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SUBJECT: Forwards response to RAI re reactor feedwater pump trip test & reactor scram which occurred on 970327.Listing of recommendations for Event Evaluation Team & Independent Evaluation Team,encl.

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June 25, 1997
GO2-97-131

Docket No. 50-397

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

Gentlemen:

Subject: **NUCLEAR PLANT WNP-2, OPERATING LICENSE NPF-21 REACTOR FEEDWATER PUMP TRIP TEST RESPONSE TO QUESTIONS**

Reference: Letter, dated June 4, 1997, TP Gwynn (NRC) to JV Parrish (SS), "Summary of Meeting with Washington Public Power Supply System (WNP-2) on May 30, 1997"

This letter provides our response to the requested information in the referenced letter pertaining to the reactor feedwater pump trip test and reactor scram which occurred on March 27, 1997. The Supply System was requested to address certain items prior to WNP-2 leaving Operational Mode 4 and entering Operational Mode 2 for startup.

Our response consists of this letter and Attachments A and B. In Attachment A, responses to each of the six items pertaining to the reactor feedwater pump test are provided. Attachment B consists of a listing of recommendations from the Event Evaluation Team (EET) and the Independent Evaluation Team (IET) and the planned response to these recommendations.

As a result of divergent findings or recommendations resulting from the IET review of preliminary results from the EET, an additional evaluation of plant response to the event was performed. The results of this evaluation were incorporated as an addendum to the final EET report.

Additional insight into the factors that contributed to the differential temperature cavitation interlock trip which preceded the manual scram is provided in the addendum. The major contributors were the effect of the conservatism in the trip logic implemented during the Adjustable Speed Drive (ASD) modification and the final power and flow conditions of the Reactor Recirculation (RRC) System pump runback. These were estimated to reduce the differential temperature margin by 1.5 to 2.0 degrees Fahrenheit and 1.5 degrees Fahrenheit, respectively.

A001

Also evaluated was the effect of power uprate and digital feedwater on differential temperature reduction. These were shown to be less significant, at 0.5 and 0.3 degrees Fahrenheit respectively. Finally, the impact of the difference in runback rates between flow control valve and ASD runback rates were confirmed to be a smaller contributor to loss of differential temperature margin. Details of the various parameters that potentially could have impacted the differential temperature cavitation interlock are contained in the addendum to the final EET report.

Should you have any questions or desire additional information pertaining to this letter, please call me or P.J. Inserra at (509) 377-4147.

Respectfully,

P.R. Bemis
Vice President, Nuclear Operations
Mail Drop PE23

Attachment

cc: EW Merschoff - NRC RIV
KE Perkins, Jr. - NRC RIV, Walnut Creek Field Office
TG Colburn - NRC NRR
NRC Senior Resident Inspector - 927N
DL Williams - BPA/399
PD Robinson - Winston & Strawn

The Supply System was requested to address the following items prior to WNP-2 leaving Operational Mode 4 and entering Operational Mode 2 for startup. For ease of reference, a restatement of each item is provided.

Item 1 **"When will the IET review of the final EET report be completed?"**

On June 20, 1997 the IET completed its review of the final EET report along with the report addendum and the proposed responses to items one through four of this attachment.

The IET concluded that the subsequent followup effort resulting in the final EET report and associated addendum adequately addresses the concerns identified in the IET report. Specifically, the EET has provided information to validate the causes for the event.

With respect to the IET recommendations, the Supply System has accepted the recommendations and has provided a schedule for resolving them. The two issues which could potentially impact reactor startup (i.e., rerun of the reactor feedwater pump test and analyze plausible causes for the event) are considered closed as a result of actions taken and planned by the Supply System. The planned actions for the remaining recommendations will be adequately resolved as part of the ongoing activities related to the event.

A separate assigned team, including a supervisor, has been established to implement and close all open issues related to the ASD and DFWLC systems.

Item 2 **"Based on questions raised by the IET regarding the thoroughness of the adjustable speed drive transient analysis with respect to the modifications, please provide your actions or plans for a thorough engineering and/or operational design feature review of the digital feedwater and adjustable speed drives and the power uprate modification. This integrated review should ensure that other operating parameters, similar to the reactor recirculation system delta temperature cavitation interlock, were not impacted by these changes."**

The original design and analysis for the Adjustable Speed Drive (ASD) and reactor power uprate (RPU) modifications were performed as an integrated product. Letter GE-NE-189-33-0392, "Preliminary Design of WNP-2 Recirculation Adjustable Speed Drive," dated March 1992, states in the first paragraph of the Introduction Section, "The preliminary design of the ASD implementation for the WNP-2 Reactor Recirculation System is developed to be consistent with the ASD & Power Uprate projects." As such, the integration of

these two projects started during the preliminary design phase. In fact, separation of the two projects had to be made to allow RPU to be implemented in 1995 with the ASD modification implemented in 1996. This split was performed due to a lack of sufficient resources to complete both projects within the same year and during the same refueling outage. During the design phase of the Digital Feedwater Level Control System (DFWLC), design inputs considered that both the ASD and RPU modifications were in place.

