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SUBJECT: Responds to Generic Ltr 88-17, "Loss of DHR."

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January 3, 1989

10 CFR 50.54(f)

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

Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Response to Generic Letter 88-17

References: 1) "Loss of Residual Heat Removal (RHR) While the Reactor Coolant System is Partially Filled", Generic Letter 87-12.

2) Letter from D. C. Hintz (WPSC) to Document Control Desk dated October 19, 1987.

3) "Loss of Decay Heat Removal", Generic Letter 88-17 received on November 4, 1988.

4) WCAP-11916 "Loss of RHRS Cooling While the RCS is Partially Filled", Westinghouse Electric Corporation, dated July 1988.

By means of Generic Letter 87-12 (reference 1), the NRC requested information on reactor coolant system (RCS) operation when the water level was drained below the top of the reactor vessel flange. The NRC's request was prompted by the large number, and potential severity, of loss of residual heat removal (RHR) cooling accidents that had occurred when the RCS was partially filled. WPSC responded to this request by providing a large body of information on our procedures, hardware and operating philosophies with regard to the RHR system (reference 2). NRC's review of the composite industries' responses found that most utilities did not understand the problems identified and were poorly prepared for RCS reduced inventory operation. This is evidenced by the frequency with which loss of RHR events are still occurring.

Therefore, the NRC believes that certain expeditious actions are necessary at all pressurized water reactors (PWRs) to rectify deficiencies in the areas of hardware, procedures and training. These expeditious actions are discussed in

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Attachment 1 to Generic Letter 88-17 (reference 3). Pursuant to 10CFR50.54(f), licensees were requested to respond with their plans to address each of these recommendations. The attachment to this letter provides WPSC's 60 day response to the eight expeditious actions identified.

Based on a review of Generic Letter 88-17 and supporting documents, WPSC has developed a three step philosophy for operating in a reduced inventory condition. This is, 1) take the actions necessary to prevent a loss of RHR cooling accident, 2) have available the equipment and procedures needed to mitigate such an accident before core damage occurs, and 3) have the ability to minimize the potential for a release of radioactive materials if an accident occurs. Our philosophy will be implemented by means of hardware modifications, procedure revisions and operator training. These specific actions are detailed in the attached response.

WPSC is currently developing a plan of action for the programmed enhancements which are also recommended in the Generic Letter. To support this work we have contracted Westinghouse to perform plant specific refinement for some of the analyses presented in WCAP-11916 (reference 4). If this additional analysis alters any of the information contained in this transmittal, we will inform you as a part of our 90 day response.

If you need further information or clarification, please feel free to contact my staff.

Sincerely,

D C Hintz

D. C. Hintz
Vice President - Power Production

SLB/cmg

cc - Mr. Robert Nelson, US NRC
US NRC, Region III

Subscribed and Sworn to
Before Me This 3rd Day
of January 1989

Jeanine M. Stein
Notary Public, State of Wisconsin

My Commission Expires:
June 23, 1991

NRC Recommendation

1. Discuss the Diablo Canyon event, related events, lessons learned, and implications with appropriate plant personnel. Provide training shortly before entering a reduced inventory condition.

WPSC Response

The Kewaunee Nuclear Power Plant (KNPP) annual refueling and maintenance outage is scheduled to begin on March 4, 1989. WPSC does not anticipate entering a reduced inventory condition prior to this date. Therefore, training for licensed operators will be completed before entering a reduced inventory condition. This training will include:

1) Maximum recommended residual heat removal (RHR) system flowrates versus reactor coolant system (RCS) levels to avoid air entrainment and possible vortex formation,

2) Recognizing the symptoms of air entrainment in the RHR system,

3) Guidance on restoring RCS cooling if air ingestion into the RHR pump suction were to occur, and

4) Anticipated RCS behavior following a loss of RHR system operation during reduced inventory condition. The impact of different RCS configurations will be included.

