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AEOD TECHNICAL REVIEW REPORT

UNIT: North Anna, Unit 1
DOCKET NO.: 50-338
LICENSEE: Virginia Electric Power
NSSS/AE: Westinghouse/Stone & Webster

TR REPORT NO.: AEOD/T707
DATE: August 5, 1987
EVALUATOR/CONTACT: S. Israel
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SUBJECT: UNDETECTED LOSS OF REACTOR WATER

EVENT DATE: June 17-21, 1987

SUMMARY

While in mode 5, the North Anna Plant experienced an undetected loss of reactor water over a three day period. This event was precipitated by implementation of non-typical plant evolutions and the reliance on the pressurizer level as an indication of reactor vessel inventory. The licensee and Region II have committed to writing generic communications that will be sent to other licensees. These communications will stress the insufficiency of the pressurizer level as an indication of reactor vessel inventory. No further action by AEOD is recommended at this time.

DISCUSSION

1. Event Description

On June 17, 1987, with the plant in mode 5, the reactor coolant pumps were started in preparation for entry into mode 4. One of the reactor coolant pump motors failed and plant heat up was discontinued with a primary system temperature of 195F and pressure of 320 psig. The licensee determined that he could complete the motor repair in a reasonable time and decided to carry out the repairs with the primary system filled rather than with reduced primary inventory (mid-loop plus 40 inches) as is the normal practice. The repair required disconnecting the motor from the pump, which would result in a leak across the reactor coolant pump seal of about one gpm assuming a 15 psig pressure differential across the pump seal.

In order to depressurize the primary system, the operators secured the pressurizer heaters and filled the pressurizer with the PORV open to cool off the pressurizer. Subsequently, the PORV was closed and the pressurizer level reduced to 20 percent. This method of depressurizing the primary system had been used previously and is covered by a terse statement in one of the operating procedures. However, normal practice has been to completely depressurize the system and continue system venting for reduced inventory activities such as steam generator maintenance or removal of the upper head. Stopping this evolution at a reduced pressure with a bubble in the pressurizer was a rare occurrence.

The charging pumps were secured and the inventory was maintained by using a 30 psi cover gas pressure on the volume control tank with the boric acid blending system maintaining the inventory in the volume control tank. The plant stayed in this mode for approximately 3 days with the operators using the stable pressurizer level along with a stable volume control tank level as the

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indication of primary system inventory. During this time period, the known coolant leakage into the containment was presumably being made up by charging from the VCT float through the reactor coolant pump seal injection (see Figure 1). The primary system was cooled down using the residual heat removal system.

The licensee had completed the installation of a new RVLIS read out instrument during this outage. During this event, there were maintenance tags on the readout instrument. The operators assumed errouneously that it was inoperable.

Part of the corrective action planned by the licensee is to modify the operating procedures for modes 4 and 5 to caution against relying on the pressurizer level as an indication of primary system inventory and to insure that sufficient diverse instrumentation is always available to validate the primary system inventory. The RVLIS system will be installed in the simulator and its use included in operator training activities. A summary of the event was included in the INPO computer network and the licensee has indicated that he will issue a study report on the event that will be sent to other licensees.

2. Analysis and Evaluation of the Event

In discussion with plant personnel*, the event was precipitated by performing pump motor repairs with a non-typical plant configuration. The management decision was influenced by the perception that the repair could be completed in a reasonable time and the usual primary system draindown would have involved additional worker exposure. There was a small primary system leak prior to the motor failure and it was understood that additional leakage would occur along the pump shaft after the motor was uncoupled.

Procedure O.P. 3.4 was used to depressurize and cooldown the plant. This procedure, which is normally used for plant depressurization, has a general directive to depressurize the reactor by raising and lowering the pressurizer level, by use of the auxiliary spray and cycling of the PORVs. This procedure was not explicit about plant parameters to monitor or expected plant response. There was no shift briefing or procedural review even though the plant had not been placed in a similar condition for 6 or 7 years.

