Radiation Center Oregon State University Corvallis, Oregon 97331 (503) 754-2341

April 17, 1981

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U.S. NUCLEAR REGULATORY COMMISSION

U.S. Nuclear Regulatory Commission
Region 5
Office of Inspection & Enforcement
Walnut Creek Plaza, Suite 202
1990 N California Blvd.
Walnut Creek, CA 94596

Attention: Director, Region

Reference: Oregon State University TRIGA Reactor (OSTR), Facility License No. R-106, Docket No. 50-243

Gentlemen:

In accordance with our telephone conversations on April 14, 1981 with Mr. Dennis Willett and Mr. D. M. Sternberg, and again on April 15, 1981 with Mr. Dennis Willett, we are submitting a report within 14 days of an occurrence involving the OSTR.

In particular, this event was reported by telephone to your office to comply with Section 6.7.a.6 of the OSTR Technical Specifications, and is being further confirmed with this written report as required by Section 6.7.b.2 of the OSTR Technical Specifications. You will notice, however, in the report details, included as Attachment A, that the net positive reactivity change which took place has now been established to be approximately $0.79. Since this is less than the $1.00 value listed in Section 6.7.a.6 of the Technical Specifications, the actual reportability of the event appears questionable. Nevertheless, Oregon State University intends to stand by their commitment to provide you with additional written details, and we are therefore happy to submit the enclosed information.

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With the submission of this written report, all actions required by Section 6.4 of the OSTR Technical Specifications will be completed. Should there be any questions or a need for further information, please let us know.

Very truly yours,

C. H. Wang
Reactor Administrator
Director, Radiation Center

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Enc.
cc: USNRC Document Management Branch, Washington DC
USRNC Office of Inspection & Enforcement, Washington DC
Director, Oregon Department of Energy, Salem OR
A. G. Johnson, Assistant Director, Radiation Center, OSU
B. Dodd, Assistant Reactor Administrator, OSU
S. E. Binney, Chairman, Reactor Operations Committee, OSU
T. V. Anderson, Reactor Supervisor, OSU
W. T. Carpenter, Reactor Operator, OSU
J. K. Ibrahim, Reactor Operator Trainee

Attachment A

REPORT DETAILS -- OSTR OCCURRENCE

April 14, 1981

Summary

This attachment describes in detail an event which occurred on April 14, 1981 when a switch failed causing a continuous control rod withdrawal resulting in an unanticipated net insertion of approximately 80¢ of reactivity. The causes, corrective actions and safety implications are also addressed.

All times and power levels in this attachment are derived from the reactor console log book and the reactor power chart.

Sequence of Events

1. Jamal Ibrahim, a Malaysian reactor operator trainee, was manipulating the OSTR controls, and William Carpenter, the licensed reactor operator, was sitting next to him directing his actions.

2. The reactor core excess had just been measured for the day at the usual power level of 15 watts. The reactor was in automatic with the transient rod, safety rod and shim rod all at 370 units. The regulating rod was at 430 units.

3. At 09:25:00 on April 14, 1981 the trainee operator (under direction from the licensed operator) started to increase power to 1 MW. He initially did this by increasing the percent demand potentiometer to over 80%. This causes the regulating rod to withdraw to meet the demanded power.

4. At 09:25:02 he switched the power range switch to the 100 W range to maintain the power increase. At the same time, in order to balance the control rods and position them for 1 MW, he withdrew the transient rod to 560 units. This is further than normally required for 1 MW, and hence, on instruction from the licensed operator the trainee inserted the transient rod to the more normal 530 units. During the transient rod withdrawal, although the reactor power was increasing, the regulating rod was being inserted by the automatic control.

5. The linear power range was switched to 300 W at 09:25:15 with the reactor at about 60 W. The reactor chart showed a hesitation in the power increase at 66 W for about 5 seconds until 09:25:24. This is believed to correlate with the transient rod insertion from 560-530 units.

6. The trainee then withdrew the safety rod to about 380 units and released the UP button. However, he kept his left hand over the buttons in readiness for further manipulations. From the licensed operator's viewpoint, it appeared that he was still pushing the UP button. When the safety rod UP button was released, the contact was not broken and the safety rod continued to withdraw.

7. The trainee operator switched to the 1 kW power range at 09:25:30 after reaching a power of 170 W. The reactor period at this time was approximately 11 seconds, which is in the normal range for the automatic mode.