Training for items 1 through 4 will be based on previous operating experiences and reference documents WCAP-11916 "Loss of RHRS Cooling While The RCS is Partially Filled" and Westinghouse Owners Group transmittal WOG 88-156, which provides interim procedure guidance for mid-loop operations.

To satisfactorily implement Generic Letter (GL) 88-17 requirements, WPSC will be developing new procedures, revising existing procedures and improving the instrumentation and equipment available to operate in a reduced RCS inventory condition. To enhance the operators knowledge of these forthcoming changes information will also be provided on:

5) The basis for containment closure, definition of such and procedural guidelines to establish a closed containment in the event of a loss of RHR system cooling. (See WPSC response to recommendation 2.)

6) Requirements to maintain two independent indications of core exit temperature whenever the RCS is in a mid-loop condition and the reactor head is on the vessel. (See WPSC response to recommendation 3.)

7) Requirements to maintain two independent RCS water level indications when in a reduced inventory condition. (See WPSC response to recommendation 4.)

8) The bases for guidelines to minimize perturbations to the RCS and support systems when in a reduced inventory condition. (See WPSC response to recommendation 5.)

9) Requirements to maintain backup cooling equipment available and the basis for such. (See WPSC response to recommendation 6.) And,

10) Revisions which will be made to the steam generator nozzle dam installation and removal procedure to minimize the time during which the plant is in a vulnerable configuration. (See WPSC response to recommendation 7.)

As stated above we do not anticipate operation in a reduced inventory condition prior to March 4, 1989. If, due to unforeseen circumstance this date were to move forward, WPSC would not be able to provide training due to the compressed time frame which we are working under. As an interim measure a copy of this submittal and the WOG guidance letter will be added to the licensed operators required reading list. It should be noted that training has already been provided on this subject during the 1987-1988 requal cycle. This training included the Diablo Canyon event, and its plant specific ramifications when operating in a mid-loop condition. This required literature review coupled with the training already provided in response to GL87-12, will assure a reasonable level of operator knowledge until the additional training can be completed.

NRC Recommendation

2. Implement procedures and administration controls that reasonably assure that containment closure[1] will be achieved prior to the time at which a core uncovery could result from a loss of DHR coupled with an inability to initiate alternate cooling or addition of water to the RCS inventory. Containment closure procedures should include consideration of potential steam and radioactive material release from the RCS should closure activities extend into the time boiling takes place within the RCS. These procedures and administrative controls should be active and in use:

   a) prior to entering a reduced RCS inventory condition for NSSSs supplied by Combustion Engineering or Westinghouse, and

   b) prior to entering an RCS condition wherein the water level is lower than four inches below the top of the flow area of the hot legs at the junction of the hot legs to the RV for NSSSs supplied by Babcock and Wilcox,

   and should apply whenever operating in those conditions. If such procedures and administrative controls are not operational, then either do not enter the applicable condition or maintain a closed containment.

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[1]Containment closure is defined as a containment condition where at least one integral barrier to the release of radioactive material is provided.

WPSC Response

One of WPSC's principal intents in addressing the entire reduced inventory issue is to avoid placing the RCS in an adverse configuration. This recognizes that maintaining a favorable initial condition will limit the accident severity if RHR system cooling were to be lost. If it is not possible to avoid certain configurations, then the time duration will be minimized to the extent practical. In addition, the operators will be aware of the plant's vulnerable status and be able to expeditiously close containment if RHR system cooling is lost and backup methods are not available. The below stated considerations for procedure revisions reflect this philosophy.

The procedures which will be impacted with regards to containment closure are N-RC-36E "Draining the Reactor Coolant System" (existing procedure), A-RHR-34 "Loss of Residual Heat Removal Cooling" (existing procedure), and N-RHR-34C "RHR Operation At A Reduced Inventory Condition" (new procedure). The following instructions will be incorporated into these procedures to guide operators when in a reduced inventory condition:

1) At least one barrier, capable of limiting the release of radioactive materials, should be maintained operable or closed for each containment penetration. If it is not possible to maintain the penetration closed then its status shall be recorded on the Open Boundary Tracking log.

