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Docket No. 50-327/328

MEMORANDUM FOR: E. L. Jordan, Deputy Director, Division of Resident and Regional Reactor Inspection, IE

THRU: W. R. Mills, Acting Chief, Events Evaluation Section, Reactor Engineering Branch, DRRRI, IE

FROM: H. W. Woods, Reactor Systems Specialist, Events Evaluation Section, Reactor Engineering Branch, DRRRI, IE

SUBJECT: SEQUOYAH EVENT ON FEBRUARY 11, 1981: INADVERTENT CONTAINMENT SPRAY FROM PRIMARY SYSTEM BLOWDOWN- (EVENT EVALUATION IE 81-2)

I. Description of Event:

The plant was in mode 5 following a shutdown 6-3/4 days before this event. The plant had operated ~5 days at ~70% power in the month prior to shutdown. The following sequence of events began February 11, 1981.

Equipment in operation before the event was:

RCP #1 and #2
"A" RHR pump
"A" centrifugal charging pump
Containment purge from upper and lower containment

Reactor conditions prior to the event were:

Reactor temperature 175°F
Reactor pressure 310 psig

TIME (CST)	EVENT	SOURCE OF INFORMATION
1940	Auxiliary Operator opened FCV 72-40 (opening RHR system to containment spray header) as result of a verbal miscommunication with the reactor (unit) operator.	interview with operator
1940	Pressurizer low level alarm	Computer
1941	Shutdown RCPs 1 and 2	Computer
1942	Pressurizer pressure atmospheric	Recorder
1942	Pressurizer level zero	Recorder
1943	Switch "A" chg pump suction to RWST from VCT	Recorder
1943 XA	Placed maximum cooling on "A" RHR	Recorder

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TIME (1)	EVENT	SOURCE OF INFORMATION
1944	Started "B" RHR with suction from reactor	Computer
1945	Reactor Building evacuation (voice announcement)	Log
1946	Opened A&B loop common RHR suction (valve 63-1) to RWST (Did not close RHR suction from reactor hot leg)	Recorder
1947	Fully energized reactor building floor and equipment drain sump pumps	Interview
1947	Stopped containment purge	Interview
1950	Pressurizer level 13% and increasing	Computer
1950	Pressurizer pressure increasing to 25 psig	Recorder
1952	Pressurizer level cycling to 13%, then decreasing, then increasing, apparently due to a check valve reseating then reopening in RWST line (caused by reactor pressure variations)	Computer
1957	Implemented IP-4 Site Emerg	Log
2000	Shift engineer called NRC - no answer after 7 or 8 rings	Log & Interview
2012	Manually initiated aux. building isolation	Log
2015	Started "B" centrifugal charging pump, suction from RWST	Computer
2015	Started "A" SI pump	Interview, not confirmed
2015	Started closing RHR containment spray valve	Log
2022	RHR spray valve closed	Recorder
2023	Stopped "A" SI pump	Interview, not confirmed
2024	Stopped "B" cent. chg. pump	Computer
2024	Reestablished letdown to VCT, normal RCS pressure & pressurizer level reestablished	Recorder and Computer
2025	Contacted NRC duty officer	NRC I.O. Log
2045	All clear announced for site emergency	Log

Due to uncertainty as to the exact flow vs. time from the RCS during the above sequence of events, it is not possible to exactly calculate the minimum water level reached in the core. However, it is possible to bound the minimum level in several ways.

a. The boron concentration before and after the event can be used to calculate that about 40,000 gallons of water were replaced in the primary system (and therefore had "leaked" from the primary system - the balance of the total of 110,000 gallons that was drawn from the RWST went directly through the RHR system to the spray header). Conservatively assuming the 40,000 gallons all "leaked" before any replacement, about a 6,000 gallon volume would have been voided in the RPV since the steam generator, pressurizer and hot legs contain about 34,000 gallons. This 6,000 gallons out of the RPV would lower level less than 5 feet in the 14 foot I.D. RPV, leaving the water level well above the core. (There are ~12 feet of water above the core in the cylindrical portion of the RPV, plus additional water above that in the hemispherical head.)

b. The RHR pumps in the core recirculation cooling mode cannot draw inventory from below the bottom of the hot leg nozzles (temperature was 175°F). This would leave about 3 feet of water above the core, conservatively assuming that water was pumped to that level (which it surely was not). With the decay heat levels present February 11, it would have taken 5 to 7 hours to boil away that 3 feet of water (pressurizer level indication was lost only 8 to 10 minutes so this time was not available).

c. The items (a) and (b) above provide conservative bounds but the best indication is that the water level remained high enough to keep the RPV (including the head) full since venting following this event produced no detectable amount of gas.

