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Safety & 10CFR 50.92 Significant Hazards Consideration Assessment For RPV Stratification Prevention Improvements At Edwin I. Hatch Nuclear Plant Units 1 & 2

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1. INTRODUCTION

This assessment addresses two proposed improvements to reduce the probability of thermal stratification at the bottom of the reactor pressure vessel (RPV). The first improvement is to lower the water level of the ATWS recirculation pump trip (RPT). The second improvement is to allow for the restart of the recirculation pump(s) within 30 minutes of a RPT. Examined are (1) the safety implications of changing the ATWS recirculation pump trip (RPT) Technical Specification (Tech Spec) trip setpoint from reactor water low-low level 2 (Level 2) to Level 2 - 26 inches, (2) adding a new slave trip unit to implement the setpoint change, (3) the benefits of a Tech Spec procedural change to allow for the restart of the recirculation pump(s) within 30 minutes of a RPT, and (4) with respect to these changes, address the significant hazards consideration criteria of 10CFR 50.92. The requested Tech Spec changes for both Hatch Units 1 and 2 are shown in Attachment A.

1.1 Background

Operating experience shows that the bottom head region of the reactor pressure vessel (RPV) experiences a rapid cooldown following a reactor scram coincident with a trip of the recirculation pumps. A factor that influences both the occurrence and the magnitude of this cooldown is that the recirculation pumps are no longer available to force circulation throughout the vessel and effect mixing.

There are two challenges to the operating crew, which occur as a result of the cooldown of the RPV bottom head region. First, the reduction in metal temperature in this region, while the steam dome pressure remains near rated, causes an approach toward the Technical Specification pressure temperature limits. Second, the reduction in the bottom head coolant temperature prevents the restart of the recirculation pumps if the temperature difference between the steam dome and the bottom head exceeds 145°F. The 145°F requirement is specified to avoid thermal fatigue on the control rod drive (CRD) penetration nozzle stub tubes in the bottom head due to a thermal shock by the reactor hot water on the cold stub tubes during the restart of the recirculation pumps.

A change that would reduce the probability of having thermal stratification is to reduce the probability of unnecessary RPTs, because having the recirculation pumps running prevents the bottom head temperature stratification.

Some BWRs have incorporated a ~10 second time delay into the ATWS-RPT Level 2 trip. A functionally equivalent design change (which would be more effective in avoiding unnecessary RPTs) would be to delay the RPT until a lower water level is reached, based on the most limiting event that uses the ATWS-RPT.

GE Service Information Letter (SIL) 251 recommends the use of the RPV drain line to remove the cold water in the bottom head area through the RWCU suction line. Also, this SIL recommends using the drain line temperature as a representative bottom head coolant temperature, and the

current Technical Specifications for Edwin I. Hatch Nuclear Plant Units (Hatch) 1 and 2 require the drain line temperature to be used. However, the drain line flow capacity for Hatch 1 and 2 may not be sufficient to remove the cold water in the bottom head region compared to the CRD cooling water flow rate. Also, the drain line may become partially plugged and the drain line temperature may not correctly represent the bottom head coolant temperature. Allowing the restart of the recirculation pump(s) within 30 minutes of a RPT would provide an acceptable alternative to the drain line temperature measurement.

1.2 Proposed Design And Procedure Changes

For Hatch 1 and 2, it is proposed that the ATWS-RPT Level 2 setpoint be lowered by 26 inches. To accomplish this functional change, the proposed (equipment) design change is to add a new slave trip unit to the low water level trip subsystem of the ATWS-RPT.

Within 30 minutes after a RPT, the temperature difference between the RPV steam dome and the bottom head is less than the 145°F limit, when (1) no HPCI/RCIC injection occurs, and (2) no feedwater injection occurs with a final feedwater temperature below 300°F. Therefore, a Tech Spec change to allow for recirculation pump restart within 30 minutes after a RPT is requested for the cases of no HPCI/RCIC injection and/or no feedwater injection below 300°F.

