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50-364

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Joseph M. Farley Nuclear Plant - Units 1 and 2
Loss of Residual Heat Removal While the Reactor
Coolant System is Partially Filled
(Generic Letter 87-12)

On July 9, 1987 the NRC issued Generic Letter 87-12, "Loss of Residual Heat Removal (RHR) while the Reactor Coolant System (RCS) is Partially Filled," in response to a recent loss-of-RHR event while operating at mid-loop of the RCS. The purpose of this generic letter is to gather information about the operation of nuclear plants with the RCS partially filled in order to assess the unanalyzed condition associated with the loss of decay heat removal possibly leading to core damage.

Provided as an enclosure to this letter are Alabama Power Company's (APCo) responses to the specific items requested by the NRC in Generic Letter 87-12. These responses are based upon current or proposed practices and may be changed in the future as deemed necessary. Information related to this issue is available onsite for NRC review. If there are any questions concerning these responses, please advise.

Respectfully submitted,

R. P. McDonald

RPM/BHW:dst-D-T.S.7

Enclosure

cc: Mr. L. B. Long
Dr. J. N. Grace
Mr. E. A. Reeves
Mr. W. H. Bradford

SWORN TO AND SUBSCRIBED BEFORE ME

THIS 18th DAY OF September, 1987

Notary Public

My Commission Expires: 9-11-88

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ENCLOSURE

LOSS OF RHR WHILE THE RCS IS PARTIALLY FILLED

1. **NRC Request**

Provide a detailed description of the circumstances and conditions under which your plant would be entered into and brought through a draindown process and operated with the RCS partially filled, including any interlocks that could cause a disturbance to the system. Examples of the type of information required are the time between full-power operation and reaching a partially filled condition (used to determine decay heat loads); requirements for minimum steam generator (SG) levels; changes in the status of equipment for maintenance and testing and coordination of such operations while the RCS is partially filled; restrictions regarding testing, operations, and maintenance that could perturb the nuclear steam supply system (NSSS); ability of the RCS to withstand pressurization if the reactor vessel head and steam generator manway are in place; requirements pertaining to isolation of containment; the time required to replace the equipment hatch should replacement be necessary; and requirements pertinent to reestablishing the integrity of the RCS pressure boundary.

APCo Response

The RCS is placed in a partially filled condition during refueling outages and some forced outages. This is required to allow refueling of the core and/or maintenance and inspections on various components.

During a refueling outage the RCS is drained to a level below the reactor vessel flange which permits the removal of the reactor vessel head and incore detector thimbles. The RCS is drained to the mid-loop level to permit installation of nozzle dams in the steam generator primary nozzles, placing reactor coolant pumps (RCP) on the backseat and performance of maintenance and inspections. Draindown of the RCS could be required during forced outages to plug steam generator tubes or to affect repairs on valves, piping or RCP seals. The following is a description of the operations performed to place the plant in a partially filled condition during a refueling outage.

Following reactor shutdown for refueling, pressurizer and main steam safety valve surveillance testing is performed at near normal RCS temperature and pressure. When the RCS temperature and pressure are reduced to less than 350°F and 400 psig respectively, the RHR system is placed in service. The RCS is maintained at this temperature and pressure while steam generator secondary side contaminants are removed via the blowdown system. This process of removing steam generator secondary side contaminants requires approximately 24 hours to complete. RCS cooldown is then continued until temperature is between 200°F and 180°F at 400 psig.

At this point the following items are completed:

- Two of three charging pumps are made inoperable by racking out their circuit breakers as required by Technical Specifications.

- Power is removed from the motor operators of the containment sump suction valves for the RHR pumps to prevent inadvertent valve operation that could result in air entrapment of RHR pumps.

- Containment personnel hatch interlocks are defeated as allowed by Technical Specifications.

- The equipment hatch is opened as allowed by Technical Specifications.

- The automatic isolation features of the containment purge system are tested and the main purge valves are opened to cooldown the containment as allowed by Technical Specifications.

The pressurizer is filled (solid plant) and the RCS is cooled to less than 160°F. Power is then removed from the motor operators of the RCS loop suction valves to the RHR pumps and the running RCP(s) may now be secured. This power removal will defeat the interlock that could cause isolation of RCS loop suction to RHR and prevent RHR flow. RCS depressurization is allowed below this temperature. RCS cooldown continues, and when conditions are established, RCS draining is commenced. RCS draining is performed using a nitrogen overpressure established via the pressurizer relief tank and the pressurizer power operated relief valves. Procedures direct the operator to account for possible differences in level indications caused by the nitrogen overpressure. The RCS is normally drained to the recycle holdup tanks (RHT's) via the low pressure letdown line which is connected to the outlet of the RHR heat exchangers. An alternate drain path is from the RHR system to the refueling water storage tank (RWST) via another line connected to the outlet of the RHR heat exchangers.

