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MEMORANDUM FOR: Carlyle Michelson, Director
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SUBJECT: REPETITIVE OVERSPEED TRIPS OF THE STEAM DRIVEN EMERGENCY FEEDWATER PUMP ON INITIAL START AT ARKANSAS NUCLEAR ONE, UNIT 2

Since 1979, Arkansas Nuclear One, Unit 2, (ANO-2) has experienced a series of occurrences where the steam driven emergency feedwater (EFW) pump, 2P7A, starts on demand and then trips on a turbine overspeed signal. The first event in this repetitive sequence is thought to have occurred on September 23, 1979. After the initial pump trip, the unit was successfully started three times without a subsequent overspeed trip. The cause of the overspeed trip was attributed to water in the steam supply header to the turbine driver. The next overspeed trip occurred on December 30, 1979. Again, the turbine trip was reset and the pump was started three times without a subsequent trip. The licensee still believed the problem to be related to condensation in the steamline because the steam trap had been inadvertently isolated prior to this event. After the pump tripped on overspeed on April 24, 1980, the licensee began to question whether condensation in the steamline was the root cause of the now apparent repetitive failures. The EFW pump was manually started once every four hours in an attempt to determine the cause of the trips. The EFW pump tripped again on April 26 and April 27, 1980. The sequence of testing was terminated with mechanical adjustments to the pump and the turbine driver controls.

The pump again tripped on May 20, 1980 on overspeed following a manual start signal. The licensee extended the steam driven emergency feedwater pump start frequency to every 12 hours to verify operability. It again tripped on June 2, 1980. Other overspeed trips occurred on July 17, 1980, August 4, 1980 and August 29, 1980. At this time, it was observed that the root cause of the problem could be related to a lack of response of the hydraulic control during the initial start of the turbine after an idle period in excess of 48 hours. The pump again tripped on October 14, 1980 and was removed for design modifications on October 17, 1980.

Initially, condensate in the steam supply line to the turbine was considered to be the probable cause for the overspeed trips. However, since steam traps had been added to the low points in the system and the problem persisted, the condensation theory was abandoned. Further investigations indicated that the overspeed trips always occurred during the initial start of the unit after a long period which it was idle, and unsuccessful attempts to start the turbine

would usually be followed by successful attempts. Also, the longer the time span between successful starts, the greater the likelihood of an overspeed trip. Further, the turbine governor valve had been visually observed either to have never moved from its full open position during the transient or to have begun to move only at about the same time as the turbine speed reached the overspeed trip setpoint.[1/]

Vendor representatives from Terry Turbine and Woodward Governor were brought onsite, preventive maintenance was performed, adjustments were made, and questionable components were replaced. Subsequent testing resulted in an overspeed trip.

Plant engineering personnel then reduced the idle speed setting, and modified the electro-hydraulic governor to delay the initiation of the ramp signal; these steps effectively let full valve operator hydraulic pressure build up before the governor valve began to stroke. A new testing program was begun, initially starting the EFW turbine at one hour intervals and doubling the interval for each successive start. The turbine started successfully until the elapsed time between starts reached 48 hours, at which time it again tripped on overspeed. However, the adjustments made seemed to enhance governor valve response.

An outside consultant was contacted to investigate the overspeed trip problem and make recommendations. The governor actuator hydraulic sump was replaced in kind and a sight glass was installed to monitor oil level in the sump. The control oil tubing was also replaced. The original design specification had called for 3/8" O.D. tubing with a 0.035" wall thickness. The existing tubing (as originally installed) had a 3/8" O.D. and 0.065" wall thickness. This difference in wall thickness caused approximately a 35% reduction in available flow area for control oil and probably was the cause of the sluggish response of the governor valve. The newly installed tubing is 3/8" O.D. and 0.035" wall thickness.

The previously described testing program was reinitiated. Elapsed time between starts was initially one day. Two starts were made for each interval and then the time was increased. The test program was concluded when two starts at monthly intervals were successfully completed. Following these modifications the slow response of the governor valve was no longer noted and the RPM overshoot reached by the turbine no longer increased as test time interval increased.

1/ The turbine governor valve is fully open during the turbine start to allow the turbine to come up to speed rapidly. The hydraulically operated governor valve must quickly ramp closed to a throttled position to prevent turbine trip on overspeed. The sluggish response of the governor valve was discovered to be the cause of the overspeed trips.

There have been no subsequent LERs from ANO-2 directly related to this problem. This improvement was also substantiated by the inspection report of March 3, 1982, where the resident inspector noted that the licensee's final design changes have apparently provided an adequate solution to the overspeed trips of 2P7A, as there have been no recurrences during the many surveillance tests and starts due to emergency feed actuation signals.

We have recently completed an evaluation of another series of repetitive failures that were reported by ANO-2. In this series, the hydraulically operated emergency feedwater flow valves failed to operate on demand because of several nonobvious deficiencies that acted in synergistic combination to produce sporadic failures over a time span of several years. The licensee, through a long-term identification of the problem and persistence, successfully implemented corrective modifications and periodic preventive maintenance to effectively solve the hydraulic operator problem.

ANO-2 has apparently also successfully solved the overspeed trip problem on the steam driven emergency feedwater pump. No further action appears necessary at this time other than to monitor the LERs for any recurrence.

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