The maintenance procedure, which was performed by Westinghouse contractors, discussed limiting the differential pressure across the seal to 15 psi to limit the leakage along the pump shaft to one gpm, however, the pressure gage in the control room was insufficient to make this determination. The pump shaft has a back seat which should limit leakage through the seal if the motor is uncoupled. To aid in back seating the shaft, the licensee erroneously maintained reactor coolant pump seal injection which is connected above the RCP backseat and therefore of questionable utility.

The evolutions using pressurizer fill and drain were aimed at reducing the pressure in the primary system (and therefore reducing the pressure across the RCP seal) as was requested by the maintenance contractors. Conceptually, these evolutions were within previous experience. The procedure directed that the charging pump be secured and the VCT pressure maintained at approximately 40 psi. This condition, known as the VCT float, uses cover gas pressure in the VCT to establish the primary system pressure and the boric acid blending system to main level in the VCT.

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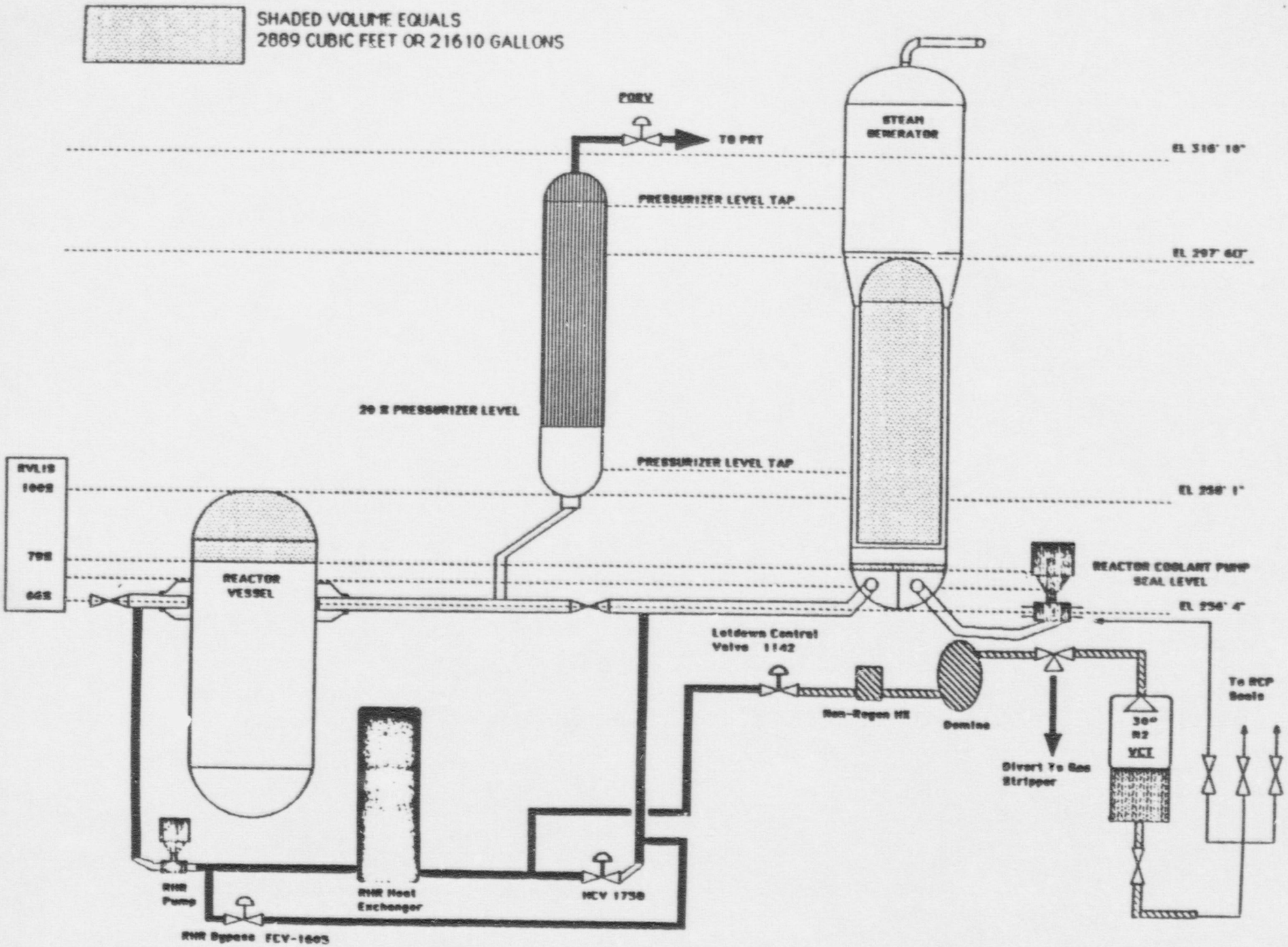
*Site visit on July 8, 1987 by S. Israel and J. Kauffman

