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Attention Linh Tran. Senior Project Manager, NPUF Division

REFERENCE: University of California Irvine, Reactor Docket 50-326, License R-116

SUBJECT – Reactor Fast Transient Rod Drive Failure and Repair

Attached is a report detailing the problem encountered with the drive mechanism for the referenced reactor's Fast Transient Rod, and its subsequent repair and reinstallation.

If you have any questions regarding this matter please contact George Miller, Reactor Supervisor at (949) 824-6649 or at gemiller@uci.edu.

George E. Miller

George E. Miller
Reactor Supervisor

cc: Prof. A.J. Shaka, Reactor Director
John Keffer, Reactor Facility Manager

U. C. Irvine Nuclear Reactor Facility Docket 50-326

Fast Transient Rod (FTR) Drive Failure and Repair

Report Date November 18th 2021

In accordance with sections 6.6.2 (Item 4) and 6.6.2.c. of the Technical Specifications for the facility we are submitting a report regarding an unusual event involving the Fast Transient Rod Drive (FTR). While this in itself did not create a safety related issue, a control rod is considered part of a safety system, so is reported under this rubric.

1. <u>Background Description of Involved Component - Fast Transient Rod (FTR).</u>

The UC Irvine Nuclear Reactor was constructed in 1969 as a standard Mark I TRIGA facility but (unusually) provided with a second, fast, transient poison rod (FTR) to operate in synchronization with the "standard" transient rod which provides adjustable reactivity insertions (ATR). Using the two rods together enhances the pulsing capability to closer to $3.00, the license limit. As a result of the initial license power and reactivity excess restrictions, the rod was located in the F ring of the core at position F13, in a lower flux and so has had a reactivity worth of only $0.60-$0.70. The latest measure was $0.68. The Adjustable Transient Rod (ATR) is currently worth $1.78 allowing a transient reactivity insertion of $2.46 when used together.

The FTR and ATR are withdrawn by operation of a single FIRE button that actuates solenoids that apply air pressure to the bridge mounted operating pistons on these rods. Various interlocks prevent operation without proper settings of measurement and other systems. Timing circuits allow for the synchronization of the prompt reactivity insertion available which could then be (with current core loading and reactivity values) up to $2.46.

The FTR which was designed and installed by General Atomic has no adjustments and is either in core or out of core. It is driven by a single stroke air piston with a 27 ½ inch travel located on the reactor bridge. Connecting rods join the piston rod to the actual control rod approximately 20 feet below. A separate underwater piston and dashpot provides for absorption of shock at the upper end of travel. More complete details are provided in section 2.9.3 of the Mechanical Maintenance and Operating Manual (MMM) for the UC Irvine reactor and in the facility SAR (1968).

It is important to note that the FTR was never intended to be used by itself – indeed its value is too small to initiate a pulse – but only in conjunction with the ATR to enhance pulsing insertions. While it has been standard practice to drive this rod from the core before steady state operation, its reactivity worth is not required for reactor shut-down or to meet any required shut-down margins. Both these functions are fully met by the facility's three remaining control rods.

We are aware that the University of Illinois TRIGA reactor and the Sandia Corporation reactor (ACPR) had a similar FTR enhanced control element, but are unaware of any others installed of this type.

2. Description of Event and Repair Actions..

On October 20th 2021 during a routine start-up, an unusual sound was noted when withdrawing (firing) the FTR. All electronic indicators (ROD UP) were normal. Suspicion was that the piston air was applied but the control element was not actually raised. A manual scram was performed and all rods were confirmed down.

Reactor operations were suspended pending further investigation.

In order to examine the rod and drive and affect repairs, the complete rod structure and the control rod were removed from core and the pool and examined on the reactor room floor. See the attached sketch for clarification of components.

On October 21st, staff proceeded to follow standard procedure to dismantle the FTR drive mechanism, at which point it was found that the 1/4th inch steel connecting rod had become separated from the dashpot piston rod that in turn attaches to the poison section. The first assumption was that the set screw had loosened allowing the connecting rod to unscrew, so after retrieval of the lower section, the drive was re-assembled and re-installed with a tightened set screw. The drive was then prepared for testing function by firing to measure drop time. The same unusual sound was experienced on the second firing attempt and unusually low drop time was measured. With no connection to the actual poison section, the drop time is simply that of the air driven piston on the reactor bridge. The drive was thus disassembled for a second time on October 28th and the drive was again found to be disconnected at the same location. A closer examination was made of the 1/4th inch rod connection and it was observed that the threads had stripped in the aluminum dashpot piston rod section.

A repair was initiated by inserting a stainless steel "helicoil" fitting to restore the ¼-20 threads in the aluminum dashpot connecting rod and providing a replacement stainless steel connecting rod and new polyethylene piston. The helicoil is a threaded unit specifically designed to replace damaged threads and is inserted following creation of an oversize tapped thread. . A 50.59 review was conducted to establish the appropriateness of this repairs. Following drive reinstallation on November 15th, the rod parameters essential to its operation (drop time and reactivity) were measured to be the same as their former values.

Normal operations were resumed November15th 2021.