The Supply System's Event Evaluation Team (EET) performed a review of the design requirements for the DFWLC and ASD systems. The Independent Evaluation Team (IET) reviewed the EET preliminary results and questioned the thoroughness of the work completed at that time, particularly with respect to the evaluation of the integration of the DFWLC, ASD and RPU changes made at WNP-2. A description of the additional integrated review performed is provided below.

The Supply System's EET reviewed the impact of the DFWLC and ASD modifications, verses the analog feedwater level control system and analog recirculation flow control system, on plant design. In particular, the EET evaluated the following transients, anticipated operational occurrences, and events and the potential impact of the ASD and DFWLC systems on these events:

a. Transient MCPR Control - FCV Failure
b. Transient MCPR Control - Idle Recirculation Pump Start-up/Recirculation Speed Changes
c. Recirculation Pump Trip System
d. SCRAM Avoidance - Core Flow Increases
e. SCRAM Avoidance - Loss Of Reactor Feedwater Pump
f. Equipment Protection - Cavitation Interlocks
g. Equipment Protection - Valve Interlocks
h. Loop Mismatch
i. Maintain Core Circulation - Reactor Recirculation System (RRC) 60 Hz Trip
j. Anticipated Transient Without SCRAM (ATWS)

In response to an IET concern regarding the completeness of the review performed by the Supply System's EET, the Supply System, in conjunction with senior members of the General Electric Nuclear Engineering (GENE) staff, performed a review of other operating parameters to ensure that they were not negatively impacted by the ASD/DFWLC/RPU modifications in a manner not evaluated as part of the modifications. Specifically, based on direction provided by the Supply System's Engineering organization, GENE engineers performed a review and submitted their preliminary results to the Supply System for review and comment.

Following Supply System comments, additional evaluation was performed by GENE and the final results and concerns were provided to the Supply System. For each of the operating parameters reviewed, consideration was given to the integrated impact of the three modifications. The results of the GENE review are consistent with those obtained during Supply System reviews.

For the RPU modification, the review group looked at the following operating parameters. Each of these parameters were included in the RPU analyses as part of the RPU modification.

APRM flow biased simulated thermal power-high scram setpoint

Reactor vessel steam dome pressure-high setpoint

APRM flow bias simulated thermal power-upscale scram setpoint equation

Neutron flux-upscale control rod block trip setpoint equation

Main steam line high pressure setpoint

Rod Block Monitor instrument flow biased setpoint

Revised Group 1 SRV setpoints and the setpoint maximum tolerances to reflect the RPU and SRV setpoint analyses

Revised reactor pressure vessel pressure-temperature curves for RPU

Required number of ADS valves required reduced by one for RPU

Turbine first stage pressure scram bypass remains at 30% reactor power

Main steam line flow differential pressure setpoint revised

Reactor pressure vessel operating steam dome pressure raised

Reactor power raised to 3486 MWt

Credited operating pressure for High Pressure Core Spray (HPCS) was raised

Rated feedwater flow was evaluated

Rated steam flow was evaluated

The runback rate for the Extended Load Line Limit was analyzed as part of the RPU and again as part of the ASD modification

For each of the RPU impacted operating parameters listed above, the review group evaluated the parameters relative to changes caused by DFWLC and ASD. No additional impacts were identified.

For the DFWLC and ASD modifications, the review group looked at the following:

a. The recirculation flow runback characteristics were changed since they were previously based on flow control valve position and closure speed With the ASD modification, these characteristics are based on pump speed. This change was previously analyzed and determined to have no appreciable effect.

b. An ASD overfrequency trip was added to terminate the flow runout event. There is a separate overfrequency trip circuit for each of the RRC pumps. This should have no effect on the other parameters or events since it stops a transient from progressing.

c. Cavitation Interlock changes

   1. Setpoints - no changes

   2. Logic - designed to be more conservative since the worst case differential temperature is selected, this is conservative from a cavitation prevention point of view, but it also results in a slight increase in the probability of a recirculation pump runback to 15 Hz and entry into Region A of the Power-to-Flow Map. The cavitation runback is a non-safety-related equipment protection feature.