1.3 Scope of Analysis

GE Nuclear Energy (GE) first evaluated all the safety analyses that could potentially be affected by the proposed change, and determined that the most limiting event is the Loss of Feedwater ATWS event. GE has performed a number ATWS analysis cases of the Loss of Feedwater event to justify lowering the ATWS Level 2 setpoint for RPT by 26 inches, to reduce unnecessary RPT occurrences. Other functions on low-low level such as ARI, and HPCI/RCIC start will not be changed. Also, GE verified that a new slave trip unit, that delays the RPT until Level 2 - 26 inches, can be installed with the existing trip unit.

An engineering evaluation examines the implications of recirculation pump restart within 30 minutes after a RPT. This procedural does not affect any plant safety analysis.

1.4. RESULTS/CONCLUSIONS

The evaluation concludes (1) that the low-low level (Level 2) setpoint for the ATWS RPT can be lowered by 26 inches (2.0 ft – 2.0 in.) and (2) that a recirculation pump restart within 30 minutes after a RPT with no HPCI/RCIC injection and/or no feedwater injection below 300°F will not involve a significant hazards consideration.

2. DESCRIPTION OF DESIGN AND PROCEDURE CHANGES

2.1 Lower The ATWS-RPT Setpoint

The design change adds a slave trip unit to each of the existing master trip units for the ATWS low water RPT. The slave trip units will meet the same qualification standards as the master trip units. A slave has no direct connection to a transmitter, and obtains its input from the analog output signal of the master trip unit. The number of independent channels for the ATWS low water level RPT will remain the same, and thus, system redundancy will not change. The slave unit will be adjusted to initiate a RPT at Level 2 - 26 inches.

2.2 Restart of the Recirculation Pump Within 30 Minutes of RPT

Review of startup test data from other BWR plants shows that restart of an idle recirculation loop is justified, if either one of the following conditions is met:

- The active loop drive flow remained above 40% of rated, or
- The active loop drive flow decreased below 40% of rated for a period less than 30 minutes.

The results from operating BWR plants provide the basis that either one of the above restart conditions will avoid lower plenum stratification, and thereby meet the intent of the Technical Specifications.

The data also justify the restart of both recirculation pumps within 30 minutes of the trip of both pumps, provided that the drive flow in either loop was above 40% of rated before the trip. This condition is applicable to RPTs following scram, or without scram. It is not applicable to events where the HPCI or RCIC injection has occurred or the feedwater injection has occurred when the final feedwater temperature is below 300°F.

The above conditions are intended for use when reliable temperature measurements may not be available to confirm that the temperature differential between the bottom of the vessel and the saturated conditions in the vessel dome is less than 145°F. If reliable temperature measurements are available, the measured temperature differential between the bottom of the vessel and the saturated condition in the vessel dome may be used to remove the restrictions related to the HPCI or RCIC injection, or the feedwater injection.

3. ATWS-RPT LEVEL SETPOINT CHANGE SAFETY ANALYSIS

3.1 Introduction

An ATWS analysis is performed with the Loss of Feedwater (LOFW) event to justify lowering the ATWS low-low level (Level 2) setpoint for RPT by approximately two feet, or to quantify an equivalent time delay, provided other Level 2 trips such as HPCI and RCIC start and Alternate Rod Insertion (ARI) remain unchanged. The feasibility of installing a slave trip unit with the existing master trip unit to accomplish this low level ATWS RPT setpoint relaxation is also evaluated.

3.2 Initial Conditions

The initial conditions for Hatch 1 and 2 are based on Cycles 15 and 11, respectively. However, the important cycle-dependent input parameters (void and Doppler coefficients) are adjusted to the generic values that are normally used for ATWS analyses in order to make the analysis cycle independent. Therefore, these initial conditions are valid for all future cycles including Power Uprate, unless a major plant change is made beyond Power Uprate, such as a change that would significantly affect HPCI capacity. Tables 3-1 and 3-2 summarize the corresponding key initial conditions.

