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United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
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SHEARON HARRIS NUCLEAR POWER PLANT
DOCKET NO. 50-400/LICENSE NO. NPF-63
RESPONSE TO GENERIC LETTER 87-12

Gentlemen:

Carolina Power & Light Company hereby submits information in response to Generic Letter 87-12, "Loss of Residual Heat Removal (RHR) while the Reactor Coolant System is Partially Filled," for the Shearon Harris Nuclear Power Plant. The attached information responds to the specific questions contained in Generic Letter 87-12. This information is submitted pursuant to 10CFR50.54(f) as requested by Generic Letter 87-12.

If you have any questions concerning the attached responses or require additional information, please contact Mr. Sherwood Zimmerman at (919) 836-6242.

Yours very truly,

L. W. Eury
Senior Vice President
Operations Support

JHE/jeh (2010NEL)

Attachments

cc: Mr. B. C. Buckley
Dr. J. Nelson Grace
Mr. G. F. Maxwell

L. W. Eury, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, contractors, and agents of Carolina Power & Light Company.

A061
1/1

Ruby R. Morgan
Notary (Seal)

My commission expires: 11/27/89

RUBY R. MORGAN
NOTARY
PUBLIC
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NRC QUESTION 1

Provide a detailed description of the circumstances and conditions under which your plant would be entered into and brought through a drain-down 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.

SHNPP RESPONSE

SHNPP would be operated with the RCS drained down to a partially filled condition during the following circumstances:

a. Work on reactor coolant pump seals,

b. Steam generator (SG) tube work or inspection (e.g., tube plugging, eddy current testing, sludge lancing), and

c. Repair of valves in the RCS located above the mid-loop position.

The time required to reach a partially filled condition from full-power operation is approximately 33 hours. These 33 hours are broken down as follows: 4 hours to cool down the RCS and place RHR in service (RCS at 350°F); 17 hours to cool down RCS from 350° to 140°F; and an additional 12 hours necessary for draining the RCS.

There are no requirements on SG levels while the RCS is partially filled. Since the SG cannot function as a heat sink under such conditions, Technical Specifications require both RHR loops to be operable to meet the heat removal function even with a single failure.

There are no special restrictions required beyond Technical Specifications requirements on changes in the status of equipment for maintenance and testing nor on coordination of such operations during RCS partially filled conditions. There are no restrictions regarding testing, operations and maintenance; however, it is a SHNPP policy that shift foreman/designee approval is necessary prior to commencing maintenance or testing, and that only operators perform valve manipulation. Minimum equipment operability requirements are provided explicitly in Technical Specifications.

The ability of the RCS to withstand pressurization if the reactor vessel head and the steam generator manway are in place is best described in terms of the provisions to prevent RCS pressurization. The RCS pressurizer relief valves are open and administratively controlled during any period of reduced RCS level in Mode 5. The pressurizer PORVs are vented to the Pressurizer Relief Tank (PRT) and subsequently

vented to the Waste Gas Compressor Suction Header which normally runs at 0.5 psig. Below, the 50 percent Cold Calibration Level on the Pressurizer, the RCS system is vented to atmosphere through the PRT. The PRT is isolated from the waste gas system. When the RCS level is -4" below the Reactor Vessel Flange, the Reactor Vessel head is also vented to atmosphere. This requirement stems from Technical Specification 3.4.9.4 which requires the following overpressurization systems operable:

a) Two power-operated relief valves (PORVs) with setpoints which do not exceed the limits established in Figure 3.4-4 or

b) The Reactor Coolant System (RCS) depressurized with an RCS vent of greater than or equal to 2.9 sq. in.

Should both PORVs become inoperable, the Technical Specifications allow 8 hours to depressurize and vent the RCS through at least a 2.9 sq. in. vent. Operators could perform this by opening the Reactor Head Vent, the third PORV, or the Pressurizer Manual Vent could be utilized while returning the other PORVs back to operable. An additional vent path not required by Technical Specification is the temporary tygon level indicator hose used during reduced level operation which is vented directly to the atmosphere with a manual isolation valve.

There are no specific requirements pertaining to isolation of containment while the RCS is partially filled. Containment integrity must be re-established prior to exceeding 200°F or commencing refueling (movement of fuel) activities as per Technical Specifications. Plant procedures require re-establishing containment integrity if RHR cooling capability is lost.

Time for replacement of the equipment hatch is dependent on the status of activities during the outage. Installation can be accomplished within approximately 8 hours. This 8 hours includes: 1 hour to locate and stage the crane, 1 hour to remove the transporting track used for moving equipment, 1 hour to place the equipment hatch onto containment, and 5 hours to torque the hatch bolts.