   3. Removed the feedwater flow cavitation runback logic

4. Changed from an analog design to a more accurate digital design as part of the ASD modification

d. The single feedwater pump trip recirculation pump runback endpoint and rate of runback were changed from flow control valve position and rate of change to a recirculation pump speed end point and rate of change. The setpoints were developed through a series of parametric studies as part of the ASD design effort.

e. Added ASD equipment protection trips. These should have no effect on other parameters since they are bounded by the recirculation pump trip analysis. The recirculation pump trip is an anticipated operational occurrence that does not result in a plant scram or have other adverse operational impacts.

f. One channel runback capability for loss of a single channel in one ASD. This does not effect any other parameters in an unanalyzed way since it is bounded by the recirculation pump trip analysis. The recirculation pump trip is an anticipated operational occurrence that does not result in a plant scram or have other adverse operational impacts.

g. Jet pump sensing line clamps were added for the variable pump speeds (and thus pump vane passing frequencies) that would be encountered. This does not effect the other parameters.

h. The recirculation flow control valves were locked open. The ASD analysis was performed with the ASDs instead of the flow control valves providing flow control.

i. Electrical bus harmonics were evaluated to determine the effects of the ASDs. Acceptable conditions were verified for the electrical distribution system and connected equipment.

j. The recirculation system runback lower limit for a single feedwater pump trip was lowered. This impacted the cavitation interlock. None of the other operating parameters were impacted.

k. An evaluation of the effect of fault logic or signal noise (transition to single element flow control) was not specifically analyzed. However, these changes were implemented to reduce the impact of equipment failure or degradation, and thus provide for improved system performance. Operation in single element control is a condition that was previously analyzed.

l. The DFWLC system was designed to fully open the feedwater pump minimum flow bypass valves back to the condenser for 30 seconds following a scram and then to ramp these valves closed. This change was implemented to reduce the potential for a high reactor water level (level 8) due to swell following a scram. This change was evaluated as part of the 10CFR50.59 Safety Evaluation for the DFWLC system. Additional analysis has recently been performed and it was determined that this valve action has little effect in avoiding the Level-8 trip, and does not adversely impact plant performance following a scram.

m. The quasi-steady state behavior of the differential temperature cavitation interlock was previously analyzed. However, the dynamic evaluation of the instrument system was not previously analyzed for impact from ASD, DFWLC, and RPU. Significant analysis has now been performed and an interim modification to the differential temperature cavitation interlock will be implemented prior to plant restart from the current maintenance and refueling outage. This includes a change to the current time delay from 15 seconds to 10 minutes. Plant procedures will be revised to reflect this change and to provide plant personnel with the information necessary to ensure that the fatigue usage of 15 minutes for the remaining life of the plant for the jet pumps is not exceeded due to cavitation. This modification may become permanent pending the results of followup cavitation logic change review efforts.

   The differential temperature setpoint will be increased from 9.9 degrees Fahrenheit to 10.7 degrees Fahrenheit. Although original evaluations resulted in a setpoint of 10.7 degrees Fahrenheit, it was determined based on initial power ascension testing results that 9.9 degrees Fahrenheit was acceptable. Subsequent increased core flow and power uprate analyses concluded that the original evaluations remain valid and no setpoint changes were required. Based on followup assessments, the setpoint is being changed to 10.7 degrees Fahrenheit.

As discussed above, the evaluations of the operating parameters and the potential impact of the ASD, DFWLC and RPU modifications did not identify adverse effects to these parameters not previously evaluated, except for the delta T cavitation interlock.

A preliminary review has been completed and did not identify any additional tests that need to be re-run to validate the initial startup test program results. In addition, after startup an evaluation will be completed of the FSAR Chapter 14 initial power accession startup test program acceptance criteria to ensure that the changes implemented by ASD, DFWLC and RPU did not impact the initial

[illegible]
[illegible]

[illegible]
[illegible]

startup test program results and conclusions.

Item 3 **"What evaluations will be performed to integrate the IET and EET findings regarding the adjustable speed drive modification and the digital feedwater problems identified in Problem Evaluation Report (PER) 297-0246?"**

The concern regarding occurrence of the post-scram high water Level-8 trip was specifically not part of the EET charter and has not been addressed by the EET or IET. Resolution of this problem is being tracked by the Problem Evaluation Request (PER) process.

Since initial startup of WNP-2, several design changes have been implemented to improve the chances of avoiding a Level-8 trip following a scram. These include setdown of the vessel level setpoint following a scram, reduction of the minimum steady-state feedwater pump governor speeds and, most recently, with the addition of the DFWLC system, momentary opening of the feedwater pump minimum flow bypass to condenser valves upon a scram to reduce the vessel refill rate.

