U. S. ATOMIC ENERGY COMMISSION
DIRECTORATE OF REGULATORY OPERATIONS

REGION III

RO Inspection Report No. 050-264/73-01

Licensee: The Dow Chemical Company
1701 Building
Midland, Michigan 48640

TRIGA Reactor
Midland, Michigan

License No. R-108
Category: F

Type of Licensee: 100 Kw, TRIGA (Non Pulsing)

Type of Inspection: Routine, Announced

Dates of Inspection: September 20 and 21, 1973

Date of Previous Inspection: June 2, 1971

Principal Inspector: J. R. Fishbaugher — 10/24/73 (Date)

Accompanying Inspector: C. H. Brown — 10/24/73 (Date)

Other Accompanying Personnel: None

Reviewed By: H. C. Dance, Senior Reactor Inspector, BWR Section — 10/24/73 (Date)

SUMMARY OF FINDINGS

Enforcement Action

A. Violation considered to be of Category II severity is as follows:

Technical Specifications Section E.3 states that the maximum available excess reactivity above cold critical shall be 1.5 percent delta k/k with experiments in place.

Contrary to the above, the reactor was operated with greater than 1.5 percent delta k/k excess reactivity on January 25, 1973. (Paragraph 7.a)

B. Violation considered to be of Category III severity is as follows:

Technical Specifications Section I.3 requires that the Reactor Operations Committee approve proposed changes in operating procedures and be responsible for determining whether the proposed change constitutes an unreviewed safety question or a change in the Technical Specifications.

Contrary to the above, a change to an operating procedure was inserted in the Operating Log for use on July 23, 1971, without formal review and approval by the Committee. (Paragraph 5.a)

Licensee Action on Previously Identified Enforcement Matters

No enforcement items were identified on the previous inspection report.

Unusual Occurrences

A. On October 22, 1971, the operator placed the reactor in automatic control mode while the reactor was subcritical, which caused the regulating rod to withdraw at maximum rate. The operator manually scrammed the rods when he noted the rod withdrawing. The manual scram was initiated before reaching the safety circuit trip points. (Paragraph 7.b)

B. On January 25, 1973, following a fuel inspection, the reactor was operated with greater than 1.50 percent delta k/k excess reactivity. (Paragraph 7.a)

Other Significant Findings

A. Current Findings

1. The reactor is being operated on short term runs for activation analysis.

2. The nuclear instrumentation has been upgraded and the modernization of the period circuitry has reduced the number of period scrams significantly.

B. Status of Previously Reported Unresolved Items

No unresolved items were identified in the previous inspection report.

Management Interview

The management interview was conducted with Drs. Turley and Anders at the conclusion of the inspection on September 21, 1973. The interview was concluded by telephone on October 2, 1973. The following items were discussed:

A. The scope of the inspection was explained by the inspector and the general findings were related to the licensee.

B. The inspector stated that operation of the reactor with excess reactivity greater than allowed was a violation of Technical Specifications. The licensee was informed that a no-response citation would be issued in that appropriate actions to prevent recurrence had been taken at the time of the event. (Paragraph 7.a)

The licensee was also informed that a response type citation would be issued for the lack of formal review of a procedure change resulting when the shim rod was functionally changed to the regulating rod. (Paragraph 5.a)

C. The number of scrams occurring from the period circuit was discussed. The licensee was informed that his attention to the problem, as shown by the nuclear instrument modification and upgrading, had alleviated the inspector's concern. The suggestion was made to the licensee that he monitor the performance to assure that the expected improvement was realized. The licensee concurred with the suggestion. (Paragraph 5.h)

D. The inspector informed the licensee of the AEC policy on failed fuel elements for pool-type reactors. The licensee stated their policy conformed and there were no plans to change. (Paragraph 4.c)

E. The inspector explained the revised procedure for forwarding inspection reports to the licensee. The inspector stated that after the licensee reviews the inspection report for proprietary information, the report will be placed in the Public Document Room.

F. The inspector noted that Dr. Turley was not on the list of members for the Reactor Operations Committee, and he suggested that the list be kept up to date. The licensee agreed and stated that he would correct the list.

REPORT DETAILS

1. Persons Contacted

Dr. O. U. Anders, Reactor Supervisor
Dr. J. Turley, Laboratory Director

2. General Information

The facility is being used primarily for activation analysis and no change in the utilization is planned. Approximately 2100 runs were conducted from June 1971 to the present with a typical run being 10 minutes long. The reactor had experienced approximately 75 scrams over the same time span, the majority being period trips attributed to antiquated instrumentation. The nuclear instrumentation has been upgraded with modern solid-state equipment, which has reduced the number of scrams from the period trip.

