U. S. ATOMIC ENERGY COMMISSION
REGION III
DIVISION OF COMPLIANCE

Report of Inspection

CO Report No. 50-264/67-3

Licensee:	Dow Chemical Company License No. CPPR-94 Category F	
Dates of Inspection:	October 24 and 25, 1967	
Date of Previous Inspection:	July 5 and 6, 1967	
Inspected By: G. Fiorelli	Reactor Inspector	Date of Report November 7, 1967
Reviewed By: H. D. Thornburg	Sr. Reactor Inspector	November 4, 1967

Proprietary Information: No

SCOPE

An announced visit was made to the 100 kw Triga Mark I research reactor located in Midland, Michigan.

The purpose of the visit was to conduct the first routine inspection of the operating facility following its initial loading to critical on July 6, 1967. Included were reviews of reactor post critical performance data and appropriate log books, observation of a startup, discussions with members of the reactor staff, and a tour of the facility.

SUMMARY

Safety Items - None.

Noncompliance Items - None.

Unusual Occurrences - None.

Status of Previously Reported Problems - No problems were reported in the previous report.

Other Significant Items -

1. Stuck Shim Rod Control Switch

   Two period scrams were experienced as a result of a sticking shim rod control switch button. Minor repairs had been made to the switch following the first scram. However, these repairs were not made until several days after the scram experience. (See Management Interview and Section F-8.)

2. Fuel Clad Failure

   The high airborne activities detected during the first rise to power operation following attainment of minimum critical was confirmed to be originating from a suspected fuel clad failure. Air monitor readings returned to normal following the removal of the fuel element from core position F-28. Radioactivity releases did not exceed limits specified in 10 CFR 20. (See Section G-1.)

3. The post critical testing program outlined in the Technical Bulletin No. 116 Rev. A submitted to Dow by General Atomic was satisfactorily conducted following the initial loading of the reactor core. Results of the tests indicated operating characteristics were essentially as expected. (See Sections F-1 thru 7.)

4. Control of experiments was found to be adequate and in accordance with the provisions of the technical specifications. No problems associated with sample irradiations have been encountered to date. (See Section S.)

5. The radiation dose rates following equilibrium power operations have been as expected. Radiation levels at full power within the facility are minimal except for the predicted 10 mr/hr exposure rate one foot above the pool water. (See Section P-2.)

Management Interview - Inspection results were discussed with Drs. W. H. Beamer and O. U. Anders. The following items were covered:

1. The writer emphasized that in his opinion the delay in attempting to repair the stuck shim rod control switch did not constitute prudent or responsible action on the part of the licensee. Repairs to the switch should have been initiated prior to resuming operation. The licensee did not challenge the position of the writer and agreed that immediate repair action would have been in order. Since the licensee has had only three months of reactor operating experience, the writer indicated further that the initiation of immediate investigation and corrective action was the proper course of action when operating problems are experienced with key systems which have a safety function.

Management Interview (continued)

2. A discussion was held on the advantages associated with maintaining a separate accounting of scram and unusual occurrence experiences. Representatives of the licensee indicated that all scram experience would be listed in a separate portion of the operating log. The inspector was also informed that serious consideration would be given to expanding the function of his maintenance log, which currently lists equipment problem experiences, to include all unusual operating experiences now covered in the operating log.

3. The inspector outlined the functions and organization of the Division of Compliance.

DETAILS

A. Persons Contacted

Dr. W. H. Beamer, Laboratory Director
Dr. O. U. Anders, Reactor Supervisor
Mr. L. G. Silverstein, Radiological Officer

B. Administration and Organization

1. The organizational staff of the facility has not changed since the last visit. Since achieving minimum critical, six members of the laboratory staff have passed the senior reactor operator tests and have received their licenses. The total number of senior reactor operators at the facility is seven.

2. The minutes of the Reactor Operations Committee were reviewed. The frequency and function of the meetings are in accordance with the intent of the provisions of the technical specifications. A special meeting of the Radiation Hazards Committee is scheduled during the month of November. According to Dr. Beamer, the agenda will include a presentation on reactor operating performance to date.

C. Operations

The reactor has been operated to check the performance characteristics of the core, to train reactor operating personnel and produce small quantities of radioisotopes. The reactor normally operates at its maximum licensed power level of 100 kw with operating runs conducted on the average of four days per week.

DETAILS (continued)

Twenty-five unintentional scrams were experienced during the 3½ month period. A breakdown of the shutdown causes is as follows:

Range switching errors	5	
Defective tube in the high voltage ion chamber supply	4	(See Section F-9a)
Power overshoots due to operator error during training period	4	
Log N channel electronic noise	10	(See Section F-9b)
Period scram	2	(See Section F-8)
Instrument technician error	1	
Total	26	

On October 25, 1967 the inspector observed a startup of the reactor. The significant observations made during the demonstration are summarized below:

1. The daily startup check sheet was completed and initialed prior to startup.

2. The run was being made to irradiate special samples. It was noted that the samples were handled properly and a completed and properly approved activation request form was used.