3.3 Analysis Methods and Assumptions

The ATWS event evaluated in this analysis is Loss of Feedwater (LOFW). The LOFW event was selected since it is the only ATWS event in which the low level ATWS RPT setpoint is reached before the high pressure ATWS RPT setpoint.

Approved analytical methods (REDY) and inputs consistent with the Hatch 1 and 2 Alternate Rod Insertion (ARI) analysis are used for the LOFW ATWS analyses for the Hatch units. The HPCI and RCIC systems were assumed to start automatically on Level 2. To eliminate any considerations of the timing of ARI or boron injection, the method chosen for this analysis was to conservatively neglect ARI and SLCS boron injection. The LOFW event was run long enough to determine that the minimum water level reached during the transient was acceptable. There is no specific evaluation criterion for minimum water level during an ATWS event. However, for operational convenience it is prudent to keep the wide range level instrumentation on scale for a LOFW ATWS event. Therefore, the approach used was to iterate on the RPT low level setpoint until the minimum level during the event just reaches Level 1. If ARI or boron injection were considered, the minimum water level would be equal to or above the levels reached in this analysis.

3.4 Results

The LOFW event is initiated by an assumed loss of all feedwater at time zero. The sequence of events is shown in Tables 3-3 and 3-4. Figures 3-1 and 3-2 show the transient behavior for several of the important reactor parameters for Hatch 1 and 2 respectively.

After loss of feedwater has occurred, the reactor pressure, water level, and neutron flux begin to fall. The main driver for the neutron and heat flux declines during the first part of the event is the core inlet subcooling reduction. Once the subcooling stabilizes at its minimum value, the power also stabilizes, but there is some overshoot of neutron flux due to the timing of void and Doppler reactivity feedback. The heat flux lags the neutron flux and its response is damped due to the fuel thermal constant. Level 2 is reached at about 22 and 21 seconds for Hatch 1 and Hatch 2 respectively, which initiates HPCI and RCIC injection to recover the reactor water level. RPT is also initiated on Level 2 after a total of 10.5 second delay for both units. For the Power Uprate conditions, the same result is obtained with a time delay less than 10.5 seconds. This RPT delay is equivalent to reducing the RPT low level setpoint by 26 inches for both Unit 1 and Unit 2. The 26 inch ATWS RPT low level setpoint change is slightly more conservative (earlier RPT) than the equivalent time delay of 10.5 seconds, and covers analysis uncertainty.

The MSIVs never close because the approach used in this analysis is to iterate on the time delay for the RPT low level setpoint until the minimum water level during the event reaches just above Level 1. The recirculation pump runback is conservatively ignored for this analysis consistent with the current standard practice and the previous analyses submitted to the NRC such as the generic ATWS evaluation reported in NEDE-24222. Since the reactor pressure and heat flux does not increase above their initial values and no SRV opens, none of three primary ATWS criteria (peak vessel pressure, peak fuel cladding temperature and peak suppression pool temperature) are challenged.

3.5 Effects on Other Safety Analyses

The ECCS-LOCA analysis assume that the recirculation pumps trip and rundown early in the event. Delaying the RPT would allow the recirculation pumps to run longer before coast down, which keeps the fuel cooler. Therefore, the ECCS-LOCA analysis will be more conservative, and does not need to change.

The plant transient (MCPR) analysis is not affected by the lowering of the Level 2 setpoint. The normal scram occurs well before the Level 2 setpoint is reached whether the setpoint has been lowered or not. This prevents the Level 2 change from affecting MCPR. Regardless, the transient analysis is continuously updated (as needed), and the results are incorporated into the Core Operating Limits Report (COLR).

The plant radiological analyses are totally independent from ATWS-RPT, and thus, these analyses can not be affected.