No Technical Specification requirements exist to establish the integrity of the RCS pressure boundary upon loss of RHR cooling capability. However, plant procedures do identify this action to be performed upon loss of RHR.

NRC QUESTION 2

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.

SHNPP RESPONSE

SHNPP has the following instrumentation and alarms available during operation with the RCS partially filled:

Instrumentation

RHR Pump Current Indicators
RHR Pump Status Indicators (Breaker)
RHR Flow Indicators
RHR Pump Discharge Pressure Indicators
Reactor Vessel Level Indicating System (RVLIS)
RHR Heat Exchanger Outlet Temperature Recorders
RHR Heat Exchanger Inlet Temperature Indicators
RHR Pump Suction Pressure Indicators
RCS Narrow Range Pressure Indicators
RCS Wide Range Hot & Cold Leg Temperature Indicators
Incore Temperature Indication
RCS Tygon Level (local only)

Alarms

RHR Trouble Alarm (Pump Breaker Trip Alarm)

In addition, it is SHNPP policy to leave at least two incore RTDs coupled as long as possible if other activities require their removal. RVLIS is used to determine vessel level in conjunction with a tygon hose installed on the RCS crossover leg during reduced level operation. SHNPP procedure GP-008 requires that the tygon hose and the RVLIS indication be cross checked periodically and that the tygon hose be monitored continually during planned changes in vessel level.

There are no specific requirements to assure that the temporary connection piping and instrumentation do not contribute to loss of RCS inventory or otherwise lead to perturbation of the NSSS while the RCS is partially filled. The tygon connection to RCS is performed under a controlled plant procedure subject to required technical and safety reviews. Any leakage which may occur would be quickly detected since the hose is monitored after installation as previously mentioned.

Upon a loss of RHR cooling capability, plant procedures require observation of RCS pressure, temperature, and levels. Capability to monitor these parameters is via the permanent instrumentation and the above-described tygon hose indication.

NRC QUESTION 3

Provide identification of 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 items (a), and (c) an evaluation of Items a and b (above) with respect to applicable Technical Specification requirements.

SHNPP RESPONSE

The following pumps are required to be operable:

- One charging/SI pump
  (Required per Technical Specification 3.1.2.3)

- Two RHR pumps
  (Required per Technical Specification 3.4.1.4.2)

The following pumps may also be available:

- Two boric acid transfer pumps

- One reactor make-up pump

- One hydrotest pump (25 gpm)

In addition, plant procedures identify emergency makeup using plant demineralized water pumps.

The availability of the charging and RHR pumps is explicitly specified in the Technical Specifications as referenced above.

NRC QUESTION 4

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.

SHNPP RESPONSE

Technical Specifications do not require containment integrity during partial fill situations, except that the containment HVAC penetrations must be isolable by an automatic and manual isolation valve system. There are no special administrative conditions required during Mode 5 operations except when fuel is being moved and full containment integrity is implemented per Technical Specification 3.9.4. Both the containment equipment hatch and the personnel hatch can be open during RCS level changes, but generally, a negative purge is maintained while in this condition.

Access to the steam generator manways, piping penetrations and electrical penetrations is not restricted during RCS level changes, but Operations is the only group that may reposition components related to the above items and hence an overall knowledge of system availability is maintained.

NRC QUESTION 5

Provide reference to and 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 drain down 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 warning, critical parameters, and notifications is to be clearly described).

SHNPP RESPONSE

The plant operating manual procedures which control plant operations while the RCS is partially filled are GP-001, GP-008, OP-111, and AOP-020. These procedures which are relevant to RHR operation and RCS level changes recognize the safety concerns that are pertinent during reduced level operation. The procedures have been written from the prevention basis, so it is assumed that operation will not allow air entrainment or vortexing and certainly not boiling in the core. These procedures were developed from information contained in the Technical Specifications and Final Safety Analysis Report. Although no prior analysis exist, a study is currently being performed (as described in response to Item 9) to model the RCS under a loss of RHR situation in order to determine the time available for operator action prior to core uncovery.

Reasonable assurance for operability at reduced RCS levels exists based on start-up testing during which the RHR pumps were run at full flow from a mid-loop level. No vortexing or inadequate suction was detected on the RHR pumps.

The procedures also provide explicit guidance upon a loss of RHR cooling capability.

General Procedure GP-001, Reactor Coolant System Fill and Vent - Mode 5

This procedure describes the necessary steps for the safe and efficient filling and venting of the reactor vessel, interconnecting loop piping, pressurizer, and pressurizer relief tank.

This procedure contains certain prerequisites to ensure the availability of decay heat removal. They are:

1. The RCS Standpipe is lined up to indicate RCS water level, and

2. If the reactor coolant loops are not filled, two RHR loops are required operable and at least one RHR loop is required to be in operation.