3. The linear compensated ion chamber came on scale at about 1 milliwatt and the log N about a decade later. The fission counter was observed to indicate from source level to approximately 1 watt (saturation level). The fission counter detection position is fixed mechanically.

4. There was no detectable difference in power indications between the log N and linear recorder when the reactor operated at 100 kw.

5. When placed on servo-control, the reactor power level did not "hunt" above 100 kw.

D. Facility Procedures

Not inspected.

E. Primary System

A review of pool water chemistry records indicated the water conductivity to be less than 1 umho/cm and the ph to range between 6.4 and 7.2. Activity measurements of evaporated water samples indicated background readings.

DETAILS (continued)

F. Reactor Control and Core Physics

1. Excess Reactivity

Following initial criticality, which was achieved with 72 elements, the core size was increased to 76 elements. With this core configuration (shown on Attachment No. 1), the maximum excess reactivity was measured to be 1.48% $\frac{\Delta k}{k}$ at 28°C. This is the maximum value noted in the operating log book and is within the 1.5% $\frac{\Delta k}{k}$ limit specified in the technical specifications.

2. Control Rod Calibrations

After final fuel loading, each control rod was calibrated by the rising period method as described in Technical Bulletin 116A Rev. A furnished to the Dow Chemical Company by General Atomic. According to the licensee the following measured values were essentially in agreement with the predicted worths.

Safety	$2.84
Shim	3.26
Regulating	0.71
Total	$6.81

3. Shutdown Margin

The minimum shutdown margin based on the stuck rod concept was determined as follows:

Total Rod Worth	$6.81	
Most Reactive Rod	3.26	
Difference	3.55	
Excess Reactivity	2.11	
Shutdown Margin	$1.44	(1.0% $\frac{\Delta k}{k}$)

This is in compliance with the technical specifications limit of 0.35% $\frac{\Delta k}{k}$.

4. Period Meter Calibration

The period meter was calibrated by inserting predetermined amounts of excess reactivity. Using the In-hour curve, the periods corresponding to the insertions were determined and the period meter was adjusted accordingly.

DETAILS (continued)

5. Power Calibration

The reactor power instrumentation was calibrated by operating the reactor at an indicated power level of 10 kw on the linear channel. The rate of temperature rise of the water was normalized to the rate of rise for a known kilowatt heat input (determined by electric heaters in other standard Triga reactor tanks). The measured power level was 9.75 kw. The power level channels were adjusted accordingly.

6. Fuel Element Worths

The fuel element worths versus water were determined for positions in the B, D and F rings of the core. According to the licensee the following representative measured worths were in close agreement with expected values.

F ring	$0.46
D ring	0.86
B ring	1.48

7. Rod Drop Times

Rod drop times have been measured several times since achieving critical. The times are measured with a stop watch and represent the time from magnet release to rod extreme down position. All times were within the one second specified by technical specifications. According to the licensee, no problems have been encountered with rod drop performance.

8. Stuck Control Rod Up-position Button

During the reactor operator training period, a reactor scram was incurred from a period trip (7 second setting) when the shim rod "up" control switch button stuck in the depressed position.

According to the licensee the cause of the sticking problem was a minimal clearance condition between the button and the console cut out. Application of force, which was not normal to the direction of button movement, caused it to bind.

The licensee stated that repairs to increase the switch button clearance were not initiated until a few days after the occurrence in order that reactor operator training operation could continue.

DETAILS (continued)

A second period scram occurred several weeks after the initial switch repairs were made. This trip was also caused by a stuck shim rod "up" control switch. Repairs were again made to increase the control button clearance and no further similarly initiated scrams have occurred.

Since the safety circuit functioned as designed and the licensee has analyzed "pulsed" transients involving greater amounts of reactivity ($3.00 excess) in the safety analysis report, the experienced period trips did not constitute an unsafe condition.

The delay in repairs to the switch was a topic for discussion during the exit interview.

9. Instrumentation Repairs

a. During the post critical testing period, scrams were occurring from a drop in the HV to the ion chambers. Replacement of a defective tube in the power supply corrected the problem.

b. The log N detector required replacement after causing 10 spurious scrams. Sudden drops in reading to hard zero and then up scale spikes caused false fast period induced scrams. The installation of a new detector corrected the condition.

10. Instrument Linearity

The linear and log N console instrumentation was compared with the referenced Keithley micromicroammeter readings taken during the post critical testing period. The results indicated that the readings were linear and compatible.