The following items are considered to be significant contributors to the event:

1. The auxiliary Unit Operator who inadvertently opened FCV 72-40 (the only barrier between the RHR/RCS and the backup containment spray header) was not experienced in the Sequoyah Auxiliary Building - he was starting his first shift in that building, and had not been provided any orientation training with a qualified person prior to that shift. He recognized that FCV 72-40 was an RHR Spray isolation valve, as stated on the metal tag hung from the valve, but apparently he felt that the reactor operators had a good reason for wanting the valve opened. He was not offered, and did not ask for, a look at system drawings before entering the Auxiliary Building to complete his assignment. He continued to open the valve which he thought he'd been told to open, even though he recognized that flow was initiated through the pipe by his action. He became aware that he may have caused a problem when he met people evacuating containment as he left the Auxiliary Building. He reported his actions to an assistant shift engineer when he arrived back in the control room at which time the operators became aware of the cause of the problem and closed FCV 72-40.

2. At least 3 control room operators are known to have looked at the two areas of the control panel where the "FCV 72-40 open" indications were present. One valve position indicating light was associated with the valve control located on the lower right corner of the control panel. The second light (indicating FCV 72-40 position) is located approximately 8 feet to the left of the valve controls and is one of many "postage stamp" sized lights on a status panel designed to warn the operators when the ECCS system is not properly aligned for the injection (safety) mode. When the first such misalignment occurs, the individual valve's light comes on and an alarm sounds and flashes. However, the status panel is designed for modes 1 through 3 when ECCS injection capability is required. On February 11 in mode 5 (RHR cooling) several valves were already (correctly) "misaligned," so this panel already showed several lights and the alarm light was already on continuously. Thus, basic design of the indicator/alarm system strongly contributed to the operator's missing the "FCV 72-40 open" indication. (Earlier discovery of the open valve would not have prevented the event, but would have diminished the amount of water removed from the RPV and the amount of water sprayed into containment).

II. Actual Consequences of Event

About 110,000 gallons of water from the primary system and the RWST were sprayed into the containment. Damage to electrical equipment as a result of the spray was minimized due to the compartmentation arrangement of the ice condenser containment. The upper volume is completely separated from the lower volume by concrete shield walls that are built over the reactor, steam generators, pressurizer, etc., so that there is little other than concrete in the upper containment.

A small amount of ice was melted when some spray impinged on the ice beds through the open intermediate level ice condenser doors (40 lbs. maximum loss from a single ice bed, 20 lbs. average loss per bed; upper level ice condenser doors were not open, thereby preventing greater ice loss).

The only remaining concerns regarding equipment that may have been flooded in the lower containment are operability of seven sump pumps. These concerns will be resolved before restart.

The hydrogen igniters will be inspected and functionally tested per recently adopted technical specifications (a "baseline inspection" was already required before this event occurred; this baseline inspection will be performed before return to power).

III. Potential Consequences of Event

Due to lack of an ECCS initiation procedure for use in mode 5 (when using the RHR cooling mode), when the RWST suction line was opened, the operators did not recognize the potential need to close the hot leg suction line to the RHR system to insure that water would be drawn from the RWST.

The plant was at 175°F primary system temperature, but if it had been in the approximate range of 212°F to 350°F, primary system pressure would have maintained the check valve in the RWST suction line closed, preventing the injection mode of the low pressure pumps from being effective. Much greater inventory losses would be theoretically possible under those conditions. Apparently, the check valve did close and reopen at least once, as indicated by the RHR pump suction temperature recorder chart, and possibly more than once, as system pressure recovered. The check valve closure resulted in level and pressure decrease due to net RCS inventory loss through the open FCV 72-40 (without makeup from the RWST) until pressure decreased enough to allow the check valve to reopen and injection flow to recommence, (i.e., a potentially cyclic process). This phenomenon does not appear to have affected the ultimate recovery of this event significantly, but at higher temperatures the effect could have been more severe. For an extremely conservative case, a calculation similar to the boiloff calculation reported in paragraph I.(b) above can be performed assuming boiloff begins 3 hours after shutdown at an RCS temperature of 350° F (about the minimum practical time to be on the RHR recirculation system for cooling) and assuming "infinite" operating time before shutdown. For this case, instead of the 5 to 7 hours quoted in paragraph I.(b), core uncovery could begin in 1/4 to 1/2 hour.

