

June 8, 1993

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C.
20555

SCHOOL OF
ENGINEERING 
& APPLIED SCIENCE

NUCLEAR REACTOR FACILITY
Department of Mechanical,
Aerospace & Nuclear Engineering

University of Virginia
Charlottesville, VA 22903-2442

Subject: Corrective Actions and UVAR Startup Plan, 982-5440 FAX: 804-982-5473
University of Virginia Reactor Facility
[Reactor Docket Nos. 50-62 and 50-396]

Gentlemen:

Please find in attachment a document entitled "Corrective Actions and UVAR Startup Plan," which is an update of the document entitled "UVAR Startup Plan" sent by facsimile to Mr. Alexander Adams (from NRC Headquarters in Washington D.C.) and Mr. Craig Basset (from NRC Regional office in Atlanta) on June 1, 1993. This update supersedes the previous document, and is sent in final fulfillment of a commitment to report on corrective actions taken and planned, made in the licensee's "14-Day Report" concerning an inadvertent reactor console modification made on April 28, 1993.

The provisions in NRC's Confirmation of Action Letter (dated April 30, 1993) have been met. The major points are summarized as follows:

1. The UVAR has been in a shutdown state since April 28, 1993 and will continue in this state until the discussions in progress with NRC Region II are finalized. NRC concurrence with reactor restart is expected within the next few days provided no new issues develop.
2. The root causes for the event have been evaluated by the Reactor Staff and by the Reactor Safety Committee. Based on these evaluations, numerous corrective actions were initiated. All short-term corrective actions necessary and sufficient for reactor restart have been concluded, as described in detail in the attached report.
3. The tie-offs of the unused inputs in the Mixer-Driver modules (MDs) introduced in the early 70's were removed following an approval received from the Reactor Safety Committee. These tie-offs are not required for the scram logic since they affected unused inputs in each MD. Because the tie-offs were not alike in both MDs, the exchange of the MDs caused the loss of certain scrams. A repeat of this event can't occur again because, among other reasons, the MDs are now alike.
4. The console electronics were checked and a cold solder joint was found and repaired in one of the Mixer Driver modules. This cold solder joint is likely to have been the source of the scrams received w/o annunciation.

9306170199 930608
PDR ADDCK 05000062
P PDR

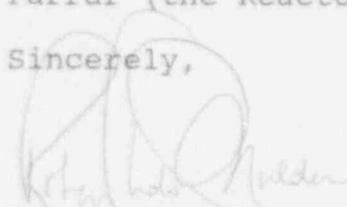
ADD 11

(Corrective Actions, cover letter, page 2, cont.)

5. The check of the console electronics also revealed that no damage was caused by the inadvertent modification to the scram drawer.
6. The updated console schematics and the console electronics have been verified to be in agreement.
7. Procedural modifications have been made. Maintenance is now clearly defined, and a check of scrams will be done prior to reactor restart whenever unplanned scrams occur. The understanding of line management authority was improved, with the Reactor Supervisor recognized as the sole focal point for reactor operations. Re-training of the Reactor Staff on these and other issues was completed on June 7, 1993.
8. A permanent caution has been installed on the reactor console, which warns operators that the electronic modules in the reactor console are not interchangeable.
9. A confirmatory inspection by two NRC officials was hosted by the licensee on June 3 and 4, 1993.
10. The licensee commits to notifying the NRC in the event that two unexplainable scrams are received over a 30-day period. If this should occur, the UVAR will be shutdown and not restarted until the console electronics have been diagnosed for the source of these scrams and additional corrective action is taken. This condition is to be in effect for three months following reactor restart.

The report in attachment provides more details about these items. However, if there are further questions please call me, or Mr. Pres Farrar (the Reactor Supervisor), at (804) 982-5440.

Sincerely,



Robert U. Mulder, Director
U.VA. Reactor Facility

encl: Corrective Actions and UVAR Restart Plan

cc: U.S. NRC Region II, Atlanta
U.VA. Reactor Safety Committee
Virginia Office of Emergency Services
Dr. William G. Vernetson, Chairman of TRTR
U.VA. Reactor Staff

CORRECTIVE ACTIONS AND UVAR RESTART PLAN

Introduction

UVAR restart has been conditioned on:

- 1) Authorization from the Reactor Safety Committee, and
- 2) Agreement from the NRC, to be obtained following the on-site confirmation by an NRC team of corrective actions taken and planned prior to restart, and conclusion of discussions with the NRC.