3. When the RHR loop is open to the RCS, the RCS is not to be pressurized above 360 psig.

General GP-008, Draining the Reactor Coolant System (Mode 5)

This procedure provides instructions for lowering the water level in the RCS prior to refueling or maintenance activities. The procedure has several prerequisites which include having one residual heat removal loop in operation, a specified shutdown margin of 2000 PCM, shutdown banks A & B fully inserted, RCS depressurized and less than 140°F, and the RCS standpipe hooked up to Loop B crossover leg drain. At the confirmation of all prerequisites, the Shift Foreman signs an acknowledgement and draining can begin. This procedure contains precautions and limitations to ensure accurate water level monitoring and prevent loss of RHR conditions.

1. Ensuring the tygon tube that is connected to the B loop drain is free of kinks that could cause false readings.

2. Noting that the RCS standpipe will indicate accurately only if the RCS is depressurized. (One pressurizer PORV is always left open during this action.)

3. Noting that water level should not be allowed to decrease to the point where air will enter the reactor coolant loop piping unless maintenance or required work dictates (67" below the reactor head flange). This ensures that the steam generator tube sides remain essentially full and able to serve as a heat sink for the RCS.

4. Limits the RHR Pump flow to a maximum of 1500 gpm for RHR operation with the reactor level between 67 and 82 inches below the reactor flange to reduce the chances of air entrainment.

5. Limits the reactor vessel level to the minimum acceptable level of 82" below the reactor flange which is the center line of the reactor coolant loops. Below this level, proper RHR operation cannot be maintained. Within the range of 67-82" continuous monitoring of level is provided by the RVLIS and periodic confirmation of RVLIS indications by comparison to standpipe indication is required.

6. Requires operator to initiate the SHNPP emergency plan when a complete loss of any function required for hot or cold shutdown has occurred.

7. Requires establishing communications between the control room and the operator monitoring the RCS standpipe whenever the RCS standpipe is in service and RCS inventory changes are being made.

8. Caution that if the RCS must be drained to below 67" below the reactor vessel head flange, care must be taken to avoid air entrainment in the RHR suction line. It also points out that below 67" the steam generator tubes will begin to drain. It stresses that with no vent path at the top of the tubes, the water will "burp" out resulting in indicated level fluctuations, and that a stable indicated level will be achieved only after the tubes are dry.

Operating Procedure OP-111, Residual Heat Removal System

This procedure provides the initial conditions, precautions and limitations, and instructions for operation of the residual heat removal system. It includes instructions for placing RHR in service and returning RHR to normal safety injection lineup.

The precautions and limitations section of this procedure contains provision to prevent loss of decay heat removal function. These include:

1. Reminder that when the RCS water level is being lowered to drain the steam generator tubes, RHR flow should be throttled to 1500 gpm to minimize the possibility of air entrainment.

2. Cautions against starting the standby RHR Pump prior to stopping the running RHR Pump to prevent possibility of losing suction.

Abnormal Operating Procedure AOP-020, Loss of Residual Heat Removal Shutdown Cooling

This abnormal operating procedure is used in the event of a loss of RHR.

Several relative symptoms are listed which include low RHR loop flow, inability to start either RHR pumps, or stopping of both pumps and rapid decrease in pressurizer level or RVLIS. For the scenario being discussed here, these are the pertinent symptoms that would be expected. For immediate action, the operators determine if the leakage is beyond the capability of the make-up system and if so, the refueling water storage tank is aligned to the RHR pumps and a safety injection initiated.

The "Follow-Up Action" section of this procedure contains the following provisions regarding loss of RHR:

1. Loss of RHR requires the initiation of the SHNPP Emergency Plan.

2. If one RHR loop is operable, RHR cooling is to be established using the operable loop using OP-111 (unless isolated for a leak).

3. If the RHR system is inoperable, containment integrity is to be established prior to exceeding 200°F primary system temperature and all operable containment cooling fans and control rod drive mechanism fans are to be started.

4. If the RCS (Mode 5) is drained for maintenance, the following is required:

   - Operators to refer to Technical Specification 3.4.1.4.2 for RHR pump operability requirements.

- Line up a path for make-up water through the charging/safety injection system.

- If normal make-up cannot be established, make up water must be lined up using a primary water hose to any opening created by the maintenance activity.

5. The procedure alerts that if water level is below the centerline of the reactor vessel nozzle, air binding may have occurred in the in-service RHR loop and states that if the in-service RHR loop has air binding, place the standby loop in service only after verifying the reactor vessel standpipe level is restored to normal.

NRC QUESTION 6

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.

SHNPP RESPONSE

A. Auxiliary Operator (AO) Training

1. The AO basic systems lesson plan on Safety Systems (SS-LP-5.0) describes the RHR system and covers the auxiliary operator's role in performance of Abnormal and Emergency Operating Procedures involving the RHR system. It also contains industry events involving the loss of RHR.