8. At 09:25:30 with the power level at 591 W, the trainee operator switched to the 3 kW power range. It is estimated that somewhere between this time and 09:25:50 the regulating rod became fully inserted at 102 units.

9. Also, during this time the licensed operator was about to ask why the trainee was continuing to withdraw the safety rod when the trainee moved his hand and the operator realized that the trainee was not pushing the UP button.

10. The licensed operator immediately assessed the situation; he saw that the safety rod was continuously withdrawing and that the regulating rod was fully inserted so he reached over and pressed the manual scram as required by the OSTR emergency procedure (OSTROP 1.13). The scram occurred at 09:26:00; however, the annunciator panel showed that the period trip had in fact scrammed the reactor a fraction of a second before the licensed operator. The maximum power level indicated on the chart was 20 kW.

11. The control rod positions at the beginning of the uncontrolled reactivity insertion and the time of the scram are shown below together with their reactivity worths.

Transient	Safety	Shim	Reg	Total
530 – $1.68	380 – $0.94	370 – $1.16	(250 – $0.42)*	4.2
530 – $1.68	686 – $2.15	370 – $1.16	102 – $0.00	4.99
	+ $1.21		- $0.42	+ 0.79 net

*estimated

12. The Assistant Reactor Administrator was notified of the incident at approximately 09:50 and the Assistant Director at 10:20. The Nuclear Regulatory Commission was notified at approximately 13:15. The Chairman of the Reactor Operations Committee was notified upon his return to the building at about 16:30.

Cause

The cause of the reportable occurrence was determined to be the failure of the safety rod UP switch which resulted in a continuous safety rod withdrawal. The switch was determined to be at fault because: (a) switches had very occasionally failed in this way before; (b) after scramming, the rod carrier stayed at the 686 unit position until the switch was pushed again; (c) there are no other components, such as relays, to fail in this circuit.

The failure of the switch was not instantly detected due to the fact that (a) the trainee operator was increasing power in automatic mode on a normal period, and (b) had his left hand generally over the control rod switches so that he could conveniently operate them. The licensed operator was about to question the trainee on his apparent continuous withdrawal of the safety rod when the trainee moved his hand. The nature of the situation became immediately apparent to the licensed operator, and he reached over to manually scram the reactor, only to be beaten by the period scram. The actions of the operator were correct and consistent with all OSTR operating procedures.

Corrective Actions

Similar malfunctions of this type of switch have occurred during the OSTR's 15-year history. From this considerable experience two types of fault have been noticed. One is due to the switch reaching the end of its useful life and the other is a random single failure. The former is characterized by the fact that the switch continues to fail in approximately one in ten cycles or less. When this occurs the switch is replaced. The second fault, as described above, is random in nature and seems as likely to occur in a new switch as in an older one. The occasional switches which have had this one-time problem have been subsequently used with no further recurrence for several years afterwards.

After the switch failure, the Reactor Supervisor and Reactor Operator cycled the switch approximately 100 times without being able to cause it to malfunction again. It was therefore concluded that this was a random single failure. Therefore, in consideration of this and the facts that:

1. a new switch is as likely to undergo a random-type failure as an old switch,

2. experience has shown that a switch that has had a single failure can still be safely used for years afterwards,

3. the difficulties encountered in the unsoldering and soldering of a large number of connectors in the small space available could cause other problems,

it was decided not to replace the safety rod UP switch at this time.

However, an Operations Instructions Bulletin (OIB 81-1) was written explaining the one-time failure of the switch, and informing the operators to be particularly attentive to the possible recurrence of this problem. The OIB also states that should this switch fail again it will be replaced.

The reactor was not operated again until the event had been reviewed by the Reactor Operations Committee and the corrective actions approved.

Safety Implications

1. The reactor safety circuits functioned correctly in that the period trip scrammed the reactor.

2. Should the period trip have malfunctioned, the reactor operator had already pushed the manual scram.

3. If the incident had gone completely unnoticed and the period trip had failed, then there were two further scrams, one on the percent power channel and one on the safety channel. These would have occurred at 1.1 MW. If both of these had also failed, then the fuel element temperature trip would have occurred at 510°C.

4. Depending on the actual reactivity insertion, it is possible that the power and fuel temperature trips may not have even been reached. An <u>instantaneous</u> insertion of 80¢ of reactivity is commonly used when the reactor is operated in the square wave mode. This may or may not be enough to bring the reactor to 1 MW, depending on the xenon poisoning in the core.

6. As a result of the above, it is concluded that the overall safety implications of this event were minimal.