Public Service
Electric and Gas
Company

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United States Nuclear Regulatory Commission
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Washington, DC 20555

Gentlemen:

RESPONSE TO GENERIC LETTER 87-12
SALEM GENERATING STATION
UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311

Public Service Electric and Gas Company (PSE&G) has received the subject NRC Generic Letter regarding the loss of residual heat removal while the reactor coolant system is partially filled. An extensive review of Salem operational and design conditions related to "midloop" operation has been performed by PSE&G engineering and operations personnel with input from Westinghouse. The resulting responses to the concerns of the Generic Letter and associated corrective actions are included in Attachment 1 to this letter. An attached Westinghouse report (Attachment 2), provides the analytical basis to support operation with the reactor coolant system partially filled and was reviewed for guidance in developing our procedures that govern operation during partially filled conditions.

Should you have any questions with regard to this transmittal, please do not hesitate to contact us.

Sincerely,

Attachments

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C Mr. D. C. Fischer
USNRC Licensing Project Manager

Mr. T. J. Kenny
USNRC Senior Resident Inspector

Mr. W. T. Russell, Administrator
USNRC Region I

Mr. D. M. Scott, Chief
Bureau of Nuclear Engineering
Department of Environmental Protection
380 Scotch Road
Trenton, NJ 08628

RESPONSE TO NRC GENERIC LETTER 87-12

STATE OF NEW JERSEY)
) SS.
COUNTY OF SALEM)

Corbin A. McNeill, Jr., being duly sworn according to law deposes and says:

I am Senior Vice President of Public Service Electric and Gas Company and as such, I find the matters set forth in our letter dated Sept. 23, 1987 , concerning our response to NRC Generic Letter 87-12, are true to the best of my knowledge, information and belief.

Subscribed and Sworn to before me
this 23rd day of September, 1987

Notary Public of New Jersey

LARAINE Y. BEARD
Notary Public of New Jersey
My Commission Expires May 1, 1991

My commission expires on _____

ATTACHMENT 1

RESPONSE TO GENERIC LETTER 87-12
SALEM GENERATING STATION
UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311

The responses to each of the questions indicated in NRC Generic Letter 87-12, Loss of Residual Heat Removal (RHR) While the Reactor Coolant System (RCS) is Partially Filled, regarding the operation of the Salem units during the approach to a partially filled RCS condition and during operation with a partially filled RCS are included in the following.

1. Provide a detailed description of the circumstances and conditions under which the 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.

The Salem RCS would be drained to hot leg centerline and the plant placed in "midloop" operation either to perform maintenance/repair activities or for decontamination and inspection. There are no interlocks which could cause a disturbance to the system while in this operating condition.

The plant will have been shutdown for at least 72 hours prior to placing the RCS in a partially filled or midloop condition. Expected conditions in this configuration would have the RCS at atmospheric pressure with the reactor coolant system vented to the Pressurizer Relief Tank (PRT). The PRT is in turn vented to the containment. RCS temperature would be less than 140°F (plant in MODE 5 or 6).

Two steam generators will be available with a secondary side level of greater than or equal to 5% (narrow range) while operating with the RCS in a partially filled condition. As long as level is maintained in two or more steam generators, decay heat would be transferred to the plant secondary system by condensation of the steam during short-term loss of RHR events. If the primary side of the steam generator manway is opened, this manway would provide the path for decay heat removal in a loss of RHR condition.

Changes in the status of equipment for maintenance and testing is controlled by shift supervision. All work orders, tags, permits and procedures are coordinated by the Work Control Center which is under the direction of the Salem Operations Department. Compliance with Technical Specification requirements is of primary concern when

considering the tagging out/isolation of safety-related equipment.

Additionally, all work on primary systems which could potentially have an effect on RCS inventory must be coordinated with shift supervision prior to work initiation. Concurrence must be obtained from the Shift Supervisor/Senior Shift Supervisor prior to work initiation in accordance with station administrative procedures. All major plant evolutions during an outage are scheduled by the Station Planning Department. The Station Planning Department interfaces with Operations shift personnel once per shift to provide an update on work progress and to review the present schedule.