Caution statements in the plant procedure for draining the RCS direct the operators to closely monitor RCS level to ensure no abnormal changes are observed. The inventory of the RCS is maintained by adjusting charging and letdown flows. To permit monitoring of the RCS level, indication is available both in containment and on the main control board. Local indication in containment is provided by a tygon hose connected to the RCS B loop intermediate leg. The hose is positioned next to a permanent, stamped metal reference plate. This plate indicates both elevation (feet and inches) and key RCS component locations such as the reactor vessel

flange and mid-loop. As a result of previous experience, procedural guidance is provided for the tygon hose to be periodically drained and refilled to ensure proper indication. Remote indication is derived from a differential pressure transmitter which is connected to the same RCS loop as the tygon hose. The differential pressure transmitter provides input to the plant process computer and to an indicator on the main control board. During level changes, the main control board operator is in contact via headphones with personnel monitoring the tygon hose indication. Unexplained discrepancies between the three indications would result in securing the draining process and resolving the discrepancies.

When pressurizer level has decreased to approximately 20%, nitrogen is injected into the intermediate leg of each loop via the RCS flow transmitter piping. This breaks the partial vacuum in the steam generator tubes, causing a continuous release of water from the tubes. Nitrogen is also injected into the reactor vessel head when the RCS level decreases below the top of the reactor vessel head. This breaks the vacuum effect in the upper head region. When the RCS is below the top of the loop the nitrogen over-pressure is removed and the pressurizer, the reactor head and the pressurizer relief tank are vented to atmosphere. The tygon hose is vented to atmosphere to ensure an accurate level indication. The tygon hose indication is periodically compared to the computer and main control board indications. Draining continues and, when the level decreases below the RCP seals, seal injection is secured. When the level reaches mid-loop, charging and letdown flows are matched to maintain this level.

During a refueling outage the mid-loop condition has been reached in approximately 56 hours after shutdown. During a forced outage, when steam generator secondary side cleaning and main steam and pressurizer safety valve surveillance testing may not be performed, the mid-loop condition can be reached in approximately 40 hours after shutdown.

Once mid-loop level is reached and stable, the steam generator primary manways are removed and loop nozzle dams are installed. The RCPs are uncoupled from the motors and lowered onto the backseats. At least part of the corrective maintenance and inspections on components which require the RCS level to be at mid-loop would be performed at this time. The amount of time spent at mid-loop is minimized to limit the possibility of losing RHR flow. Removal of the residual heat removal system for maintenance is not permitted by Technical Specifications until Mode 6 and the refueling cavity level is greater than 23 feet. Closing of the equipment hatch, reinstating personnel hatch interlocks, and lifting of the reactor vessel head occurs approximately 7 days after shutdown. The equipment hatch can be closed from the open position in two hours.

No specific steam generator levels are required during mid-loop operation. Additionally, when the steam generator primary manway covers have been removed, the steam generator can not be used for cooling the RCS.

Following refueling, the RCS level is lowered to below the reactor vessel flange and the reactor vessel head is installed. Shortly after the installation of the head the equipment hatch is re-opened. The RCS level is again lowered to mid-loop to perform corrective maintenance and inspections not performed while previously at mid-loop. Also, while in this condition the steam generator nozzle dams are removed, primary manway covers are installed and the RCP's are coupled to the motors. When all mid-loop work has been completed, the RCS level is raised to just below reactor vessel flange level. RCS filling and venting is then conducted when conditions are met.

2. **NRC Request**

Provide a detailed description of the instrumentation and alarms provided to the operators for controlling thermal and hydraulic aspects of the NSSS during operation with the RCS partially filled. You should describe temporary connections, piping, and instrumentation used for this RCS condition and the quality control process to ensure proper functioning of such connections, piping, and instrumentation, including assurance that they do not contribute to loss of RCS inventory or otherwise lead to perturbation of the NSSS while the RCS is partially filled. You should also provide a description of your ability to monitor RCS pressure, temperature, and level after the RHR function may be lost.