3. Facility Administration

a. Staffing

The reactor operating staff is essentially unchanged since the previous inspection. There are four licensed operators with SRO licenses. Four trainees had taken the licensing examination for SRO just prior to the inspection, but the results had not been received.

b. Reactor Operations Committee

The inspector examined the meeting minutes for the period since July 1971, for scope of topics, recording and reporting of minutes, membership, frequency of meetings, and the committee procedures and judged that they were satisfactory, with respect to the Technical Specifications requirements and the committee procedure, 3.2.2 of the Operating Manual. There were 13 meetings held during this period.

c. Control of Experiments

The inspector examined (spot check from July 1971 to present) the experiment records and no deficiencies were noted.

The experiments are classified into three categories - routine, modified routine, and special. The "special" tests are reviewed by the Reactor Operations Committee in conformance with Section I.2 of the Technical Specifications.

The inspector noted that the bulk of the testing activity was represented by sample irradiation in the reflector "lazy susan" with occasional use of a "rabbit" that is located in the F ring of the core. The "lazy susan" rotates during reactor operation and the "rabbit" capsules are inserted and withdrawn with the reactor operating. These movements typically have a measurable effect on reactor power. The magnitude of this effect is being adequately controlled by established experiment review and approval practices. The licensee stated that the reactor is generally operated in the manual mode when samples are in the "lazy susan" due to the amount of regulating rod motion in the automatic mode of control.

d. Operating Records

The following records were reviewed:

(1) Reactor Operating Log, 6/71-9/17/73

(2) Radioactivity released or discharged, 2/73 to present

(3) Scram Log, 7/71-9/17/73

(4) Maintenance Log, 6/72 to present

(5) Experimental Log, 2/73 to present

(6) Daily Check Sheet, 6/15/73-7/20/73

(7) Weekly Check Sheet, 6/15/73-9/14/73

(8) Monthly Check Sheet, 6/29/73-9/17/73

(9) Semi-Annual Check Sheet, 3/73 and 9/73

The above records fulfill the requirements of the license, Section 3.C.

e. Operating Procedures

Technical Specification Section 1.7 enumerates certain procedures that are required to be written for operations involving the reactor. These procedures were found to be available and were spot checked with no deficiencies noted.

f. Security

Facility security has been improved by the addition of a large sliding bolt to the reactor room outside door and an expandable grating secured with two padlocks on the doorway between the reactor and console rooms. The skylight in the reactor room has had a metal grate added beneath it. In response to a question, the licensee stated that RO:III would be notified in the event of civil disturbance.

4. Core Status

a. Current Loading

The current core status board was examined and showed 76 fueled elements and nine graphite elements installed. The graphite elements were installed in E and F locations around the core. The source was installed in F-17. The status board also indicates the positions of the control elements, three neutron detectors, and the rabbit transfer tube core position, all of which are consistent with the Safety Analysis Report. The core loading data are recorded on the monthly check list.

b. Fuel Element Examination

Technical Specifications Section E.4 requires that fuel elements be visually inspected once per year. The requirement is being met with the last inspection having been conducted on February 9, 1973. The elements are examined by removing each one from the core, lifting it to approximately six feet below the surface of the water. The element is then brought to the horizontal and rotated to check for bowing, bulges or cladding failure. If the trueness is suspect the element is checked by inserting it into a "go" gage which is built to manufacturing tolerances. During the February 9 examination all the elements had the normal oxide coating per the licensee. No fuel element has been replaced as a result of the visual examination.

The core loading status is maintained in the operating log by element serial number, with any notes of anomalies and corrective action.

c. Policy for Failed Fuel Elements

The inspector stated that the AEC considers continued operation of pool type reactors with a failed fuel element to be an unreviewed safety question. The licensee stated that the Dow policy is to replace a failed fuel element as soon as it can be located. The one failure that has occurred at the facility was during initial startup and could not be located visually, so the reactor was operated and by process of elimination the failure was located and removed.

5. Reactivity and Power Control

a. Rod Calibration

Technical Specifications Section F.11.d requires a rod worth calibration for each control rod be done at least semi-annually. The method used to perform the calibration utilizes a rising period measurement at six increments per rod for the shim and regulating rod. The safety rod is then calibrated against the regulating rod. The six points are plotted and curve extrapolated with the assumption that the rod worth is symmetrical. No deficiencies were noted. The latest test was performed on September 18, 1973, with the following recorded results: safety rod worth $2.90, shim $0.84, and the regulating rod $2.94.