If the reactor vessel head and steam generator manway were in place and RCS repressurization were to occur due to air entrainment and loss of RHR, trapped air in the primary side of the steam generator will be vented through the pressurizer PORV or the reactor head vent. Repressurization analyses utilizing various combinations of steam generator condensation and RCS leakage were performed by Westinghouse to determine the response of the Salem units (see the attached Westinghouse report). The worst case analysis involved RCS repressurization with no steam generator condensation and the RCS intact. The loss of RHR was assumed to commence 72 hours after plant shutdown. The results of this analysis revealed that the RCS would reach a pressure of 101.6 psig and a temperature of 333.8°F in approximately 33 minutes. It is expected that RHR flow would be reestablished to provide decay heat removal within this amount of time. Recovery from this condition would be initiated either by restoring level and starting one of the two RHR pumps or by establishing a vent path.

Should circumstances preclude RHR recovery within above noted time frame, the Westinghouse analysis demonstrates that the maximum pressure resulting from this postulated event will not compromise RCS integrity. Further, the potential for a significant repressurization event is made even more remote by the Technical Specification 3.4.9.3 (Salem Unit 1) and 3.4.10.3 (Salem Unit 2) requirement to provide for overpressure protection via two (2) Pressurizer Overpressure Protection System (POPS) relief valves or to maintain an RCS vent to containment of greater than or equal to 3.14 square inches with RCS cold leg temperature less than or equal to 312°F (and the reactor vessel head installed).

The ability to fill the RCS from the Refueling Water Storage Tank (RWST) by gravity drain may not be available if repressurization causes conditions which exceed the

hydraulic head available in the RWST. Although this condition is not likely, makeup from the RWST could still be provided by the available charging pump. The amount of makeup provided by the available charging pump would be more than adequate to compensate for boiloff and prevent core uncovery at the maximum decay heat rate during the loss of RHR event in a partially filled RCS condition.

Present procedures do not require isolation of the containment in this operating configuration since the equipment and personnel hatches could be opened for extended periods of time during refueling outages for various purposes. The attached Westinghouse report contains an analysis, performed at the request of PSE&G, to determine the consequences of the discharge of primary coolant (liquid or steam) without containment integrity during a loss of RHR event while operating with a partially filled RCS. The results indicate that offsite doses would only be a "small fraction of 10CFR100 limits." As such, containment isolation prior to entering this condition is not being considered at this time. It is estimated however, that during an event of this type, the containment could be evacuated and appropriately isolated in 4 hours.

Although the reestablishment of the RCS pressure boundary and restart of a reactor coolant pump may be possible in some cases, this evolution could not realistically be accomplished within an acceptable period of time in a "worst case" partially drained RCS condition (i.e. with the reactor coolant pumps uncoupled). Since the availability of the reactor coolant pumps cannot be assumed for the partially filled RCS condition, our major concern would be the reestablishment of RCS level through other available means.

2. Provide a detailed description of the instrumentation provided to the operators for controlling thermal and hydraulic aspects of the NSSS during operation with the RCS partially filled.

A summary of the instrumentation provided either in the control room or locally to monitor the RCS while in a partially filled condition is provided in Table 1.

One of the RCS loop flow transmitters on Loop #3 at Salem is temporarily converted during any RCS draindown condition to provide a control room indication of RCS level during draindown to the level of the reactor pressure vessel flange. The RCS hot leg level alarm is at 97'6". The minimum draindown level by procedure will be 98'0"$\pm$3".

Tygon tubing is used to provide local RCS level indication in containment. The Tygon tubing is only aligned to the RCS loop while the operator is making a level determination.

The tubing is isolated from the loop at all other times to preclude the potential for an inadvertent loss of RCS inventory. Salem Systems Engineering will provide installation, operation and maintenance instructions for this level indication during the upcoming refueling outage at Salem 1.