APCo Response

The instrumentation used by the operators to control and monitor the thermal and hydraulic aspects of the NSSS with the RCS partially filled includes: cold calibrated pressurizer level, RHR flow, RHR pump discharge pressure, RHR pump amps, RHR heat exchanger inlet and outlet temperature, RCS pressure, reactor coolant inventory tracking system (if reactor head is still in place), RCS level tygon hose, RCS level main control board meter and plant process computer. One indication of RCS level while partially filled is provided by a tygon hose connected to loop B. This tygon hose acts as a manometer to indicate RCS water level. When it is installed, the tygon hose is verified to be free of kinks. A differential pressure transmitter is permanently installed to the same loop connection as the tygon hose. This transmitter has a readout available to the operator in the control room. This transmitter is recalibrated before use during outages. The output of this transmitter also goes to the plant computer where RCS level is trended. The plant computer will produce an alarm if RCS level drops below the minimum level. An RCS level annunciator is available on Unit 2. Additional alarms that alert the operator to a possible problem are high RHR pump discharge pressure, RHR pump overload trip, and low RHR heat exchanger outlet flow.

While the RCS level is draining to mid-loop and while at mid-loop the following occurs:

- the tygon hose is verified to be free of kinks.
- the tygon hose is periodically drained and refilled and its level indication is compared to the main control board indication and plant computer. Any unexplained discrepancies in level indication are resolved.
- a continuous watch is placed at the tygon hose in continuous communication with the main control room.

Upon reaching an elevation below the top of the loops, the reactor head, pressurizer, pressurizer relief tank, and tygon hose are vented to atmosphere. All indications are compared and any unexplained differences are resolved.

While conducting work at mid-loop levels, RCS level is maintained between 122 feet 11 inches and 123 feet 1 inch which is slightly above the mid-loop level of 122 feet 9 inches.

If the RHR system were to become inoperable, RCS level and pressure could still be monitored. Wide range RCS temperature could be monitored if the reactor coolant loops are filled. Incore thermocouples could be monitored if the reactor vessel head were in place and instrument cabling terminated; otherwise, there would be no means of monitoring RCS temperature.

3. **NRC Request**

Identify all pumps that can be used to control NSSS inventory. Include: (a) pumps you require be operable or capable of operation (include information about such pumps that may be temporarily removed from service for testing or maintenance); (b) other pumps not included in item a (above); and (c) an evaluation of items a and b (above) with respect to applicable technical specification requirements.

APCo Response

Pumps used to maintain RCS inventory that are required by Technical Specifications include one RHR pump (two RHR pumps are required in MODES 5 and 6 except when the water level is greater than 23 feet above the top of the reactor pressure vessel flange), one charging pump, and one boric acid transfer pump. Additional pumps that are available to maintain inventory are one reactor makeup water pump and two recycle evaporator feed pumps.

Procedurally, the other two charging pump motor breakers are racked out as required by Technical Specifications and another reactor makeup water pump motor breaker is racked out to prevent an inadvertent dilution accident. These pumps could be made available in a timely manner if required. The second boric acid pump is normally aligned for recirculation, however it could be aligned to the RCS. Other flow paths where water could be gravity drained into the RCS are the RWST and accumulators.

4. **NRC Request**

Provide a description of the containment closure condition you require for the conduct of operations while the RCS is partially filled. Examples of areas of consideration are the equipment hatch, personnel hatches, containment purge valves, SG secondary-side condition upstream of the isolation valves (including the valves), piping penetrations, and electrical penetrations.

APCo Response

The containment personnel and equipment hatches may remain open while the RCS is partially filled except during core alterations or movement of irradiated fuel within the containment. With the containment hatches open containment purge is normally operating (except when required to be secured for maintenance), and flow from outside into containment is maintained by the auxiliary building exhaust fans. Any potential release of contaminants would be drawn through the purge filters or auxiliary building radwaste ventilation system and out the plant vent stacks.

During core alterations or movement of irradiated fuel within the containment, the containment building penetration status is governed by Technical Specifications. The Technical Specifications require that the equipment door be closed with a minimum number of bolts inplace, one door in each airlock be closed, and each penetration providing direct access from the containment atmosphere to the outside atmosphere be closed or capable of being closed. Otherwise, these containment building penetrations may be open.

5. **NRC Request**

Provide a summary description of procedures in the control room of your plant which describe operation while the RCS is partially filled. Your response should include the analytic basis you used for procedures development. We are particularly interested in your treatment of

draindown to the condition where the RCS is partially filled, treatment of minor variations from expected behavior such as caused by air entrainment and de-entrainment, treatment of boiling in the core with and without RCS pressure boundary integrity, calculations of approximate time from loss of RHR to core damage, level differences in the RCS and the effect upon instrumentation indications, treatment of air in the RCS/RHR system, including the impact of air upon NSSS and instrumentation response, and treatment of vortexing at the connection of the RHR suction line(s) to the RCS.