Permission for UVAR restart subject to item 2) above was obtained from the Reactor Safety Committee on May 27, 1993 based on corrective actions implemented by the Reactor Staff.

Due to the long lead-time required to schedule a confirmatory visit by NRC officials, the NRC was contacted before all corrective actions had been completed. A team from the NRC visited the Reactor Facility on June 3 and 4, 1993.

The corrective actions planned and taken by the U.Va. Reactor Staff in response to the inadvertent reactor console modification event of April 28, 1993 are presented below. The completion of these corrective actions constitutes the UVAR Restart Plan.

Corrective Actions

The majority of the corrective actions are closely linked to previously identified root causes for the reactor console event. These root causes were covered in the licensee's "14-day report" to the NRC. Corrective actions can be classified under the hardware (reactor console), procedural and management areas. Following the completion of those corrective actions identified as necessary for reactor restart, and with the concurrence of the NRC, the UVAR will be authorized to restart. Additional corrective actions which may be taken in response to the TRTR recommendations made in the Peer Review Report may be implemented following reactor restart.

Corrective Actions Pertaining to the Console Electronics

Mixer-Driver Modifications

Permission was obtained from the Reactor Safety Committee to remove the jumpers tying-off together the unused inputs within the Mixer Driver (MD) modules. This request was based on a safety analysis which concluded that this action would not change the scram circuit logic from that indicated in the console schematics and would not

(Reactor Restart, page 2, cont.)

pose unreviewed safety questions. The Reactor Staff, the Reactor Director and the Reactor Safety Committee reached the conclusion that the return of the Mixer Drivers to their unmodified state would be in the interest of safe operations. The jumpers were removed after the Reactor Safety Committee authorization was obtained. A newly adopted maintenance sheet was used to document this action and the required testing on the MDs was successful.

The removal of the MD tie-offs should permit MD interchange in the future. However, it is noted that an interchange of modules would be made subject to enhanced procedural controls which have been enacted recently. These controls include pre-approval for the work and testing of the modules for operability following its completion.

Review of Reactor Console Circuit for "Traps"

The reactor control console was scrutinized for electronic modules which were internally modified and which could pose problems if interchanged. A few modules were found that also had tie-offs of unused inputs. The staff plans to submit to the Reactor Safety Committee requests for specific authorization to remove the tie-off from these modules in the near future.

However, the removal of tie-offs in modules other than the MDs should not become a prerequisite to reactor restart. A caution has been posted on the reactor console alerting operators that modules in the console are not to be interchanged. Improved labelling has been applied to the modules in the console (see the description below). If the modules were to be left as is and not interchanged, no problems would exist. In fact, it is not certain that the removal of further tie-offs will be authorized by the Reactor Safety Committee.

A check of the console drawings was made concurrent with the review of the console electronics. As necessary, a few slight modifications which had been made to the modules many years ago (circa 1970), and which had not been documented at the time, were incorporated in the updated copy of the facility's manual containing the module schematics. The console drawings and the as-built console were certified to be in agreement.

Improved Labelling of Electronic Modules

A improved labelling scheme for the reactor console electronic modules was proposed by the staff and approved by the Reactor Director. The re-labelling was completed prior to the confirmatory inspection by the NRC officials. The new labels carry more

(Reactor Restart, page 3, cont.)

information than before, and now identify modules that have been (and must remain) modified from the off-the-shelf state, as well as modules that are unique and may not be interchanged.

All console modules were checked and it was ascertained that their circuitry does correspond to the updated electronic schematics of the reactor console.

Search for Source of Spurious Scrams

The spurious scram signals were identified as a contributing root cause for the event because they led to the informal troubleshooting involving the exchange of the MDs. A search for the source of the spurious trip signals was made and may have been found. Diagnostics were run on the console, and a resistor in one of the MD modules was found to have a "cold" joint. The joint permitted some movement when pressure was applied with a probe.

It is hypothesized that this cold joint, which resulted in a variable increase of electric resistance, could have caused spurious drops in voltage in the MDs, from the +10 V necessary to hold the control rods up, down to intermediate values of about 8 V which would result in control rods being released into the core. While a trip signal is stated as having 0 V, in fact voltages in the circuit below about 8 V are as effective as 0 V in producing a scram. An occasional temporary drop in voltage to a level of around +8V in a scram logic circuit could explain why first one of the rods would trip, forcing the trip of the remaining rods, without an annunciation of the source. The scram observed on April 28, 1993 was a "soft" scram as described above.