For the upcoming refueling outages at Salem Units 1 and 2, there will be no provision for continuous indication of RCS temperature with the RCS partially filled. This is due to work scheduled during these outages to remove the existing core exit thermocouples and install bottom-mounted thermocouples.

3. Identify all pumps that can be used to control NSSS inventory.

During operation with the RCS partially filled, one of the two RHR pumps is operating to provide decay heat removal. The other RHR pump is required to be operable by Technical Specifications. No maintenance activities are scheduled on the RHR pumps during this operating configuration unless such actions are necessary to assure the operability of the pump.

Salem Technical Specification 3.1.2.3 requires the operability of at least one charging pump for reactivity control purposes at all times while in this operating condition. The makeup available from the charging pump with the least amount of flow capability (positive displacement charging pump - 98 gpm) will adequately compensate for boiloff and prevent core uncovery during the loss of RHR event.

Additional makeup is available via gravity flow from the RWST to the RCS. Sufficient volume will be maintained by procedure to ensure that adequate head is available to provide the necessary driving force required for gravity flow. The Diablo Canyon 2 event demonstrated the effectiveness of RCS level recovery in this manner prior to the restart of the RHR pumps.

The maximum projected boiloff rate or inventory loss from accidental leakoff during midloop operation is not expected to exceed 98 gpm. From the information presented above, adequate makeup capability exists in this operating condition to prevent core uncovery.

4. Describe the containment closure condition required for the conduct of operations while the RCS is partially filled.

Current procedures at Salem do not require containment isolation during operation with the RCS partially filled. The attached Westinghouse report includes an evaluation of offsite dose consequences resulting from the worst case loss of RHR condition during partially filled RCS operation at Salem. The results of this evaluation indicate that 10CFR100 offsite dose limitations would not be exceeded.

During a typical draindown after plant degassing for a period of 24 hours, concentrations of Xe-133 and I-131 are expected to be 0.4 μCi/ml and 0.04 μCi/ml respectively. The resulting whole body and thyroid doses calculated at the site boundary are only a "small fraction of 10CFR100 limits" (see attached Westinghouse report).

As a result of the offsite dose evaluation noted above, PSE&G does not believe that the implementation of a requirement to isolate the containment with the plant in this operating configuration is warranted. It is estimated that containment evacuation and subsequent containment isolation can be accomplished in approximately 4 hours if a loss of RHR event with an accompanying release of RCS inventory to the containment should occur. This contingency will be incorporated into a Salem Abnormal Operating Procedure which is presently under development. A procedural precaution will also be included in the procedure which currently provides guidance for entrance into a partially filled RCS condition to prohibit draindown with an RCS I-131 concentration of $\geq$ 0.1 μCi/ml.

5. Reference and provide a summary description of procedures in the control room which describe operation while the RCS is partially filled. Response should include analytic basis for procedures development.

   Explain the analytic basis to support the following: (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 NSSS if RHR cannot be restored, control of effluent from the containment if the 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.

The current operating procedure which provides guidance to draindown the RCS to accomplish maintenance or inspection activities is being revised to provide additional information to the operators regarding the potential for a loss of RHR condition. A new operating procedure is being developed to more descriptively address the prerequisites, precautions and limitations related to plant operation while operating with the RCS partially filled. This procedure will require the hot leg level to be maintained at a minimum of 98'0"±3" during partially filled RCS conditions. The bottom of the manway is at 98'7". This allows for 7" of level flexibility between the steam generator manway and the minimum maintained RCS level to account for instrument error and/or hydraulic phenomena. The Westinghouse analysis indicates that if hot leg level is maintained 6" above the centerline level of 97'0", no vortexing will result as long as RHR pump suction flow rate from the RCS hot leg does not exceed 3000 gpm. Applicable procedures will include a precaution to maintain a maximum RHR flow rate of 3000 gpm.