The drive mechanisms and associated circuitry for the shim and regulating rods were interchanged in July 1971.1/ A note was added in the Reactor Operating Log on July 23, 1971, stating, in effect, that the regulating rod (a smaller worth rod) was now the shim rod and was to be withdrawn to approximately 400 on the rod position indicator and then the reactor was to be taken critical with shim rod (which was now the regulating rod) and to maintain the reactor in the manual mode of control until the reactor was at the desired power level before shifting control to the automatic mode. This change to the operating procedure was not formally reviewed until August 13, 1971, by the Reactor Operations Committee.

Satisfactory operation has been experienced from both rods.

b. Excess Reactivity

Technical Specifications Section E.3 requires that the excess reactivity above cold critical with no xenon be maintained less than 1.50 percent Δ K/K ($2.14, β = .007). The excess is checked at cold critical on the first startup of the day and recorded on the Daily Startup Checks. For the last six months, excess reactivity has been approximately $1.70. On one occasion, the reactor was operated with excess reactivity greater than the limit (Paragraph 7.a); otherwise, no deficiencies were noted.

c. Shutdown Margin

Technical Specifications Section F.3 requires a shutdown margin of 0.35 percent ($0.50) with the strongest rod withdrawn. The shutdown margin is checked and recorded on the Semi-Annual Check List as follows:

1/ Letter, Dow to DRL, dtd 4-30-71, and letter, DRL to Dow, dtd 7-20-71.

(1) On September 18, 1973, the rod calibration showed rod worths to be: shim $0.84, safety $2.90, and regulating $2.94. The excess reactivity on that date, from the daily startup checks, was $1.62; therefore,

Safety rod	$2.90
Shim rod	.84
Total	$3.74
Excess	-1.62
Shutdown Margin	$2.12

(2) On April 5, 1973, the shutdown margin was $2.23

No deficiencies were noted.

d. Reactivity Insertion Rate

Technical Specifications Section F.4 requires that the reactivity insertion rate be less than 0.15 percent Δ K/K per second.

The monthly check list provides for checking and recording the following:

(1) Rod position indicator operational check

(2) Rod withdrawal timing check (by stopwatch)

The withdrawal time for the strongest rod (regulating rod) was 45.3 seconds on June 29, 1973; 46.3 seconds on August 31, 1973; and 55.5 seconds on September 17, 1973. The withdrawal times for the other rods were longer than the above times.

Examination of the rod calibration curve showed that the maximum rod worth per increment can vary as much as 1.5 times the average. From the above information, the following insertion rate is calculated for the regulating rod (strongest)

$$\% \Delta K/\text{second} = \frac{\$2.94}{45.3 \text{ sec}} \left| \frac{0.7\% \Delta K}{\$} \right| \frac{1.5}{} = 0.066\% \Delta K/\text{sec}$$

No deficiencies were noted.

e. Rod Scram Time

Technical Specifications Section F.11.6 requires that the control rod drop time be less than one second and verified by test semiannually.

The test is conducted weekly by raising one rod at a time to the full out and pushing the scram button for that rod and simultaneously starting a stopwatch. The watch is stopped when the rod indicates full insertion as indicated by rod bottom light. The inspector judged this method adequate for the purpose. The review of the weekly check lists for June 15 to September 14, 1973, showed the drop time to be less than one second, varying from 0.6 to 0.8 second.

f. Rod Inspection

Technical Specifications Section F.2 requires that the control rods be visually inspected at least once every two years. The control rods were being inspected on a twice a year frequency until January 1973, when the Reactor Operations Committee approved a once per year inspection. The inspections have not found any significant distortion or deterioration of the rods and all rods appear to have the normal oxide coating per the licensee. The last inspection was completed on January 25, 1973.

g. Power Calibration

Technical Specifications Section F.12 requires that the linear power level channel reading be calibrated at least annually by a thermal power calibration.

The calibration is accomplished by holding the reactor at some arbitrary power level and measuring the pool heatup rate. The licensee stated that the heat capacity of the pool was determined by Gulf Atomics using electrical heaters. Minor calibration changes for the channel are accomplished by repositioning the chamber. During the most recent test, conducted on February 8, 1973, actual power was calculated to be 80 percent, with the linear channel reading 90 percent and the log channel reading 72 percent. Both channels were reset to read 80 percent power. No deficiencies were noted in this area.

h. Upgrading Nuclear Instrumentation

The licensee described the new instrumentation that has been installed at the facility. The tube type instruments were replaced with solid state, one chamber was replaced and a recorder was added.2/ The

2/ Dow letters to DRL dtd April 30, 1971, and March 1973; DRL letters to Dow, dtd July 20, 1971, and April 16, 1973.

modification was accomplished in two stages; the first in mid-1971 and the second in June 1973. The modification completed in June 1973 included a modernization of the period circuit which appears to have made the period trip more reliable as the number of scrams, during startup from instrument noise, has been reduced.