The cold joint was resoldered, the output signals in each of the MDs bench measured, and the availability of all scrams successfully tested following the return of the MDs to the console. To conclude with certainty that this cold joint was the source of the spurious scrams will require observation of unplanned UVAR trips in the future. The licensee commits to notifying the NRC in the event that two unexplainable scrams are received over a 30-day period. If this should occur, the UVAR will be shutdown and not restarted until the console electronics have been diagnosed for the source of these scrams and additional corrective action is taken. This condition is to be in effect for three months following reactor restart.

Procedural Improvements

Numerous changes to UVAR Standard Operating Procedures (SOPs) have been approved by the Reactor Safety Committee. These changes have been discussed at reactor staff meetings. The principal ones which deal with the console event are discussed below.

(Reactor Restart, page 4, cont.)

Management Controls over Maintenance

Provisions were added to SOP 2. General Regulations increasing management controls over maintenance of the reactor console by the reactor operators. The Reactor Supervisor has been re-identified as the "focal point" for daily reactor operations, and must authorize maintenance or trouble-shooting of the console electronics.

A new UVAR Safety-Related Systems Checklist was adopted for use following the performance of maintenance on the reactor console. Also, this same checklist will be used prior to reactor restart following a reactor trip that can't be explained.

In addition, management controls over maintenance activities having safety significance was clarified and increased in UVAR SOP 7. A new "Trouble-shooting/Repair Documentation Sheet" was developed and made part of SOP 7.0, to track maintenance and management approvals prior to and following maintenance. An appraisal of tag-out requirement and non-existence of unreviewed safety questions is called for on this checklist. Authorization for work and return of a serviced system to service requires that this checklist be signed twice by the Reactor Supervisor.

The procedural improvements described above have been implemented. SOP revision sheets were distributed to each staff member so that individual copies of SOPs could be updated. All reactor operators were retrained on the new procedures during a one hour and a half meeting held on June 7, 1993. The procedural improvements made will prevent operators from ever starting up the reactor without having all Technical Specifications (TS) required scrams available.

Definitions for Maintenance

UVAR SOP 7 on System Calibration and Maintenance was improved with the addition of definitions for "maintenance" and "troubleshooting." (Troubleshooting, whether formal or informal, has been recognized as a form of maintenance). The new definition for maintenance was developed by the reactor staff after numerous discussions, so there is no doubt that it is well understood. No troubleshooting will be allowed without a written plan and appropriate approval by the Reactor Supervisor, as called for in the "Trouble-shooting/Repair Documentation Sheet."

Self-critique Staff Meetings

Over the course of past four weeks, many staff meetings were held. At these, the root causes for the event and improvements to the

(Reactor Restart, page 5, cont.)

SOPs were discussed and clarified. Line management authority has been upgraded. Thus, the potential for judgement error on the part of the SRO and Reactor Supervisor based on an improper understanding of what constitutes maintenance can be expected to have been greatly reduced. Also, the approval process for troubleshooting and for maintenance has been formalized with the adoption of the "Trouble-shooting/Repair Documentation Sheet."

Electronic Expertise

Redundancy of Staff Electronic Skills

Recently, a new reactor operator was licensed by the NRC. This operator has a Ph.D. in Engineering Physics and a Bachelors Degree in Electrical Engineering. The new operator is becoming more familiar with the console electronics and will assist the SRO who has been the individual mainly responsible for console maintenance.

Additional Reactor Safety Committee Member

A few days following the console event, the President of the University of Virginia appointed to the Reactor Safety Committee a faculty member who has a background in electronic systems, to bolster the electronic expertise of the Reactor Safety Committee. This member began attending ReSC meetings immediately following his appointment.

TRTR Peer Review

The Reactor Director requested the National Organization of Test, Research and Training Reactors (TRTR) to send a group to perform an official peer review of the reactor operations program at the University of Virginia. The group was composed of Mr. Tawfik Raby, Chief, Reactor Operations and Engineering at the National Institute of Standards and Technology Reactor, and Dr. William G. Vernetson, Director Nuclear Facilities at the University of Florida. Mr. Wade J. Richards, Director of Nuclear Operations at McClellan Air Force Base, was unable to participate in the visit. However, he participated in the phone discussions with the TRTR visitors about their findings as well as in the preparation of the peer review report.

The peer review concentrated on management issues, i.e., a study of how U.Va.'s "line management" for research reactor operations functions. The entire Reactor Staff was interviewed. The reactor scram system were reviewed. Based on the interviews and the verification of the facts related to the console event, the TRTR

(Reactor Restart, page 6, cont.)

panel produced a report with findings and recommendations. This report was finished on May 27, 1993. The Reactor Director asked TRTR to send its official report directly to NRC officials at Headquarters and Region II.