2) When possible, establish and maintain a large, unobstructed hot leg side vent opening. The hot leg side vent should be of a magnitude that will prevent the RCS from pressurizing if core boiling were to occur.

3) If plant conditions and scheduled work activities permit, maintain at least one steam generator (SG) water filled. This secondary heat sink will significantly reduce the rate of RCS pressure increase if RHR cooling is lost. This in turn will provide additional time to restore RCS inventory and RHR cooling. If there is an intact steam generator with narrow range level established, then feedwater addition to compensate for SG secondary side boil-off is an acceptable means of providing alternate cooling for several hours.

4) Avoid placing the RCS in an adverse configuration, i.e., cold leg side opening(s) totaling greater than one square inch, with no hot leg side vent. If this configuration cannot be precluded, then either maintain the containment closed, or have the ability to close it within 30 minutes.

5) If the RCS is intact, or nearly intact with no cold leg openings, e.g., pressurizer PORV's and vent lines under $\frac{3}{4}$" are open, then either maintain the containment closed, or have the ability to close it within $2\frac{1}{2}$ hours.

6) When a large unobstructed hot leg side opening exists and two core exit thermocouples are in service, or the reactor vessel head is removed, the plant is in the least vulnerable configuration for mid-loop operation.

Although time is available for operator action, in the unlikely event that RHR cooling is lost and inventory cannot be added, the operators will promptly initiate containment closure activates. Once initiated, containment closure activate will continue until completed or RHR cooling is restored and the RCS is returned to a controlled and stable condition.

The times selected to establish containment closure are based on information contained in the generic letter, WCAP-11916 and reasonable expectations for various plant conditions. When the RCS is in an adverse configuration operator action is required within minutes to prevent boiling and core uncovery. Time spent in this undesirable situation will be minimized and the containment should be maintained essentially closed. The 30 minute time frame will be adequate for the operators to recognize the condition, review the status of open penetrations, and take appropriate actions.

The RCS intact, or nearly intact is reflective of plant conditions with the PORVs open to the pressurizer relief tank (PRT) and the head vent system open to containment. The time frame of $2\frac{1}{2}$ hours for containment closure under these conditions is adequate as there are several methods available to restore RCS inventory and prevent core uncovery.

When a large unobstructed hot leg opening exists, the plant is in the most desirable configuration. Operator action to prevent core uncovery is not needed immediately and inventory addition could be performed by one of several active systems, or by passive gravity feed from the RWST. When in this configuration it is permissible to have several containment penetrations open for work activities. If RHR system cooling would be lost and in the highly unlikely event that inventory could not be added, the operators would promptly initiate closure activities. Containment closure activities would continue until they are completed, or RHR cooling is restored and the RCS is returned to a controlled and stable condition. Westinghouse is calculating the vent size required to

preclude RCS pressurization following a loss of RHR cooling accident for KNPP. The vent size required, and how to achieve it, will be substituted for the words "large unobstructed hot leg side opening" in the KNPP operating procedures.

The status of containment penetrations will be controlled when operating in a reduced inventory condition. A log of open containment boundaries and the reason they are open will be maintained in the control room. The shift supervisor will ultimately be responsible for determining if a penetration can or cannot be opened when approaching or in a reduced inventory condition. The shift supervisor's determination will be based on the nature of the work to be performed, the capability of other downstream valves or devices to serve as a barrier, whether the penetration can be closed within the allotted time frame, and whether the closure activity can be performed in a harsh environment.

NRC Recommendation

3. Provide at least two independent, continuous temperature indications that are representative of the core exit conditions whenever the RCS is in a mid-loop condition[2] and the reactor vessel head is located on top of the reactor vessel. Temperature indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Temperature monitoring should be performed either:

   a) by an operator in the control room (CR), or

   b) From a location outside of the containment building with provision for providing immediate temperature values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.[3]

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[2]Mid-loop condition exists whenever the RCS water level is below the top of the flow area of the hot legs at the junction with the RV.

