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March 30, 2005

Nuclear Regulatory Commission  
Document Control Desk  
Washington, DC 20555

Re: Reportable Occurrence – TS 3.2.6  
License R-s, Docket No. 50-005

Dear Sir or Madame:

This report is being submitted in accordance with Sections 6.5.2 and 6.6.2 of the Penn State Breazeale Reactor (PSBR) Technical Specifications (TS). Initial verbal notification of this reportable occurrence was made to Marvin Mendonca, NRC HQ on March 22, 2005 and was confirmed by email to Marvin Mendonca and Tom Dragoun on that same day.

TS 3.2.6, SCRAM Time, states: "The time from SCRAM initiation to the full insertion of any control rod from a full up position shall be less than 1 second."

#### Description of Event

On Monday, March 21, 2005, routine pulsing of the PSBR was being conducted. During a pulse, the reactor is automatically scrammed about three seconds after the initiation of the pulse. Three pulses had been performed. After the fourth pulse, the operator, while verifying that the normal responses to the automatic SCRAM had taken place, observed that the console computer mimic display appeared to show the transient rod (TR) did not reach full insertion in the normal time frame.

The DUTY SRO and the System Expert were notified, the reactor was tagged out, and a drop time measurement of the TR was performed. The drop time was measured to be just over 1.4 seconds. Thus the PSBR was in violation of TS 3.2.6.

A routine TR cleaning and lubrication was conducted and the TR drop time was measured to be in the mid-700 millisecond range. The TR drop time had last been measured during the annual maintenance on August 19, 2004 with a value of about 680 milliseconds. An increased frequency of drop time measurements was implemented, the situation reviewed, and the reactor was returned to normal operation. At that time it was believed that the lubrication had dried out during the seven-month period. In the past we had lubricated the TR at more frequent intervals in an attempt to limit the hiss associated with normal air leakage from the TR air cylinder.

On Monday, March 28, 2005, the TR drop time was measured as had been scheduled following the return to service of the reactor. The drop time was in the mid-800 millisecond range. Since these two measured drop times (March 21 and March 28) were longer than those that had been routinely observed since a related occurrence in 1999 (high 600 millisecond range) it was decided to perform another cleaning and lubrication to further improve the drop time.

Following that cleaning and lubrication, we observed further degradation of the TR drop time although the TS drop time was still met (note the reactor was shutdown and tagged out during this effort). Multiple further lubrication efforts were made to achieve satisfactory drop time with no success, in fact the drop time was observed to be increasing; thus it appeared that there might be a problem other than lubrication.

Based on the degradation that was being observed, it was decided to disassemble the TR drive system and perform a more complete inspection, cleaning, and lubrication such as was done in 1999. See our 14-day letter for that event which was dated October 18, 1999. This effort was conducted on March 29, 2005.

JE22  
AO20

The TR in the pulse mode is actuated utilizing an air cylinder; the TR is actually attached to the piston rod of the air cylinder. During disassembly it was found that the Teflon TR piston shaft seal at the bottom of the TR air cylinder had deteriorated and the TR piston rod was dragging on the O-ring that backs up the seal. This deteriorated seal was the actual cause of the degraded drop time since the material of the O-ring did not provide the smooth slick surface of the Teflon seal.

The TR piston rod was mechanically cleaned with diamond paper as well as being cleaned with acetone and ethyl alcohol prior to being lubricated. The Teflon seal and its O-ring were replaced. The air cylinder was cleaned and lubricated in place. The drive system was reassembled and tested. The drop time was now measured to be in the mid-600 millisecond range; although the drop time was fully acceptable, excessive air leakage at the bottom of the air cylinder where the seal housing screws onto the air cylinder was noted. The drive system was again disassembled, inspected, lubricated, reassembled with a larger O-ring for the seal housing to air cylinder joint, and tested multiple times. All drop times were in the mid- to high-600 millisecond range. It should be noted that the second O-ring sealing the seal housing to the air cylinder is not the one associated with the piston rod seal that had failed.