Some preliminary findings were communicated verbally to the Reactor Director at the end of the peer review. While there is no problem with the "safety culture" at the Reactor Facility, and the staff members are "highly competent," the TRTR panel suggested that another contributing root cause for the console event. The weak, informal authorization given by the Reactor Supervisor for a restart of the UVAR following the exchange of the MDs was attributed to unclear lines of responsibility and authority.

To address this root cause, it was recommended that the Reactor Supervisor become the sole, clear focus for all reactor operations. All operators engaged in reactor operations should keep the Reactor Supervisor well informed of their current activities and the state of the reactor. Strengthening the reactor staff hierarchy and avoiding "collective" management of reactor operations is encouraged by TRTR. The Reactor Director believes that the procedural improvements made to date satisfy the requirement of making the Reactor Supervisor the focal point for reactor operations and addresses the thrust of the TRTR report.

Definition of Personnel Responsibilities

It appeared to the TRTR peer review team that confusion could be generated among the reactor operators as to who was in charge by virtue of the Reactor Staff having two state positions with the reactor supervisor label. Internally, the senior-most reactor supervisor has been called the "Reactor Administrator," while the junior supervisor was called the "Services Supervisor." The junior supervisor has been the designated substitute for the first, when the first is on vacation or away from the Reactor Facility.

In respond to this TRTR finding, the former "Reactor Administrator" will be called **the** Reactor Supervisor, and the "Services Supervisor" will now be called the Services Manager. The term Reactor Supervisor is the only one used in the SOPs, thus with the above change there will be no chance for misidentification.

With regard to the TRTR position on the unclear management line, it should be pointed out that the SRO performing the troubleshooting on the console approached the "correct" individual (that is, the "Reactor Administrator" or the senior Reactor Supervisor) to explain the troubleshooting effort and request permission for UVAR restart with the modules in the interchanged positions. There is

(Reactor Restart, page 7, cont.)

general agreement by the licensee that TRTR is correct in stating that the approval given by this Reactor Supervisor was passive and not well documented. This deficiency has been corrected in that a written maintenance/troubleshooting plan with formal authorization is now required by the "Trouble-shooting/Repair Documentation Sheet."

The Reactor Staff has discussed the RO, SRO, cognizant SRO, Reactor Supervisor and Reactor Director functions in detail at several meetings. The Reactor Supervisor (or his designee) will be updated regularly about the status of reactor operations.

Long-term Corrective Action

UVAR SOP 3 deals with Reactor Staff responsibilities. These are listed on a single page and were last reviewed and updated in 1988. It is time for SOP 3 to be updated and a draft revision is being worked on. While the UVAR SOPs have been used successfully during the past 33 years to safely operate the UVAR, SOPs could be improved by formally defining the line organization for reactor operation and maintenance in SOP 3. Also, increased detail can be presented there as to the responsibilities, duties and authority of the Reactor Operator, the Senior Reactor Operator, the Reactor Supervisor and the Reactor Director.

A first draft of the complete rewrite of SOP 3 is ready and being reviewed by the Reactor Staff and the Reactor Supervisor. A final draft of SOP 3 must be reviewed and approved by the Reactor Safety Committee at a future meeting before the revised SOP 3 goes into effect. Completion of this planned corrective action is not a necessary prior to UVAR restart because the personnel duties and the chain of responsibility for reactor operations and maintenance are well understood by the Reactor Staff following the retraining they have received.

Concluding Remarks

The Reactor Director believes that the timely and extensive corrective actions taken by the licensee to improve the UVAR SOPs both meet the thrust of the TRTR recommendations and adequately address the root causes identified by the licensee for the event. It is now extremely unlikely that a repeat of the console event, or occurrence of a similar event, will ever occur again.

Corrective actions proposed by the Reactor Staff, to address the recommendations listed in the TRTR report, can be expected to be sent to the Reactor Safety Committee within the next few weeks. Follow-up on TRTR recommendations dealing with management structure issues that do not address directly the console event of April 28, 1993 are not a precondition to reactor restart.

(Reactor Restart, page 8, cont.)

A formal reply to the TRTR report will be made by the Reactor Director in the coming weeks, as time permits. A copy of this report will be made available to the NRC in the future.

This report documents that significant steps have been taken to assure a safe return to reactor operations. The U.V.A. Reactor Safety Committee has given its permission for UVAR restart based on these corrective actions. Agreement from the NRC for UVAR restart is now sought.