G. Core and Internals

Fuel Failure

Upon reaching 90 kw during the first rise to power operation following attainment of minimum critical, it was noted that the continuous air monitor reading had increased above its normal 200 cpm background. Following a determination that the airborne activity was not associated with normal activation products, a systematic air sipping procedure was initiated to locate what was suspected to be a defective fuel element. The cladding failure was located in position F-28. Prior to resuming post critical testing, the element was removed into the shipping cask and returned to General Atomic.

DETAILS (continued)

No isotopes except those associated with water impurities were detected from the gamma ray spectrometer analysis of the pool samples. Fission products (Rb-87, Rb-88, Cs-137, Cs-138) were detected in the air samples only when the reactor power level approached full power of 100 kw. The maximum concentration of airborne activity in reactor room during the 4 day period required to locate the defective fuel element was calculated to be 0.2% of the permissible concentrations specified in 10 CFR 20 to unrestricted areas.

Since the stainless steel clad fuel elements had been previously used at General Atomic reactor facility, each element was inspected for dimension and surface defect before delivery to Dow. It is suspected that the fuel element was damaged during the pre-shipment loading operation at the General Atomic facilities.

H. Power Conversion System

Not applicable.

I. Auxiliary Systems

Not inspected.

J. Electrical Systems

Not inspected.

K. Containment

Not inspected.

L. Emergency Core Cooling Systems

Not applicable.

M. Other Engineered Safeguards

Not applicable.

N. Emergency Power

Not inspected.

O. Fuel Handling

Not inspected.

DETAILS (continued)

P. Radiation Protection

Radiation experience since initial startup was reviewed with Dr. Beamer and Mr. Silverstein. To date they have experienced no problems with contamination control or irradiated sample handling procedures. The significant points of the discussion and observations are summarized as follows:

1. Personnel Exposures

Dosimetry reports from the Landauer Company showed that exposure to radiation of each person working at the reactor facility has been below the minimum detectable.

2. Radiation Levels

Except for the area immediately above the pool water, the radiation levels have been minimal in other reactor areas. With the reactor power at 100 kw the radiation dose rate 1 foot above the pool was measured to be 10 mr/hr (B & γ). No detectable dose rate due to neutrons could be measured from an 8 hour film badge exposure at this location. The reactor control room, lab., and demineralizer area dose rates were less than 1 mr/hr.

3. Contamination Control

No contamination control problems have been experienced according to the licensee. The writer observed that smears have been taken on sample capsules removed from the reactor.

4. Posting and Labeling

Radiation areas and radioactive material storage locations located at the facility were observed to be adequately posted in accordance with 10 CFR 20.203.

Q. Radioactive Waste Systems

Not inspected.

R. Environment

Not applicable.

S. Experiments and Tests

The writer reviewed numerous activation request forms which are prepared and approved prior to sample insertion into the reactor. In each

DETAILS (continued)

case all information required by the form (see Attachment #2) was observed to have been entered. In every form, measured radiation levels were significantly below the estimated values. The range of experiment worths was noted to be between $0.08 and $0.12 which is in compliance with the technical specifications requirement of $2.00 maximum. According to the licensee, no problems have been encountered with the operation of the lazy Susan or rabbit transfer facilities.

The reactor operation committee meeting minutes disclosed 4 meetings devoted to special sample irradiation reviews.

T. Facility Modification

The licensee stated that the carryover items listed in CO Report No. 264/67-1 will be covered in a letter to DRL in the very near future.

U. Miscellaneous

Not applicable.

V. Reliability Information

The inspector observed that the daily, weekly and monthly component and operational checks required by Sections F and G of the technical specifications are being made at the required frequency. No failures or malfunctions were noted.

Attachments:
1 and 2

RADIOCHEMISTRY RESEARCH LABORATORY

Nuclear Chemistry

Reactor Activation Request Form

Date:_____ Experimentor_____ Serial No._____

Department_____Charge_____ Phone_____ Problem # _____

Person authorized by Rad. Haz. Comm. to receive activity. _____

Intended method of final disposal _____

Type material_____ Major Constituents _____

Sample No. _____ Container _____

Amt. of sample _____ Flux desired _____x 10-- Position _____

Est. total activ._____ Expected activities_____

Activity expected_____ Expected dose rate 1 ft. _____rem/hr

Shielding required to reduce to 200 mrem/hr on contact _____

Time limited_____ Class of experiment _____

Authorization of sample permitted _____
(Reactor Supervisor, Rad. Haz. Comm.)