The Abnormal Operating Procedure noted in the response to Question 4 is being developed to provide clear and concise guidance to the operators for recovery from a loss of RHR event while in a partially filled RCS condition including containment isolation contingencies.

These procedures will be available for NRC review prior to the next entrance into a partially filled RCS condition at Salem, if requested.

To provide the analytical basis for these procedures, PSE&G requested Westinghouse to provide an evaluation of partially filled RCS operation at Salem to include the effect on RCS level of air entrainment and vortex formation, the treatment of boiling in the core, the approximate time from loss of RHR to core uncovery, and other information pertinent to this operating condition. The resulting Westinghouse report is attached for your review.

Based on this evaluation of the Salem NSSS design response, plant makeup capabilities, and a review of the 37 loss of RHR events listed in Table 1 of NRC Generic Letter 87-12, PSE&G has concluded that occurrence of core uncovery is unlikely at Salem. The procedure improvements noted above will provide administrative precautions to minimize the probability of occurrence of a loss of RHR event while approaching or operating with the RCS partially filled.

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.

The existing training provided to the control room operators in this area has dealt, for the most part, with the operational steps to be taken to place the plant in a partially filled RCS midloop operation condition. Control room personnel will be informed of the concerns identified as a result of our response to this Generic Letter prior to the commencement of the upcoming Salem 1 refueling outage (scheduled for 10/2/87). In addition, the new procedures noted in the response to Question 5 will be distributed with appropriate background material to all control room operators. Formal training related to these concerns will be incorporated into the licensed reactor operator training program (both license training and requalification training).

Also, supervisors from other station departments which may be affected during this operatng condition (e.g. plant maintenance, station planning, health physics, inservice inspection/testing ....) are to be instructed regarding the need to minimize perturbations to the RCS during midloop operation and to be sensitive to the the actions which may be required on their part to assist the Salem Operations Department in the recovery from a loss of RHR condition.

7. 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.

During operation with the RCS partially drained, the Salem Operations Department (licensed operators) is cognizant of those activities with the potential to impact the RCS. The Shift Supervisor Engineer (STA Qualified) is readily available to the operating shift to provide analytical support to the control room operators. Additional engineering/technical support is available on a call out basis.

8. Compare the requirements implemented while the RCS is partially filled and requirements used in other MODE 5 operations.

Entrance into the partially filled RCS condition at Salem is generally intended to carry out maintenance or inspection activities on an RCS component(s) during MODE 5 or 6. As stated in the response to Question 1, restrictions are placed on time from shutdown (72 hours) and availability of

steam generators for decay heat removal (minimum of two steam generators) prior to entering a partially filled RCS condition, in addition to other requirements for MODE 5 operation.

Reduced RHR flow rate to minimize the likelihood of vortexing and air entrainment is not practiced at Salem as Technical Specification Surveillance Requirement 4.9.8.4 does not allow an RHR flow of less than 3000 gpm in MODE 6. Additionally, Salem Unit 1 is also restricted by Technical Specification Surveillance Requirement 4.1.1.3.b. in all MODES to a minimum RHR flow of 3000 gpm to ensure adequate boron mixing. It should be noted here that the operating procedures will instruct the operators to reduce RHR flow below 3000 gpm if vortexing should occur while in a partially drained RCS condition. This action would require entrance into the applicable Technical Specification Action Statement.

The Westinghouse report has indicated that further analysis has shown that a minimum flow requirement of 1000 gpm is adequate to prevent boron stratification. As such, PSE&G is considering the submittal of a proposed Technical Specification change in the near future to permit operation at a reduced RHR flow rate to minimize the potential for vortexing and air entrainment.

9. Describe changes which have been made or will be made as a result of the consideration of the issues presented in NRC Generic Letter 87-12.

As a result of the reviews conducted of existing procedures regarding midloop operation, loss of RHR, and feed and bleed operation of the RCS as well as NUREG-1269 and other industry related information, the following steps are being taken at the Salem Generating Station in an attempt to preclude a loss of RHR event and to improve recovery operations if a loss of RHR event were to occur.