[3]Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

WPSC Response

Temperature indication, as described in the generic letter requirements, will be provided by the existing core exit thermocouples. Two core exit thermocouples will be left in service until prior to head lift. At this point in time the RCS water level is above the hot leg inlet to the vessel. When the head is reset, two core exit thermocouples will be reconnected before the RCS is drained to the midpoint of the hot legs.

Indication of core exit temperature is available in the control room and a computer alarm will be established to alert the operators to abnormal temperature conditions.

NRC Recommendation

4. Provide at least two independent, continuous RCS water level indications whenever the RCS is in a reduced inventory condition. Water level indications should be periodically checked and recorded by an operator or automatically and continuously monitored and alarmed. Water level monitoring should be capable of being performed either:

   a) by an operator in the CR, or

   b) from a location other than the CR with provision for providing immediate water level values to an operator in the CR if significant changes occur. Observations should be recorded at an interval no greater than 15 minutes during normal conditions.[4]

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[4]Guidance should be developed and provided to operators that covers evacuation of the monitoring post. The guidance should properly balance reactor and personnel safety.

WPSC Response

Two independent, continuous RCS water level indications will be provided to meet the intent of the generic letter. One method of indication will be provided by the existing level system, and a new system which will be installed prior to being in a reduced inventory condition for the 1989 refueling outage.

The water leg for the existing system is off the loop A intermediate leg. The system is hard piped, with a sight glass for local indication, and a d/p transmitter which provides an input to the operators control panel as well as the plant process computer. The existing reference leg is vented to the containment atmosphere; however, rerouting the reference leg to the pressurizer in order to eliminate inaccuracies caused by pressure variations in the RCS is being evaluated for feasibility.

The new level indication system will consist of two d/p transmitters, one narrow and one wide range. The water leg will be the thimble guide tube used for the RVLIS and the reference leg is planned to be piped to the pressurizer. The reference leg tap will be independent of the existing system. Indication of both narrow and wide range level will be available on the plant process computer. A computer alarm will be established to alert the operators to abnormal level conditions.

Although reference leg venting of either of these instruments to the pressurizer appears impracticable for the March 1989 outage, the configuration will be reassessed in the future. In the interim, mid-loop operation will be implemented in conjunction with removal of the pressurizer safety valves. This will provide a relatively large vent path to containment to minimize pressure

variations between the RCS (pressurizer) and the instrument reference leg (containment). In addition operator training has heightened the awareness of the potential for pressure differences and cautions that the drain and fill evolutions are to be performed slowly as a preventive measure.

Information provided by Westinghouse on level gradients throughout the RCS will be reviewed to estimate a relationship between the RCS level at the RHR suction inlet nozzles versus the measured level. This information will be provided as a guidance to the operators to account for the differences that will be indicated in the control room.

NRC Recommendation

5. Implement procedures and administrative controls that generally avoid operations that deliberately or knowingly lead to perturbations to the RCS and/or to systems that are necessary to maintain the RCS in a stable and controlled condition while the RCS is in a reduced inventory condition.

   If operations that could perturb the RCS or systems supporting the RCS must be conducted while in a reduced inventory condition, then additional measures should be taken to assure that the RCS will remain in a stable and controlled condition. Such additional measures include both prevention of a loss of DHR and enhanced monitoring requirements to ensure timely response to a loss of DHR should such a loss occur.

WPSC Response

Operating procedure N-RHR-34C "RHR Operation At A Reduced Inventory Condition" will include a precaution to avoid operations that could lead to known perturbations of the RCS and support systems. If operations which may perturbate the RCS must be conducted while in a reduced condition, then additional measures shall be taken to ensure the RCS remains in a stable and controlled condition.