The inspector discussed 10 CFR 50.59 with the licensee and he displayed an understanding of the requirement. To date the licensee has informed DRL of proposed changes before the changes are performed.

6. Reactor Pool

a. Surveillance

Technical Specifications Section D.1 requires that action be taken if either the pool temperature exceeds 120°F or the pool level is less than 15 feet above the top grid plate while the reactor is operating. The review of the Operating Log from June 1971 to September 17, 1973, showed that the water temperature is recorded for every startup and power change with the highest reading noted being 90°F. The licensee stated that no problem had been experienced in maintaining the temperature less than the 120°F limit. The temperature is monitored at the console, with a monthly check of the RTD readout by a lab type thermometer. The monthly check list for June 29, 1973 - September 17, 1973, showed good agreement of the two temperature devices. The pool level is checked daily for reactor startup. The loss in level amounts to approximately one half inch per week (approximately 500 gallons per year), and is made up once-a-week. The evaporative loss has been the same since the startup of the facility, based on a spot check of the startup check sheets, and indicates that the level has been maintained greater than 15 feet above the core.

The pool water conductivity is measured by conductivity cells before and after the ion exchange column. Both cells are read out on the console and checked monthly with an independent meter. The pH is also measured at this time. The Technical Specifications Section D.2 conductivity limit is 5 micromhos per centimeter. The normal reading is approximately 0.3 micromhos. When the ion exchange resin (HOH) starts to deplete the resin is changed out and disposed of as solid waste per the licensee. The column read 2 mrem/hr on contact per the September 17, 1973, monthly checklist.

Pool activity is measured by a chamber monitoring the purification flow, with backup of a CAM sampling the air in the reactor room and an area monitor. The surveillance on these instruments conforms to

Section G of the Technical Specifications as noted from the weekly checklists June 16, 1973 - September 14, 1973, and semi-annual checklists March 1973 and September 1973. The pool activity monitor chamber reads out on the console and the reading is recorded on the daily checklist.

b. Containment

The pool water heat exchanger represents a containment boundary between pool water and river water. The flow paths and the pressure control valving for both primary and secondary sides of the heat exchanger were traced. The licensee demonstrated the control of river water pressure on the heat exchanger, and described the administrative control on river water outlet pressure so that it is higher than the pool water inlet pressure. Consequently any leak would be into the pool. The two pressure gages are located in the console room next to the heat exchanger river water outlet isolation valve, which is used to maintain a back pressure on the heat exchanger.

Pool water flow through the heat exchanger is sufficient so that the pool temperature is maintained with the reactor operating at full power. The purification piping bypasses the heat exchanger and the flow is maintained at approximately 5 gpm. The licensee indicated that with this flow rate all the pool water (~5000 gallons) will go through the ion exchange column at least once per day.

7. Unusual Occurrences

a. Reactivity in Excess of Limit

Technical Specifications Section E.3 requires that the excess reactivity be less than 1.5% Δ K/K. On January 25, 1973, following a fuel inspection and other annual checks, the core excess reactivity was found to be $2.22 (approximately 1.56 percent delta k). The licensee then performed a rod calibration. Using the recalibration data the excess reactivity was found to be $2.28. The reactor was then shut down and the core loading changed. The postmortum by the licensee attributed the change in reactivity to cumulative effects of random rotation of fuel rods resulting from the fuel inspection. The licensee also recognized the fact that no operation of the reactor should have proceded until the excess reactivity was reduced. The licensee was informed that the condition was considered to have been a Technical Specifications violation but that in view of his report[3/] and actions taken to prevent recurrence no response would be required.

3/ Dow letter to DRL, dtd February 16, 1973.

b. Erroneous Use of Automatic Controller

On October 22, 1971, the reactor was placed in automatic control while the reactor was still subcritical. With no signal to the controller the regulating rod withdrew at the maximum rate and produced a fast power rise. Upon noting the above the operator manually scrammed the reactor. The manual scram was accomplished before any of the safety trip points were reached. This was an operator error and the licensee indicated that personnel involved were contacted. The procedural controls were clarified and re-emphasized to the operating personnel. The licensee stated that the capability exists for automatic control on a period signal, but is not used. The inspector examined the procedure (Section 3.4.2 of the Operations Manual) and verified that the requirement was available to operate in manual until the power is in the desired range before shifting automatic mode. No deficiencies were noted in the licensee's review, report, or corrective action taken on this event.