ACTIVITY	SCHEDULED COMPLETION DATE
Revise existing operating procedure for draindown to provide more information to operators while draining RCS to a partially filled condition. Address administrative control prohibiting draindown if RCS I-131 concentration is $\geq$ 0.1 μCi/ml.	10/2/87

ACTIVITY	SCHEDULED COMPLETION DATE
Develop operating procedure to provide guidance during operation with the RCS partially filled. Revise minimum required level in RCS hot leg to prevent vortexing and air entrainment to be consistent with the level required to prevent spilling due to removal of the steam generator manway.	10/2/87
Develop Abnormal Operating Procedure to provide improved guidance during a loss of RHR event while in partially filled RCS condition. Include contingency for isolation of containment if a release of RCS inventory to containment is encountered.	10/2/87
Provide guidance for installation, operation and maintenance of Tygon tubing level indication.	10/2/87
Address training on potential for RCS perturbations due to actions performed while the plant is in midloop operation.	
Instruct control room personnel	10/2/87
Incorporate into operator training	4/88
Instruction of other affected departments	10/2/87

TABLE 1

INSTRUMENT	PARAMETER MEASURED	LOCATION	COMMENTS
FT-0435	FULL RANGE RCS LEVEL ALARMS AT 97'6"(ft.)	C.R. RZ1000B BEZEL	RE-CALIBRATED FLOW METER, SET FOR HYDROSTATIC PRESS. ALARMS FO 440A FROM 13 INTERMEDIATE LEG
TYGON TUBE	RCS LEVEL (ft/in)	LOCAL CONTAINMENT	TAPPED OFF 13(23) RC 15 DRAIN VALVE
FA-5021 FA-5908	#11 RHR PUMP COLD LEG INJECTION FLOW (GPM)	C.R.	FLOW IS MEASURED AT 11(21)SJ49 VALVE
FA-5022 FA-5909	#12 RHR PUMP COLD LEG INJECTION FLOW (GPM)	C.R.	FLOW IS MEASURED AT 12(22)SJ49 VALVE
IA-5001	#11 RHR PUMP CURRENT INDICATOR (AMPS)	C.R.	SCALE IS 1 TO 10 X 10 AMPS
IA-5002	#12 RHR PUMP CURRENT INDICATOR (AMPS)	C.R.	SCALE IS 1 TO 10 X 10 AMPS
PI-403 PI-405	HOT LEG PRESSURE ON RHR SUCTION LEG (PSI)	C.R.	PRESS RANGE MEASURED 0-60X10 AND 0-30X10^2 PSI
FI-917	CHARGING PUMPS DISCHARGE FLOW (GPM)	C.R.	0-80X10 GPM
LI-112	VCT LEVEL (%)	C.R.	0-10X10 % LEVEL
FI-134	LETDOWN FLOW (GPM)	C.R.	0-20X10 GPM
PI-135B	LETDOWN PRESS (PSI)	C.R.	0-60X10 PSI
TI-412, 422 432, 442	AVERAGE TEMPERATURE RCS LOOPS 11, 12, 13, 14, °F	C.R.	53-63X10 °F

INSTRUMENT	PARAMETER MEASURED	LOCATION	COMMENTS
TA-1425	#11 RHR HEAT EXCHANGE OUTLET TEMPERATURE	PLANT COMPUTER	P-250 COMPUTER IN C.R. T0627A DATA POINT
TA-1408	#11 RHR HEAT EXCHANGE OUTLET TEMPERATURE	PLANT COMPUTER	P-250 COMPUTER IN C.R. T0630A DATA POINT
TA-1413	#12 RHR HEAT EXCHANGE OUTLET TEMPERATURE	PLANT COMPUTER	P-250 COMPUTER IN C.R. T0631A DATA POINT
TA-6486	#12 RHR HEAT EXCHANGE OUTLET TEMPERATURE	PLANT COMPUTER	P-250 COMPUTER IN C.R. T2360A DATA POINT