



REACTOR FACILITY

November 5, 1990

John B. Martin, Administrator, Region V  
 U. S. Nuclear Regulatory Commission  
 1450 Maria Lane, Suite 210  
 Walnut Creek, California 94596

RE: Docket 50-288, License R-112

Dear Mr. Martin:

This letter is written as a follow-up report on the anomalous behavior of the linear power channel on the Reed Reactor Facility, TRIGA Mark I Reactor previously reported on October 8.

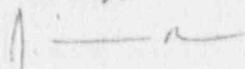
Attached are copies of a report prepared for the Reactor Operations Committee (ROC) following testing and repair of the system and the minutes of the ROC meeting where this was considered and authorization to resume operation granted.

The direct cause of the problem is attributed to either dirt and corrosion on the mode switch and circuit board contacts and/or incorrect adjustment of the linear power amplifier. Complete cleaning of these contacts and calibration of the entire linear channel has eliminated both the reported problem and additional electronic noise problems in the console.

The root cause is that the console electronics is aging. I have contacted GA to request a cost estimate to hire an electronics technician, experienced in working with the TRIGA console. This individual would work with, and train, Reed's new electronics technician in conducting a complete calibration and cleaning of all electronic systems. In addition, we have begun an evaluation of both the technical details and the 10CFR50.59 questions involved in modifying the reactor by installing a second linear power channel (wide-range power channel donated to Reed by Northrup, Inc.) to provide us with a third scram-capable power channel. This system would replace both the mode switch and the automatic servo control system which have given us minor problems for many years.

If you or your staff have any further questions, please contact me.

Sincerely,

  
 J. Michael Pollock  
 Acting Director

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cc: Douglas Bennett, Provost  
 David Stewart-Smith, ODOE  
 Junaid Razvi, General Atomics

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REACTOR FACILITY

**Minutes of Special Reactor Operations Committee Meeting**  
October 24, 1990

**Subject:** Problems with linear channel

**Attendance:** Johnny Powell, Chair, Reactor Operations Committee;  
Committee Members: D. Griffiths, P. Terdal, L. Church; Dan  
Gerrity, Chair, Reactor Oversight Committee; Staff Members:  
M. Pollock, Acting Director, S. Herbelin, Reactor Supervisor, M.  
Begel, SRO

Meeting was called to order by Chairman Powell at about 17:30.

Copies of the attached October 19, 1990 report of the Acting Director had been distributed in advance of the meeting. Copies of the October 8 letter to Mr. John Martin, USNRC were distributed.

As the first order of business, Mr. Junaid Razvi, Director of the Radiation Facility at General Atomics, was available by telephone to present his evaluation of the problem and response to it and to answer questions from committee members.

Mr. Razvi began by emphasizing that he could officially comment only on technical matters related to the reactor hardware and that it was Reed's responsibility to address requirements of the NRC and Technical Specifications. He indicated that the problem appeared to result from infrequent cleaning and maintenance of the electronic components of the reactor. It was his opinion that the staff had taken the proper action to correct the problem and that, with proper maintenance it should not recur. He indicated, however, that as the facility ages, similar problems are likely to increase. He also indicated that GA conducts, as part of their semi-annual maintenance, electronic calibrations of their primary power channels and includes cleaning of the inside of the console and certain switches.

Mr. Terdal questioned Mr. Razvi with respect to whether the linear power scram would have functioned had the operator chosen to raise the power during the 6 minutes the system was apparently operating anomalously. Mr. Razvi indicated that, although that would be hard

to say for sure, it is possible that the actual reactor power would have exceeded 275 kW without a linear power scram. He emphasized however, that this is the reason for redundant safety systems on the TRIGA reactor and that, in his opinion, the incident raised no unreviewed safety questions. Specifically, he commented that:

- 1) The percent power channel, which is completely independent and unaffected would have scrambled the reactor;
- 2) Even if the percent power channel had failed as well, the reactor power would have stabilized at about 300 kW, well within the limits discussed in the safety analysis report;
- 3) All concern could be prevented in the future by installing a 3rd scram channel (the wide-range channel donated by Northrup); and
- 4) Training operators to carefully observe all power channels, is the best way to detect anomalies and prevent overpower operation.

There being no more questions from the committee, Mr. Razvi was thanked and excused.

Motion (L. Church, seconded by P. Terdal) Limit the discussion at this meeting to questions related to restarting the reactor; postpone long term maintenance decisions for the next regular meeting when the staff will bring recommendations to the committee. Passed unanimously.