Date irradiated_____ Operator_____ Log. book page _____

Sample position_____ Irrad. Start_____ Irrad. End _____

Flux _____ at _____ Water temp. bef._____°C, after _____°C

Time of removal from reactor_____ Survey Instr._____

Cond. of container _____ (dry) at 1 ft._____rem/hr at contact_____rem/hr

Intermed. Storage pos._____

Time of transfer to experimentor_____ Shipping cask _____

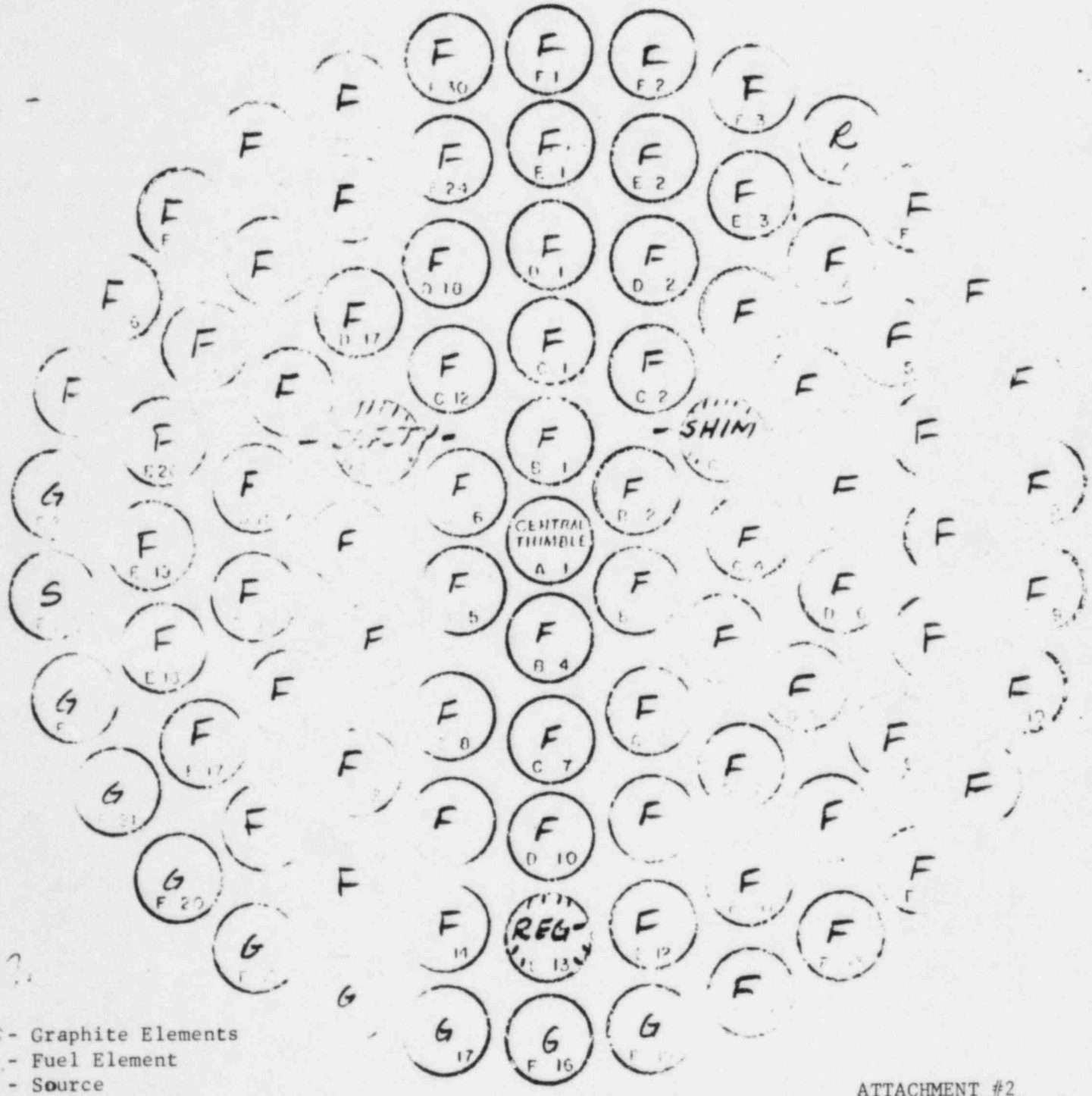
Dry at contact_____ Shielding used_____ than at contact ___rem/hr

Health Physics notified (when necessary)_____

_____ _____ _____
(Experimentor) (Operator) (Reactor Supervisor)

ATTACHMENT #1

Type of Control Rod	Control Rod Locations Steady-State Reactors	Pulsing Reactors
Regulating	C-13	E-21
Shim	C-3	None
Safety	C-11	C-3
Pulse	None	E-9



F - Graphite Elements
CODE: F - Fuel Element
S - Source
R - Rabbit Facility

ATTACHMENT #2