B. Reactor Operator Training

1. The General Operating Procedure lesson plan on draining the Reactor Coolant System (GP-LP-3.8) provides specific training on operation while the RCS is partially filled. The training emphasizes the Precautions and Limitations, which address proper installation and operation of the tygon tube used for vessel level measurement, minimum vessel levels allowed for various stages of the RCS drain, maximum RHR flow rates allowed when the level is below the top of the hot legs, and the permanently installed Reactor Vessel Level Indication System.

2. The Systems lesson plan on the RHR System (RHRS-LP-3.0) provides detailed training on the system, including indications available to the operator, alarms, and references to related normal, abnormal, and emergency operating procedures. It also provides training on industry events related to the loss of RHR.

3. The Systems lesson plan on Inadequate Core Cooling Monitor (ICCM-LP-3.0) provides training on the Reactor Vessel Level Indication System.

4. The Abnormal Operating Procedure lesson plan (AOP-LP-3.8) includes specific training on operator response to degradation or loss of RHR while the RCS is drained. This training covers alternate sources of make-up water, response to air binding of the pumps, indications to monitor, restoration of RHR cooling, and related Technical Specifications.

5. RO qualification cards require performance or simulation of the task, draining the RCS, which includes partial drain operations.

C. Senior Reactor Operator Training

1. The Abnormal Operating Procedure lesson plan of Loss of RHR (AOP-LP-3.8) is presented. (See description above.)

2. The Systems lesson plan on RHR including related industry events (RHRS-LP-3.0) is presented as a part of the Prelicense Review. (See description above.)

D. Licensed Operator Requalification Training

- The Licensed Operator Requalification Training Program routinely covers recent industry events, system and procedure reviews, and procedure changes. In the 1986 and 1987 Requalification Programs, the lessons related to RCS partial fill operations and loss of RHR covered so far are as follows:

  a. Review of the RHR system.

  b. Review of the Safety Injection System.

  c. Review of and changes to the General Operating Procedures associated with filling the RCS, draining the RCS, and fill and drain of the refueling cavity.

  d. Various industry events related to loss of RHR, including SOER 83-4, Loss or Degradation of Residual Heat Removal Capability in PWRs, which discusses several loss of RHR events and lessons learned.

E. Maintenance Training

Training provided for maintenance personnel has not been specific to the issue of operation while the RCS is partially filled.

Conduct of Operations, which is covered in the POM and basic systems course, is related to operation while the RCS is partially filled in that personnel are instructed that valves and electrical breakers are operated only by operations personnel with concurrence of the Shift Foreman.

Additionally, maintenance procedures and surveillance tests have precautions and/or prerequisites that reduce the probability of perturbing other equipment/components while performing work on tests.

NRC QUESTION 7

Provide identification of 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.

SHNPP RESPONSE

During Mode 5, there are no requirements to provide additional special resources to operators while the RCS is partially filled. SHNPP operators are provided with the specialized knowledge concerning partial filled operations as part of the normal training program.

Plant policy is also such that prior to special or infrequent operations, shift briefings are conducted to review pertinent procedures, evolutions, etc.

NRC QUESTION 8

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.

SHNPP RESPONSE

The following table provides a comparison of the requirements implemented while the RCS is partially filled and requirements used in other Mode 5 operations.

		Other Mode 5	
Activity	Mid-Loop Vessel Level Below the Flange by 4 inches or more	Pressurizer Level (Cold Calibration) > 50% and RCS Depressurized	Pressurizer Level (Cold Calibration) < 50% and RCS Depressurized
PORVs Open	YES	YES	YES
Head Vented	YES	NO	NO
RHR Throttled	YES	NO	NO
Tygon Hose Installed and Aligned	YES	NO	YES

NRC QUESTION 9

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.

SHNPP RESPONSE

As a result of the consideration in Item 5, SHNPP is conducting a study to model the RCS under a loss of RHR condition in order to determine the time available for operator actions prior to core uncovery. The model contains the following assumptions:

1. RHR level is at 82" below the flange. (The minimum allowable level which corresponds to mid loop operation.)

2. RHR is maintaining 140°F RCS temperature at time of incident.

3. RHR is lost at 33 hours after reactor shutdown.

4. Time of incident is during fuel cycle 1 where maximum decay heat would be produced.

5. Reactor is open to atmosphere which would allow most rapid burn off of volume. (Actually the head being on would suppress boiling and lengthen the time to core damage.)

This model is being generated as an engineering task to create an analytical basis for reduced level situations. The computer simulation "ORIGEN II" tied with heat transfer calculations will predict the time to boiling and the time to core uncovery/damage.