3.6 Conclusions

The low level RPT setpoint relaxation is justified at both Hatch units based on the LOFW ATWS analyses performed with the REDY analytical methods. The LOFW ATWS event remains as a non-limiting event with respect to any of the three primary ATWS acceptance criteria (peak vessel pressure, peak suppression pool temperature and peak fuel cladding temperature). Lowering the RPT level makes all the existing Loss-Of-Coolant-Accident (LOCA) analyses conservative because the recirculation pump provides additional cooling. All other plant transients are bounded by the ATWS event. Therefore, the low level RPT setpoint may be relaxed using the above ATWS analysis. On the basis of the results obtained from several iterative cases, the maximum allowable low water level RPT relaxation is calculated to be 2 feet 2 inches for Hatch 1 and 2. Installing a slave trip unit with the existing master trip unit for low water level setpoint indication and initiation will reduce the probability of the reactor coolant stratification without affecting plant safety.

Table 3-1

INITIAL OPERATING CONDITIONS FOR HATCH 1

(Provided in GE Proprietary version.)

Table 3-2

INITIAL OPERATING CONDITIONS FOR HATCH 2

(Provided in GE Proprietary version.)

Table 3-3

SEQUENCE OF LOSS OF FEEDWATER EVENT FOR HATCH 1

(Provided in GE Proprietary version.)

Table 3-4

SEQUENCE OF LOSS OF FEEDWATER EVENT FOR HATCH 2

(Provided in GE Proprietary version.)

(Provided in GE Proprietary version.)

Figure 3-1. ATWS RPT Transient Results of Hatch 1 for Loss of Feedwater Event
(Note: HPCI Flow Indicated is Half the Actual HPCI Flow)

(Provided in GE Proprietary version.)

Figure 3-2. ATWS RPT Transient Results of Hatch 2 for Loss of Feedwater Event
(Note: HPCI Flow Indicated is Half the Actual HPCI Flow)

4. SAFETY ASSESSMENT OF THE RECIRCULATION PUMP RESTART

Allowing restart of a recirculation pump within 30 minutes of a RPT (with no HPCI/RCIC injection and no feedwater injection below 300°F) helps prevent thermal stratification at the bottom of the RPV, and maintains RPV ΔT within the 145°F limit. Therefore, the proposed change helps maintain the integrity of the reactor coolant pressure boundary (RCPB), and has no effect on any plant safety analysis.

5. ASSESSMENT AGAINST 10CFR 50.92 CRITERIA

For this significant hazards consideration assessment the criteria of 10CFR 50.92 were applied to (1) changing the ATWS-RPT low-low water level trip setpoint to Level 2 - 26 inches and (2) allowing the restart of a recirculation pump within 30 minutes of a RPT with no HPCI/RCIC injection and/or no feedwater injection below 300°F. The conclusions are based on the evaluations provided in this report, and are summarized as appropriate to the following safety considerations in accordance with 10CFR 50.92.

1) **Will the change involve a significant increase in the probability or consequences of an accident previously evaluated?**

   NO: The changes discussed herein will not significantly increase the probability or consequences of an accident previously evaluated.

   The probability (frequency of occurrence) of Design Basis Accidents occurring are independent of the ATWS-RPT, and all regulatory criterion established for plant equipment (e.g., IEEE standards, etc.) will still be imposed. Therefore, the probability of an accident will not increase.

   As the recirculation restart procedural change helps maintain the integrity of the RCPB, this change can not increase the probability of any accident previously evaluated.

   The plant accident radiological analyses are totally independent from both proposed changes, and thus, these analyses can not be affected by the change. Therefore, there will be no increase in the consequence of any accident previously evaluated.

2) **Will the change create the possibility of a new or different kind of accident from any accident previously evaluated?**

   NO: As summarized below, these changes will not create the possibility of a new or different kind of accident from any accident previously evaluated.