Motion (L. Church, seconded P. Terdal) The reactor be considered to be back in operation.

Mr. Terdal questioned whether a 10CFR50.59 review was required for restarting the reactor. Mr. Pollock pointed out that, although 10CFR50.59 specifically refers to making changes in the facility or procedures, committee approval to restart the reactor should imply a determination that no unreviewed safety questions exist and that the reactor can be operated safely.

Mr. Church indicated his belief that the staff had conducted the appropriate testing including attempts to repeat the anomaly.

The question was called and the motion passed unanimously.

The Acting Director indicated that he would be immediately issuing a notice to operators on this incident and would be filing a follow-up report with the NRC.

October 19, 1990

To: Reactor Operations Committee

From: J. Michael Pollock, Acting Director

Subject: Anomalous linear channel behavior in automatic mode.

On October 7, 1990, beginning at about 15:40, the reactor power was increased to 150 kW as part of a flux monitoring experiment. The apparently anomalous behavior occurred immediately after the reactor was switched into the automatic mode of operation at 15:49.

For a period of approximately 6 minutes, the signal reaching the linear power chart recorder led the operator to believe that the reactor power was 150 kW. Other observations suggest that the actual power climbed slowly and stabilized at a power level between 215 and 240 kW; specifically, the log recorder indicated a power level matching its normal reading at 240 kW, the recorded core excess of \$1.29 corresponds to a power level of 240 kW (see attached core-excess record), and a 15 second flux measurement made in the pneumatic transfer system during this interval indicated a flux, based on measurements during previous experiments, of about 215 kW. The percent power reading, which was recorded sometime during this interval, was recorded at 65%; however, it is uncertain when during that period it was recorded.

At 15:55, the linear channel reading increased sharply to almost 97% (240 kW) and the automatic system immediately adjusted the regulating rod to return the reactor power to 150 kW. At this point the reactor core-excess of \$1.70 was normal.

At no time did any of the reactor channels indicate that the reactor power exceeded our licensed level of 250 kW. In addition, daily instrument calibration and safety system checks, routinely performed prior to the operation, were normal. The tests of the linear channel were repeated by the operator following the occurrence and were again normal.

## ACTIONS TO IDENTIFY AND CORRECT THE PROBLEM

- 1) Reactor operation was suspended. General Atomics (GA) was consulted and, although there was not believed to have been a violation of the Technical Specifications, the NRC was notified of the anomalous behavior. Bob Ormond, the new campus electronics technician was contacted. Mr. Ormond spent several days familiarizing himself with the reactor documents in preparation for testing.
- 2) Review of the chart record by GA and subsequent phone consultation resulted in several recommendations: 1) to test temperature effects on germanium transistors with a low temperature heat gun; 2) to remove all circuit boards from the linear channel for cleaning; 3) to evaluate continuity through any "cold soldered" contacts; and 4) to check and adjust the amplifier gain to match the specifications found in the Instrumentation Maintenance Manual.
- 3) Past maintenance records were searched and problems related to the mode selector switch (including associated linear power scrams), automatic mode operation, and calibrations and alterations previously performed on the linear channel were noted and discussed.
- 4) Attempts were made to recreate the problem with reactor at zero power, ie. all control rods in core. Switching the mode switch caused "spikes" on both linear and log channels. On two occasions, turning the switch produced a rapid rise in linear recorder indication similar to the occurrence on 10/7. The first event was interrupted before an automatic SCRAM occurred by the operator switching ranges, and then a manual SCRAM. The second event was allowed to continue until a reactor SCRAM occurred (about 110% of 0.1 W but it happened too rapidly to be any more precise) and was corrected by "jiggling" the mode switch but allowing it to remain in automatic. Noise spikes were noted on the log channel but no "loss of signal" occurred.
- 5) The following maintenance operations were conducted by Michael Begel, SRO, and Bob Ormond, electronics technician, with assistance and consultation from Michael Pollock, Acting Director.
  - a) Heat testing was conducted by gently blowing warm air over circuit boards. Calibrations were noted to fluctuate

significantly but in a smooth manner with changes in temperature. No sudden failures or instantaneous changes were noted.

b) The Mode Switch was inspected for corrosion, dirt, and electrical continuity. Minor copper oxide deposits were noted; considerable dirt was present. The switch was cleaned.

c) All circuit boards in the linear channel were removed and the contacts cleaned.

d) Linear Channel testing and calibration was performed following the GA procedure (Chapter 5, Instrumentation Maintenance Manual). Included in this calibration and testing was an adjustment of the gain on the 10 KC Amplifier. The initial voltage measured between TP1 and TP3 (ground) during the test was 1320 mV compared to the 1215 mV called for in the procedure (See maintenance log book).