3. Subsequent Considerations and Actions

The FTR is present to enhance pulsing capability. However in steady state it has been used as a "safety" rod merely being added to the scram amount by removing it before operating at steady state, so no poison is present in that outer part of core. As a result it is conservatively estimated that it has been fired over 40,000 times during its 52 year lifetime as a consequence of start-up testing/verification of SCRAM function, drop time and worth measurements. Only about 2000 operations have actually been associated with pulsing. Since precise timing of removal is completely un-necessary except when it is being used in pulsing, the air pressure for removal needs to only be adequate for removal. Higher air pressure places more stress on all connecting components over time. Air pressure has very little effect on scram/drop time – indeed less air to vent should mean shorter scram/drop time. So an air pressure of 40 psi will be used to reduce stress on the system. Higher air pressure can be restored if and when it seems necessary to tune up pulsing operation. GA Diagram TOS254J100 and the MMM contain a prescription for adjusting the lower shock absorber on the FTR with changing air pressures in order to achieve appropriate deceleration as air pressure is increased from 40 to 80 psi. The remaining (REG, SHIM, and ATR) control rods at this facility do not have similar drive connections and continue to function as designed.

4. Reporting

This event was reported to the UCI Project Manager and other NRC staff by email as the event progressed. This report represents a final report.

Submitted

George E. Miller

Reactor Supervisor

John Keffer

Reactor Manager

A.J. Shaka

Reactor Director

Notes:

Connecting Rod = 1/4th inch stainless steel threaded into:

Dashpot Piston rod (aluminum) holds polyethylene dashpot piston at upper end and is threaded on to poison section at lower end.

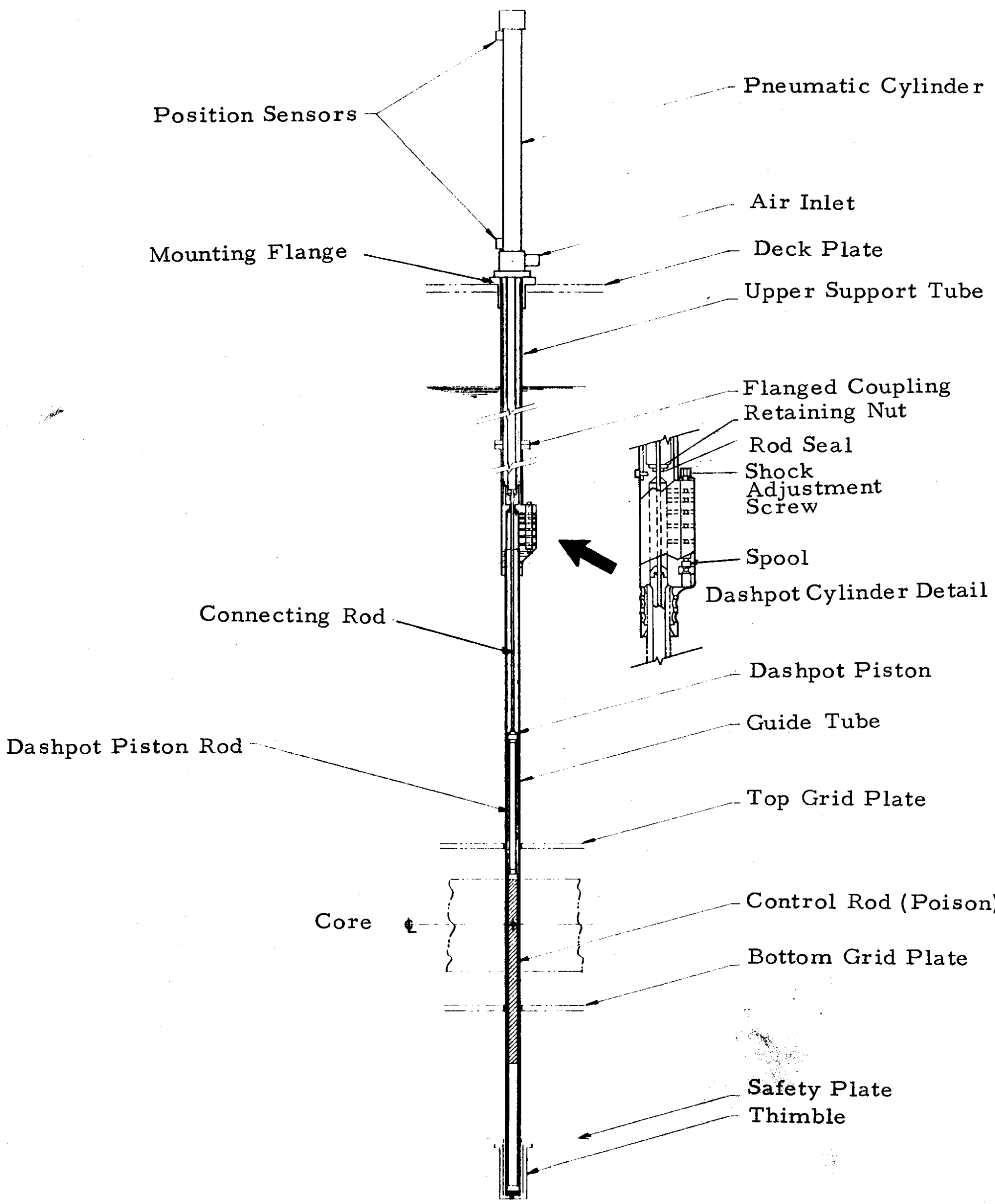

Fig. 2-11. Fast transient rod drive