Equipment that could be affected by the ATWS-RPT setpoint change, the addition of a new slave trip unit and the recirculation restart procedural change have been evaluated. The new equipment is functionally identical to equipment already in use at Hatch. No new plant operating mode, safety-related equipment lineup, accident scenario, or equipment failure mode was identified. Therefore, the proposed equipment and Technical Specification changes can not create the possibility of a new or different kind of accident.

3) **Will the change involve a significant reduction in a margin of safety?**

NO: The ATWS-RPT setpoint change and the addition of a new slave trip unit will not involve a significant reduction in a margin of safety, as plant equipment and reactions to ATWS events, transients and hypothetical accidents will not change or will not result in exceeding the presently approved NRC acceptance limits. Allowing the restart of a recirculation pump within 30 minutes of a RPT (with no HPCI/RCIC injection and/or no feedwater injection below 300°F) has no effect on any plant safety analysis.

The changes will reduce the probability of reactor coolant stratification, and thus, helps ensure the integrity of the reactor coolant pressure boundary.

Delaying the RPT will provide a small improvement in core cooling during a LOCA, and thus, the current ECCS-LOCA analysis will become slightly more conservative.

After reducing the low water level RPT by 26 inches, there will still be >75 inches in water level margin to the TAF.

Consistent with current practices, any changes (none expected) to the MCPR operating limits will be accounted for in the COLR.

Conclusions

This assessment has investigated reducing the ATWS-RPT Technical Specification trip setpoint from reactor water low-low level 2 (Level 2) to Level 2 - 26 inches, examined adding a new slave trip unit to implement the setpoint change, and examined allowing the restart of a recirculation pump within 30 minutes of a RPT (with no HPCI/RCIC injection and/or no feedwater injection below 300°F). The plant licensing challenges have been evaluated and demonstrate that these changes can be accommodated without a significant increase in the probability or consequences of an accident previously evaluated, without creating the possibility of a new or different kind of accident from any accident previously evaluated, and without a significant reduction in a margin of safety. Having arrived at negative declarations with regards to the criteria of 10CFR 50.92, this assessment concludes that the ATWS-RPT Technical Specification trip setpoint change to Level 2 - 26 inches and its associated equipment changes, and that allowing for the restart of a recirculation pump within 30 minutes of a RPT (with no HPCI/RCIC injection and/or no feedwater injection below 300°F) do not involve a Significant Hazards Consideration.

Attachment A

Requested Changes To Appendices A To Operating Licenses Nos. DPR-57 and NPF-5, Safety Technical Specifications For Edwin I. Hatch Nuclear Plant Units 1 and 2

Table 3.2-9

INSTRUMENTATION WHICH INITIATES RECIRCULATION PUMP TRIP

Ref. No. (a)	Instrument	Trip Condition Nomenclature	Required Operable Channels per Trip System	Trip Setting	Remarks
1.	Reactor Vessel Water Level (ATWS RPT)[g]	Low (Level 2) -26 inches	2[b][f][g]	≥ 47 (73) inches H_2O	Power must be reduced and the mode switch placed in a mode other than the RUN Mode.
2.	Reactor Pressure (ATWS RPT)	High	2[b][f][g]	≤1095 psig	Power must be reduced and the mode switch placed in a mode other than the RUN Mode.
3.	EOC - RPT[d]	1. Turbine Stop Valve Closure 2. Turbine Control Valve Fast Closure	2[b][f][e]	1. Stop Valve ≤90% Open 2. Control Valve Hydraulic Press Trip Point	Trips recirculation pumps on turbine control valve fast closure or stop valve closure when reactor is > 30%.[h]

(a) The column entitled "Ref. No." is only for convenience so that a one-to-one relationship can be established between items in Table 3.2-9 and items in Table 4.2-9.

