is preset to 20 cm/hr. The operator will not need to adjust the paper speed.

VII. Chart Recorder Pens

A. Normal Storage of the pens is up and capped

B. The pens are to be uncapped at the point in the procedure where the operator checks pens and ink. The pens are capped when they are lifted after shutdown.

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