IV. Corrective Actions

A. Short Term - (Before Restart)

1. The most urgent immediate action involves correction of the licensee's problems in the areas of inadequate personnel training, inadequate communication and/or instruction, and inadequate control/coordination of operation and/or maintenance activities in the plant. These items are addressed in the enclosed Confirmation of Action Letter to TVA from the IE Region II Office. As stated in that letter, these items were the subject of a meeting with TVA management at the Region II office on February 27, 1981. IE Region II concurrence of satisfactory correction of the problems by verification of adequacy by Region II onsite inspection is required before restart will be allowed.

2. IE is considering requiring a physical lock on the handwheel of Valve FCV 72-40 to require more deliberate thought/concurrence before it can be manually opened. The power to the valve is normally "racked out" to prevent spurious actuation from the control room or inadvertent operation due to circuit failure. It was not "racked out" during this event (thereby allowing its closure from the control room) because a surveillance procedure (stroke test) had just been completed.

3. IE is reviewing the TVA procedure to hand-seat valves (G.O.I. #6) which states the valves are "not to be turned more than 1/4 turn after the initial point of contact." IE is concerned that the valves could be tightened so as to preclude automatic (power) opening. A related conern also under IE review is the TVA practice of "turning over a valve to 'Maintenance' for testing".

at the "earliest convenience" after packing is tightened, etc. This practice has the potential for leaving one or more valves inoperable (potential common mode following packing adjustment accomplished on the back-shift).

4. TVA has committed to examine stresses in the cont spray piping, with results to be presented before restart. The concern is for the piping downstream of FCV 72-40, some of which was subjected to pressures which may have been above the pipe's design pressure.

5. IE has requested TVA to place a caution statement in the "initiation of low pressure injection" procedures that when reactor temperature is greater than some certain temperature (to be specified but ~200 F) the recirculation suction valves from the reactor hot leg must be closed when the RWST suction valve is opened.

Acceptability of restart is dependent on IE Region II verification and concurrence that the licensee has satisfactorily resolved all of the above items. Details will be presented in an IE Inspection Report to be issued by Region II following restart. However, preliminary inspection results have shown that the licensee's own investigations, in conjunction with IE investigation of this incident, have resulted in substantial improvement in the licensees administrative controls, communications, and training procedures. We believe these improvements, and the licensees stronger awareness of his problems, are sufficient to justify trial of the new methods (i.e., by restarting and operating the plant).

B. Long Term - (After Restart)

1. IE will issue an Information Notice outlining the event and its contributing causes, and advising licensees to evaluate ECCS-LOCA procedures during shutdown cooling modes. Potential problems in these modes due to design of indicators/annunicators that are primarily designed for modes 1 through 3 will also be covered.

2. NRR may wish to review, from a human factors viewpoint, the ECCS board layout and design with its alarms and indicators.

3. NRR may wish to review acceptability of single valves forming the RCS boundary (FCV 72-40 and FCV 72-41, for examples) when the plant is using the RHR for cooling.

4. The NRC may wish to consider rulemaking in the areas of use of non-licensed personnel in safety-related jobs.

5. The NRC may wish to consider how the escalating number of required surveillance activities (8400/yr at Sequoyah vs. 1400/yr at Browns Ferry) has impacted overall, total plant safety. There is an optimum number of required surveillance activities considering tradeoffs between such items as mean-time to failure, the probability

of the surveillance itself causing a problem (as this event), etc. Possibly, requirements may now be beyond that optimum.

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Enclosure: Confirmation of
Action Letter

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WPC:CY	RRRI:IE	RRRI:IE WRM
3/6/81	RWoods	WRMills
WOODS(M)	3/ 1 /81	3/9 /81