Explain how your analytic basis supports the following as pertaining to your facility: (a) procedural guidance pertinent to timing of operations, required instrumentation, cautions, and critical parameters; (b) operations control and communications requirements regarding operations that may perturb the NSSS, including restrictions upon testing, maintenance, and coordination of operations that could upset the condition of the NSSS; and (c) response to loss of RHR, including regaining control of RCS heat removal, operations involving the NSSS if RHR cannot be restored, control of effluent from the containment if containment was not in an isolated condition at the time of loss of RHR, and operations to provide containment isolation if containment was not isolated at the time of loss of RHR (guidance pertinent to timing of operations, cautions and warnings, critical parameters, and notifications is to be clearly described).

APCo Response

The Farley Nuclear Plant operating procedure entitled, "Draining of the Reactor Coolant System", provides the initial conditions, precautions and limitations, and instructions for draining the RCS. This procedure is used by the operator in the control room. The description of the process used to bring the RCS inventory to mid-loop is provided in Item 1. Another operating procedure, entitled "RHR System Malfunction", provides symptoms and subsequent operator actions for the loss of one or both trains of RHR. Procedural guidance is provided to 1) identify causes for loss of RHR, 2) specify cautions associated with loss of RHR and 3) restore one or both RHR loops. Plant operation procedures associated with mid-loop operations were originally based upon procedures provided by Westinghouse at the time of initial startup. These Westinghouse procedures were not based on specific analyses. The current Farley Nuclear Plant procedures associated with draining down and mid-loop operation have evolved from experience at Farley Nuclear Plant and within the industry.

Upon loss of RHR during MODE 6, the containment penetrations providing direct access from the containment atmosphere to the outside atmosphere are closed within four hours as required by Technical Specifications. If one RHR loop is not operable in MODE 5, immediate corrective action to return the loop to operable status is required by Technical Specifications. With no RHR loops operable in MODE 5, Technical Specifications require that all operations involving a reduction in boron concentration of the RCS be suspended and immediate actions to return the loop to operation be initiated.

The Westinghouse Owners Group (WOG) is considering a program to address certain issues related to this NRC request. If approved by the WOG, Alabama Power Company will evaluate the results and determine if any additional actions are required.

6. **NRC Request**

Provide a brief description of training provided to operators and other affected personnel that is specific to the issue of operation while the RCS is partially filled. We are particularly interested in such areas as maintenance personnel training regarding avoidance of perturbing the NSSS and response to loss of decay heat removal while the RCS is partially filled.

APCo Response

Operations personnel receive training in procedures identified in Item 5 which govern RCS draindown and loss of RHR. All maintenance activities performed while at mid-loop must be approved and coordinated by plant operations personnel. Therefore, no specific training regarding the potential problems of mid-loop operation is provided to maintenance personnel.

7. **NRC Request**

Identify additional resources provided to the operators while the RCS is partially filled, such as assignment of additional personnel with specialized knowledge involving the phenomena and instrumentation.

APCo Response

In addition to the procedural guidance that is provided to the plant operator, operational staff personnel who are experienced in RCS draindown evaluations and who are cognizant of potential problems associated with the loss of decay heat removal during RCS draindown are typically in the control room while the reactor is being drained to mid-loop.

8. **NRC Request**

Provide a comparison of the requirements implemented while the RCS is partially filled and requirements used in other Mode 5 operations. Some requirements and procedures followed while the RCS is partially filled may not appear in the other modes. An example of such differences is operation with a reduced RHR flow rate to minimize the likelihood of vortexing and air ingestion.

APCo Response

With the RCS partially filled, only one RHR pump is normally running and recirculating to the RCS. This is done to preclude the loss of both trains of RHR should RCS level drop below the suction lines and pump cavitation occur. However, two RHR pumps are maintained operable while the RCS is partially filled. In addition, time at mid-loop is minimized and a continuous watch is placed at the tygon hose.

9. **NRC Request**

As a result of your consideration of these issues, you may have made changes to your current program related to these issues. If such changes have strengthened your ability to operate safely during a partially filled situation, describe those changes and tell when they were made or are scheduled to be made.

APCo Response

The existing Abnormal Operating Procedure (AOP) has been strengthened to identify causes, cautions and recovery associated with a loss of RHR. Existing procedural guidance has been consolidated and included in the AOP to provide a more central location. The existing drain down procedure has been modified to add requirements to maintain RCS level between 122 feet 11 inches and 123 feet 1 inch and to maintain a continuous tygon hose watch while at mid-loop levels. Alabama Power Company believes that the existing guidance has provided the ability to operate safely. As described in response to Item 5, the WOG is considering a program that if approved by the WOG could be a source of additional changes by Alabama Power Company.