Preliminary evaluations determined that each of the design change features operated correctly and sluggish governor valve actuation had caused the Level-8 trip. General Electric and Lovejoy Controls, Inc., assisted Supply System Engineering in reviewing the feedwater turbine response. Based on available data, it was concluded that the Digital Feedwater Level Control (DFWLC) System appeared to function correctly. Initial analyses indicated that a sluggish relay valve was the most likely cause of vessel level reaching Level-8. Based on the recommendations, testing and intrusive investigations were completed and found the relay valves in both Reactor Feedwater Pump Turbines A and B to be sluggish and scored. The relay valves were removed, polished and cleaned and confirmed to be working properly. A representative from Lovejoy Controls, Inc., was on site during the relay valve work effort. The cause of the problem appears to be less than adequate filtration in the feedwater pump turbine oil system.

To further determine the most likely cause of the Level-8 trip, computer (RETRAN) simulations, specific to WNP-2, were recently completed by the Supply System to evaluate the effectiveness of these enhancements as well as to quantify the effect of the sticking relay valve. Results determined that each had minimal effect in either causing, or avoiding, the Level-8 trip point. In fact, the only effective means of avoiding vessel overfill was determined to be improvement in the responsiveness of the governor controller following a scram. The required changes are complex. These changes will continue to be evaluated after reactor startup and a remedy implemented at the first future window of

appropriate plant conditions.

In order to assess the impact of continued operation of the plant without resolution of this problem, an assessment of the safety significance was performed. Results determined that a post-scram Level-8 trip of this type does not represent a safety concern. Additional actions may be required to preclude or recover from a Level-8 trip. However, plant operators are trained that a Level-8 trip following a scram may occur. This training includes actions that can be taken to either avoid the trip or respond accordingly should a trip occur.

Item 4 **"Provide an accounting for each of the EET and IET recommendations. This accounting should provide a direct correlation between the recommendation, its acceptance or denial, whether the action is complete or its status, and whether the recommendation actions will be implemented prior to plant restart."**

The Supply System response to this question is provided as Attachment B and contains the EET and IET recommendations. In each case, the recommendations have been accepted and entered into the Plant Tracking Log. Completed actions have been identified as well as those which will be completed prior to reactor startup.

The criteria for completion before startup include items that would adversely affect plant safety or clearly decrease plant reliability or capability. Corrective actions that met this criteria are identified as items that require completion before the end of the R-12 Maintenance and Refueling Outage.

Item 5 **"Determine whether the installed adjustable speed drive modification resulted in an unreviewed safety question and whether an additional submittal will need to be reviewed by the NRC modifying the previous safety evaluation. Your response should also include whether the planned delta T cavitation interlock setpoint resolution will require NRC review and approval."**

1. Plant Response to the Event

For the purposes of an unreviewed safety question determination, the activity is defined as the plant response to the reactor feedwater pump trip test event. This includes the differential temperature cavitation interlock trip and associated reactor recirculation pump runback, indicated entry into Region A of the Power-to-Flow Map, and water level response.

The cavitation interlock protects the recirculation pumps and jet pumps from cavitation damage. The interlock signal is the differential temperature between the steam dome temperature (derived from steam dome pressure measurement) and the recirculation pump suction temperature. Increasing the pump speed above the minimum value is prevented if the temperature difference is less than the setpoint. Similarly, the pumps are automatically run back to the minimum speed if the setpoint is reached. Minimum speed is below the cavitation threshold.

Followup sensitivity evaluations were performed that considered the effect of changes in various parameters and plant characteristics as a result of implementation of power uprate and the ASD and DFWLC modifications. These analyses further defined the extent to which final test conditions, a more conservative trip logic, and other variables, combined to reduce overall operating margin during the trip test. However, initiation of the interlock and subsequent runback of the RRC pumps to 15 Hz is bounded by the more severe and previously-analyzed trip of two recirculation pumps transient.

Reactor recirculation system flow run-back and recirculation pump trip events leading to entry into stability Region A of the WNP-2 Power-to-Flow Map were considered in establishing the stability region boundaries. Response to entry into Region A of the Power-to-Flow Map is controlled by Technical Specification 3.4.1, "Recirculation Loops Operating." Compliance with the limiting condition for operation action statements in this specification, in the event of entry into Region A, assures that a USQ does not exist.