Figure 1 North Anna Plant Schematic



According to discussions with the plant management, the operators rely on the pressurizer level as an indication of primary system inventory except under upset conditions where subcooling margin and RVLIS are addressed in the emergency procedures and in operator training. The plant was not considered to be in an upset condition even though there was known primary system leakage. The pressurizer level remained constant with a bubble in the pressurizer and the VCT level was maintained within a reasonable operating range. The plant was ostensibly in a stable, controlled condition. A primary system temperature of about 110F, a pressure around 15 psi, and an operating RHR system added to a sense of well being.

Over the three day period, the pressurizer cooled off (a 240F pressurizer bubble temperature was noted after the initial depressurization) and the dissolved gases in the reactor water came out of solution and collected in the upper head as the plant continued to slowly depressurize. The operators did not use RVLIS which had maintenance tags hanging (also not required to be operable below mode 3), did not monitor pressurizer bubble temperature, and did not perform a mass balance check even though there was known leakage. While the operators monitored the pressurizer level, about 20 percent of the reactor inventory drained out of the system.

Although there was no immediate safety concern, the plant was "operated" for the three days in an unknown and degraded condition. Discussions with plant management indicated that a bubble may always occur in the upper head unbeknown to the operators when the plant is depressurized. In these situations the plant is usually on the way down to venting and draining so a gas bubble is ultimately expected in the usual evolution.

Numerous actions have occurred or are being contemplated because of the North Anna event. The licensee:

1. Provided a summary description of the event for the INPO computer network.

2. Will revise procedures for modes 4 and 5 to direct the operator to monitor other plant instrumentation to verify reactor vessel inventory.

3. Will incorporate RVLIS/subcooling monitor in the plant simulator to accustom the operators with its use.

4. Distribute a report on the lessons learned from this event to other licensees.

Region II is developing an information notice covering the salient aspects of this event. The resident inspector is also writing an inspection report that will cover specific remedial actions at the North Anna plants.

CONCLUSIONS

The cause of the event was the implementation of an off normal plant evolution without significant preparation and attention to detail. General directives in the procedures, low primary system temperature and pressure, and the expressed

need to maintain a low primary system pressure all contributed to the failure of at least three shifts of operators to catch the ongoing reactor vessel draindown over three days. A most serious flaw illuminated by this event is the reliance on pressurizer level as an indication of reactor vessel inventory.

After the Three Mile Island accident, multiple modifications in equipment, procedures, and training were directed at the insufficiency of the pressurizer level as an indication of reactor vessel inventory. Apparently, the focus was on transients/accidents at power or at high pressure rather than all plant modes. Although other indications were available, such as pressurizer bubble temperature and core exit thermocouples (subcooling) and RVLIS (vessel inventory), the operators were not trained to routinely monitor these instruments to confirm vessel inventory especially in a "stable" situation and consequently were deceived by the pressurizer level.

The licensee and the region have committed to issuing generic communications to all licensees regarding this event. At this time, additional action by AEOD does not appear necessary; however, the generic communications should be reviewed to assure that the insufficiency of the pressurizer level as an indication of primary system inventory is stressed and feedback obtained from the resident inspectors regarding the impact of the communications.