A full surveillance for the movement, speed, and drop times of all control rods was conducted with satisfactory results. The TR air cylinder issues do not affect the three other control rods as they utilize rack and pinion drives with electro-magnet coupling.

The TR drop time was measured again the following morning, March 30, 2005, with a result consistent with the mid-600 millisecond value. The reactor was returned to normal operations on March 30, 2005. An administrative requirement to measure the TR drop time prior to operations each day has been put in place until sufficient information is available to justify a move to less frequent testing.

Reviews were made of operational information to determine when the failure of the shaft seal probably occurred. Based on our records the shaft seal was installed in October of 1999. The drop time measured during our annual inspection conducted in August of 2004 showed the expected mid- to high-600 millisecond value. In November of 2004 a pulse and a square wave were performed and based on console messages available for review the drop time was normal.

The next console message information available is in February of 2005 and although not definitive it is possible that the TR drop time had begun to degrade but likely did not exceed the TS limit. The first information found which is clearly indicative of a degraded TR drop time that exceeds one second is for a pulse conducted March 16, 2005. More definitive information relating to the time of failure for the TR piston shaft seal cannot be developed. It should be noted that the console messages which were used to arrive at these conclusions are subject to a great deal of uncertainty and it is only after the observed slow drop times that one can readily make the interpretations needed.

A review of the console messages for the four pulses conducted on March 21, 2005 indicates that the TR drop time for the first pulse was marginal and that the TR drop times for the subsequent three pulses likely exceeded the one second value. It was on the fourth pulse that the operator observation of the mimic display was made. Note that the timing from the console messages cannot provide definitive drop times; that can only be accomplished utilizing the equipment and procedure specifically intended to measure drop times.

#### Corrective and Preventative Action

We are in the process of reviewing records related to the TR drop times and maintenance since the event of 1999. These records provided much of the guidance and procedures utilized in the disassembly, cleaning, and lubrication. No evidence of the air contamination noticed during that former event was found so there is good evidence that the efforts to provide a dry and clean air supply were successful.

Following the return to service an accelerated daily measurement of TR drop time has been put in place for the immediate future. We are also reviewing our scheduled maintenance intervals and procedures. Based on the observed good drop time behavior over the years since the 1999 event we had moved away from a full disassembly each year even though we performed the annual inspection, lubrication, and drop time measurements. The

inspections being performed did not extend to a full disassembly or observation of the Teflon seal and it's O-ring. The seal and its housing were not removed from the air cylinder.

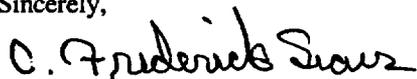
We will be changing our annual maintenance to require inspection and probably replacement of the piston rod seal that was found to be the basic cause of the degraded drop time. We expect to change our drop time surveillance requirements to be more frequent than the annual period of TS 3.2.6. Although at present we expect we will settle on a quarterly period, we will make that decision after more frequent testing over the next six months.

The event and the subsequent maintenance and repairs have been briefed to the operations staff on several occasions. Discussions of how operators might observe such degradation have been presented. It is noted that the PSBR console has some unique capabilities that permitted the operator opportunity to detect this degradation.

The senior Penn State administration responsible for the reactor has been briefed several times as has the Chairman of the Penn State Reactor Safeguards Committee (PSRSC). This event and our corrective actions will be reviewed with the PSRSC at their next regular meeting. We also are planning to make a presentation of our TR performance, surveillance, and maintenance at the September 2005 TRTR meeting so that other TRIGA users can benefit from our experience.

If you have any questions regarding this matter, please call the PSBR Director, at 814-865-6351,

Sincerely,



C. Frederick Sears  
Director, Radiation Science & Engineering Center

CFS/skr

Pc: M. Mendonca  
T. Dragoun  
E. Pell  
L. Burton  
T. Litzinger  
T.L.Flinchbaugh

Subscribed and sworn before me on the 30<sup>th</sup> day of March 2005, Notary Public in and for Centre County, Pennsylvania.



NOTARIAL SEAL  
SUSAN K. RIPKA, Notary Public  
The Pennsylvania State University  
Centre County, PA  
My Commission Expires May 12, 2007