(b)1. Whenever the reactor is in the RUN Mode, there shall be two operable trip systems for each parameter for each operating recirculation pump. If the required number of operable channels cannot be met for one of the trip systems, place the inoperable channel in the tripped condition or take the indicated action within 14 days. If the required number of operable channels cannot be met for both trip systems, take the indicated action within 1 hour.

(b)2. One instrument channel may be inoperable for up to 6 hours to perform required surveillances prior to entering other applicable actions.

(c) Anticipated Transients Without Scram - Recirculation Pump Trip

(d) End of Cycle - Recirculation Pump Trip

(e) Either of these two EOC - RPT systems can trip both recirculation pumps. Each EOC - RPT system will trip if 2-out-of-2 fast closure signals or 2-out-of-2 stop valve signals are received.

(f)1. The requirement for these channels applies from EOC-2000 MWD/t to EOC. The RPT system may be placed in an inoperable status for up to 2 hours to provide the required monthly surveillance. If one EOC-RPT system is inoperable for longer than 72 hours or if both EOC-RPT systems are simultaneously inoperable, an orderly power reduction will be immediately initiated and reactor power will be <30% within the next 6 hours.

(f)2. One instrument channel may be inoperable for up to 6 hours to perform required surveillances prior to entering other applicable actions.

(g) Either of these two ATWS-RPT systems can trip both recirculation pumps. Each ATWS-RPT system will trip if 2-out-of-2 reactor low water level signals or 2-out-of-2 reactor high pressure signals are received.

Amendment No. 76, 103, 169, 185

TABLE 3.3.9.1-2

ATWS RECIRCULATION PUMP TRIP SYSTEM INSTRUMENTATION SETPOINTS

TRIP FUNCTION	TRIP SETPOINT	ALLOWABLE VALUE
1. Reactor Vessel, Water Level - Low Low, Level 2 -26 inches	≥ ~~-47~~ -73 inches *	≥ ~~-47~~ -73 inches
2. Reactor Vessel Pressure - High	≤ 1095 psig	≤ 1095 psig

*See Bases Figure B3/4 3-1.

REACTOR COOLANT SYSTEM

IDLE RECIRCULATION LOOP STARTUP

LIMITING CONDITION FOR OPERATION

3.4.1.3 An idle recirculation loop shall not be started unless the temperature differential between the reactor coolant within the dome and the bottom head drain is ≤ 145°F, and

a. The temperature differential between the reactor coolant within the idle loop to be started up and the coolant in the reactor pressure vessel is ≤ 50°F when both loops have been idle, or

b. The temperature differential between the reactor coolant within the idle and operating recirculation loops is ≤ 50°F when only one loop has been idle, and the operating loop flow rate is ≤ 50% of rated loop flow.

APPLICABILITY: CONDITIONS 1, 2, 3 and 4.

ACTION:

With temperature differences and/or flow rate exceeding the above limits, suspend startup of any idle recirculation loop.

SURVEILLANCE REQUIREMENTS

4.4.1.3 The temperature differential and flow rate shall be determined to be within the limit within 30 minutes prior to startup of an idle recirculation loop.

Alternatively, the restart of the recirculation pumps is allowed within 30 minutes of a pump trip, if no HPCI, RCIC or feedwater (with feedwater temperature < 300°F) injection occurred, and provided that the recirculation flow prior to the trip was sufficient to prevent stratification.

LIMITING CONDITIONS FOR OPERATION	SURVEILLANCE REQUIREMENTS
3.6.E. Recirculation Pump Start The reactor recirculation pumps shall not be started unless the coolant temperatures between the dome and the bottom head drain are within 145°F.	4.6.E. Recirculation Pump Start Prior to starting a recirculation pump, the reactor coolant temperatures in the dome and in the bottom head drain shall be compared and permanently recorded.

Alternatively, the restart of the recirculation pumps is allowed within 30 minutes of a pump trip, if no HPCI, RCIC or feedwater (with feedwater temperature < 300°F) injection occurred, and provided that the recirculation flow prior to the trip was sufficient to prevent stratification.