UNIT: McGuire, Unit 1
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LICENSEE: Duke Power Company
NSSS/AE: Westinghouse

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SUBJECT: COOLDOWN DURING LOSS OF CONTROL ROOM TEST

EVENT DATE: September 14, 1981

SUMMARY

While performing the loss of control room test during startup testing, plant operators had difficulty controlling the auxiliary feed system, resulting in an abnormally fast cooldown rate and a safety injection.

The greatest contributing factor to the magnitude of the transient was the inability of the operators to control auxiliary feedwater addition. Also, inadequate procedures failed to indicate that all operators should be present at the auxiliary shutdown panels before the reactor was tripped. The lack of reset switches for the auxiliary feed control valves outside of the control room indicated a design deficiency which further complicated the event.

DISCUSSION

As part of the loss of control room test, the reactor must be scrammed outside the main control room. As the test started operators left the control room to man the reactor trip circuit breakers, the auxiliary shutdown panel, and the auxiliary feedwater pump control panels. Following the reactor trip from the reactor trip breakers, the main feedwater isolation valves closed on reactor trip coincident with Tave less than 564°F. The S/G levels dropped to the Lo-Lo level setpoint which resulted in automatic start signals to the three auxiliary feedwater pumps. These pumps started and pumped water into the S/G's at the maximum flow rate since the auxiliary feedwater pump throttle valves were fully opened by the automatic start signal. As steam generator levels began increasing, the operators at the shutdown panels unsuccessfully tried to gain control of the auxiliary feedwater pump level control valves. As a result, the S/G's filled rapidly with the excessive auxiliary feedwater flow. Pressurizer level and primary pressure decreased at a corresponding rate. Operators started the second centrifigal charging pump (the first was running) to recover pressurizer level and reactor coolant system pressure.

As reactor coolant pressure dropped below the P-11 setpoint (1955-psig), the operators blocked SI to prevent further cooldown. When pressurizer level decreased to zero, the operators tripped all four reactor coolant pumps to avoid damaging them.

As the two charging pumps refilled the pressurizer, primary pressure was restored from a minimum of about 1900 psig. When the primary pressure exceeded the P-11, setpoint the SI block was cleared and SI was initiated by S/G low pressure. The SI caused the main steam isolation valves to close which prevented further heat loss from the primary system.

SI was reset on both trains. The two D/G sequences were reset and recovery was proceeding smoothly until a second SI was initiated. This occurred when the reactor trip circuit breakers were reset without sufficient steam generator pressure. During the resulting transient primary system temperatures exceeded the 100°F/hour cooldown rate permitted by Technical Specifications. The maximum temperature change during the hour following the reactor trip was 116.8°F. Excessive cooling by the S/G's, the large amount of water injecting into the primary system during initial level recovery, and the tripping of the reactor coolant pumps contributed to the excessive cooldown.

FINDINGS

Westinghouse reviewed the data from the cooldown transient and concluded that although the technical specification limits for the 100°F/hour cooldown of the vessel were exceeded no fracture concern exists because the absolute temperatures remained high. The ASME Code Section III Appendix G stress limits were not exceeded. In addition, the fatigue usage factor contribution of this transient was insignificant.

Main feedwater isolation on low Tave coincident with reactor trip will occur on virtually every reactor trip. This response and the rapid S/G level drop which resulted in the automatic start of the three auxiliary feedwater pumps are characteristic of Westinghouse units similar to McGuire Unit #1. Steam generator levels dropped from normal operating valves to the Lo-Lo setpoint in less than five seconds.

On an automatic start signal to the auxiliary feedwater system, solenoid valves interrupt the air supply to each of the auxiliary feedwater system control valves and the valves go to the fully open position. The recirculation valves on each pump go to the fully closed position. The solenoid valves must be reset to allow normal operation of the auxiliary feedwater level control and recirculation valves. Resetting all of the level control valves following an automatic start (other than SI) is done with two mechanically latching switch modules located in the control room. If the reset switches in the control room are depressed and the proper control station is selected on the auxiliary shutdown panels, then the level control and recirculation valves can be operated normally from outside the control room.

The reactor was tripped as soon as the first group of operators reached the reactor trip breakers. The transient was well underway when the second group of operators reached the auxiliary shutdown panel, since the auxiliary shutdown panels are much further away from the control room than the reactor trip breakers. Upon reaching the auxiliary shutdown panels, the operators tried unsuccessfully to reset the auxiliary feedwater system flow controls. Operators that were stationed in the control room depressed the reset buttons with no apparent results. Later, the auxiliary feedwater system flow logic was tested including the equipment, wiring and functional tests of the circuitry. The logic of the two flow reset switches is completely separate so the possibility of a double failure is remote. There was some confusion present during the test, and it is possible that the reset worked but that the operators did not recognize it due to inadequate training or experience. The operators tripped the reactor coolant pumps out of a percieved need to protect the pumps from damage due to loss of level in the pressurizer. This action, although specified in the emergency procedure, was premature. The conditions for tripping the pumps had not yet been reached and thus this action was inappropriate. In this particular event tripping the pumps caused no safety concern because there was no significant decay heat.

The causes of the event appear to be the following:

First, the operators were not experienced in controlling auxiliary feedwater addition.

Second, the procedure was deficient because it did not indicate that all operators be present at the auxiliary shutdown panels prior to reactor trip.

Third, the design of the plant allowed the operators to reset the auxiliary feedwater system control valves only in the control room itself. Although the reset may be locked-in prior to tripping the reactor, the need to perform any action in the control room represents a design deficiency.

LICENSEE ACTION

The licensee installed duplicate reset switches in the auxiliary shutdown panels. The procedures were modified to require depressing the auxiliary flow control reset switches before leaving the control room, and to require the reactor trip-to-breaker panel operator and the auxiliary control panel operator to establish communications before tripping the reactor.

CONCLUSIONS

The second loss of control room test was performed on September 17, 1981 using the revised procedures. The operators were able to control the auxiliary feedwater flow to the S/G's and the primary system parameters responded as expected. No further investigation is planned by this office at this time.