The Outage Coordinator, aided by the plant management staff, will review prescheduled activities to ensure they will not knowingly challenge the stability of the RCS while it is in a reduced inventory condition. However, the ultimate control over work and test activities rests with the shift supervisor. He will be knowledgeable of plant status and interfaces that could perturbate the system. The precaution to preclude such work activities will be emphasized by operating procedure N-RHR-34C and training.

NRC Recommendation

6. Provide at least two available[5] or operable means of adding inventory to the RCS that are in addition to pumps that are a part of the normal DHR systems. These should include at least one high pressure injection pump. The water addition rate capable of being provided by each of the means should be at least sufficient to keep the core covered. Procedures for use of these systems during loss of DHR events should be provided. The path of water addition must be specified to assure the flow does not bypass the reactor vessel before exiting any opening in the RCS.

WPSC Response

Operating procedure N-RHR-34C, "RHR Operation At A Reduced Inventory Condition" will require that one high head safety injection (SI) pump, and one other means of adding inventory be available when the RCS is in a reduced inventory condition. The other means for adding inventory may include, the other SI pump, one of the three positive displacement charging pumps, or gravity feed from the refueling water storage tank. Westinghouse is presently analyzing the RCS boil-off rate following a loss of RHR cooling accident for KNPP. The plant specific results will be used to determine which combinations of methods of inventory addition will be maintained available when in a reduced inventory condition.

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[5]Available means ready for use quickly enough to meet the intended functional need.

For the purposes of the generic letter, "available" is being interpreted to mean that the device and its associated flow path have a reliable power supply and operator action may be relied upon to align and start the components. WPSC understands that this position is acceptable to the NRC as long as the time frame for operator action is reasonable.

Operating procedure A-RHR-34 "Loss of Residual Heat Removal Cooling" will be revised based on WCAP-11916 and Westinghouse Owners Group letter WOG-88-156 which provides guidance for recovering from a loss of RHR system cooling due to air entrainment.

NRC Recommendation

7. (Applicable to Westinghouse and Combustion Engineering nuclear steam supply system (NSSS) designs.) Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by nozzle dams unless a vent path is provided that is large enough to prevent pressurization of the upper plenum of the RV. See references 1 and 2.

WPSC Response

The procedures which control steam generator manway and nozzle dam installation and removal will be revised. The procedure revisions will be based on the generic letter concerns and the need to allow flexibility for different RCS configurations. To restate an earlier point, a principal intent is to avoid adverse configurations, and where this is not possible to minimize the time duration and ensure the operators are aware of the plant's status.

A designated engineer will be responsible for the job flow on each shift when steam generator manways and nozzle dams are being worked. This person will be cognizant of the job status and communicate the progress of activities to the operators.

The procedure framework will allow for a variety of initial conditions. The most favorable condition is establishment of a large hot leg side vent path. This is desired to prevent the failure of the cold leg side nozzle dam if a loss of RHR cooling were to occur. When this hot leg vent exists, the procedures for manway and nozzle dam work will require the engineer to keep the shift supervisor and control room operators apprised of the major evolutions.

The procedure for S/G nozzle dam installation and removal will require the cold leg nozzle dam to be installed prior to installation of the hot leg nozzle dam and that the cold leg dam be removed after the removal of the hot leg dam. A similar requirement will be implemented for S/G manways.

When a large hot leg side vent path cannot be established, control room operators will be notified prior to blocking the final hot leg side opening. With the hot leg side blocked, containment shall either be maintained closed or be able to be closed within thirty (30) minutes while in mid-loop operation.

NRC Recommendation

8. (Applicable to NSSSs with loop stop valves.) Implement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by closed stop valves unless a vent path is provided that is large enough to prevent pressurization of the RV upper plenum or unless the RCS configuration prevents RV water loss if RV pressurization should occur. Closing cold legs by nozzle dams does not meet this condition.

WPSC Response

Does not apply to KNPP.