6) Following this maintenance, shutdown testing indicated virtually no spikes on either the linear or log pens when the mode switch was changed.

7) Following consultation with Dan Gerrity, Chair, Reactor Oversight Committee, and informal phone discussion with Mr. Michael Cillis, USNRC, testing with the reactor critical was performed by Michael Begel, SRO, Michael Pollock, SRO and Acting Director, and Bob Ormand, electronics technician. At 5 watts the core excess was normal at \$2.77. Repeated switching between manual and steady-state operation at 5 watts produced no "spikes" or anomalous readings. Attempts were made to turn the switch too slowly or incompletely since some problems have been noted in the past with both the mode switch and the range switch which were related to poor electrical contact being made during switching. The power level was then increased in manual mode to 80% of 100 kW and the mode switch operated repeatedly. The reactor power was lowered to 60% of 100 kW in automatic and the mode switch tested again. Since the original problem occurred with the % demand potentiometer at about 60%, this pot was adjusted up and down through the range from 58-65 % to see if any anomalous behavior was noted. The reactor was then taken to 60% of 250 kW and the operation where the anomalous behavior originally occurred was duplicated without any abnormality. The mode switch was again operated repeatedly at this level with no spikes or anomalous behavior occurring. Core-excess measurements during these tests were normal and are included on the attached sheet.

8) Although the anomalous behavior of the linear channel seems to have been fixed and system noise resulting from the mode switch significantly reduced, the reactor was again shutdown pending approval of the Operations Committee to resume normal operations.

#### CONCERNS RELATING TO FUTURE OCCURRENCES

1) Periodic minor problems in the facility, and especially in the console, must be addressed in a more timely fashion. This is the second situation which we have reported to the NRC recently which could probably have been avoided by a better preventative maintenance program. The first, the sticking "up button" on a control rod occurred after several occurrences of sticking "down buttons" which proved to have the identical cause. The current problem occurred following several years of noisy operation of both the log and linear channels occurring during and immediately following the switching into the automatic mode of operation. This "noise", including associated linear power SCRAMS but not the identical problem seen on this occasion, has plagued the facility since 1968! However, reducing these problems sooner would most likely have prevented this occurrence.

2) The scope of console checkout included in the annual checkout should be carefully examined. Annual testing of all instrument circuits, voltages, calibrations, etc. could improve operations; however, attempting to "fix" something which is "not broken" could cause additional problems. Mr. Begel has suggested that a procedure be drafted of determining voltages, etc. at test points throughout the console, without removing boards or making adjustments in the system. Criteria could then be established which would trigger more detailed testing and adjustments.

3) A better method needs to be developed to insure that information about previous problems and the knowledge gained from correcting them is transferred to future management and operators. It was difficult to obtain information from past related maintenance operations. The Acting Director will evaluate various possibilities related to this item.

4) The SOP-01 instructions on checking the calibration of the log channel need to be revised to match the GA Manual Procedure to improve the calibration of this channel. This change will also prevent the log and linear pen from overlapping at full power.

5) Operator training/retraining needs to be upgraded to address the handling of "off-normal" occurrences in much more detail than it currently is. The first priority is to have the instruments operate as well as we possibly can by conducting periodic preventative maintenance, and repairing or at least evaluating fluctuations as they arise. However the console is old and these situations will probably become more common. New and unusual situations will arise which require operators to make rapid judgements and any errors must be on the conservative side.

6) Serious consideration needs to be given to installing the wide-range channel donated by Northrup. This would provide a second, completely independent, linear power channel with SCRAM capability reducing the possibility of a Tech Spec violation in case of a failure. More importantly, it would replace both the mode selector switch and the automatic servo controls (original equipment), which have given us headaches for years, with circa 1980 electronics.

7) At the suggestion of Mr. Ormond, we are looking for a strip chart recorder to connect temporarily to the percent power channel. This would provide additional information for diagnosis in the remote possibility that there should be a recurrence of this anomaly.

8) The experience of the reactor staff working with Mr. Bob Ormond on this matter indicates that his addition to Reed will allow all of the science departments to function more smoothly, and in the case of the reactor at least, more safely in the future. His presence allows us to believe that facility improvements such as installation of a wide-range channel are possible.