It was recognized during development of the stability region that there is reasonable probability that unplanned operational occurrences, most notably recirculation pump trips and run-backs, could lead to entry into the stability region. The region definitions account for entry into the region as a result of a core flow reduction, independent of the probability of occurrence of such a reduction in core flow.

As an aside, the Supply System has committed to implement Stability Solution Enhanced Option I-A. General Electric Licensing Topical Report NEDO-32339-A, "Reactor Stability Long-Term Solution: Enhanced Option I-A," Revision 0, was developed to provide a methodology for prevention of reactor instabilities. The NRC determined that Enhanced Option I-A was acceptable for referencing in license applications to the extent specified, and under the limitations delineated in NEDO-32339 and the associated NRC technical evaluation.[1]

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1 Letter and Safety Evaluation, RC Jones (NRC-NRR) to RA Pinelli (BWROG), "Acceptance for Referencing of Topical Report NEDO-32339, Reactor Stability Long term Solution: Enhanced Option I-A (TAC M89222)," dated April 24, 1995

In the Topical Report, it was recognized that the establishment of the Exclusion and Restricted Regions assures stability at anticipated terminal reactor state conditions following plant transients. It was stated in the report that transients that result in limiting reactor stability conditions are loss of feedwater and core flow reduction events.

Events whose reactor state trajectories would enter the Exclusion Region terminate with automatic reactor scram at the region boundary. The treatment of events that terminate within the Restricted Region depends upon whether they initiate inside or outside of the Restricted Region.

In a followup to the Topical Report, it was also recognized that flow reduction events may have a significant effect on reactor stability performance.[2] Examples of flow reduction events are one or two reactor recirculation pump trips, reactor recirculation pump runbacks, and reactor recirculation flow control valve runbacks.

However, the specific mechanism causing these events is irrelevant. Reasonably limiting flow reduction events considering the combination of all parameters affecting stability performance are defined for the stability region boundary validation analyses.

The ASD and DFWLC system response pre-scram to the feedwater pump trip and subsequent recirculation flow runback was as expected with regards to the reactor vessel water level and did not result in a Level-3 scram. As the feedwater flow stabilized out, the reactor vessel level swelled and peaked at slightly over 51 inches, avoiding a Level-8. Initiation of a feedwater pump trip not initiating a reactor trip indicates that the control system response does not increase the probability of a more severe transient resulting from an operational event. Other, less limiting, operational events are analyzed in the General Electric ASD control system report and are shown not to degrade due to ASD and DFWLC system response. Therefore, less limiting transients do not become additional transients for FSAR analysis.

The post-scram response is not dissimilar to what would have been seen with the previous analog system. Since the Level-8 trip was reached post-scram, there was no adverse impact on the fuel thermal limits. For long term cooling and inventory make-up, the High Pressure Core Spray (HPCS) System would be available once the water level lowered to the initiation setpoints. Therefore, the

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2 NEDO-32339, Revision 1, "Licensing Topical Report - Reactor Stability Long-Term Solution: Enhanced Option I-A," dated December 1996

transients in the FSAR are still bounding and, as a result, the consequences of an accident as analyzed in the FSAR were not increased. The Reactor Core Isolation Cooling (RCIC) System would also be available once the water level lowered.

In conclusion, this situation does not result in a condition where 1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased, or 2) a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created, or 3) the margin of safety as defined in the basis for any technical specification is reduced.

2. Differential Temperature Cavitation Interlock

With regard to the cavitation interlock, the following changes to the differential temperature logic for reactor recirculation flow control system cavitation protection are planned:

- Differential Temperature Setpoint

  The differential temperature setpoint will be increased from 9.9 degrees Fahrenheit to 10.7 degrees Fahrenheit.

- Differential Temperature Setpoint Reset

  The differential temperature setpoint reset will be increased from 10.9 degrees Fahrenheit to 11.2 degrees Fahrenheit.

- Differential Time Delay to Runback

  The differential time delay to runback will be increased from 15 seconds to ten minutes.

- Alarm Features

  Alarm annunciation will be changed from actual runback initiation to the start of the timing period.

The cavitation interlock protects the recirculation pumps and jet pumps from cavitation damage. The interlock signal is the differential temperature between the steam dome temperature (derived from steam dome pressure measurement) and the recirculation pump suction temperature. Increasing the pump speed above the minimum value is prevented if the temperature difference is less than the

[illegible]
[illegible]

setpoint. Similarly, the pumps are automatically run back to the minimum speed if the setpoint is reached.

The cavitation interlock setpoint is being changed to reflect calculated values, includes margin, and accounts for the high cavitation conditions which would be experienced under increased core flow. Increasing the existing time delay will result in the avoidance of unnecessary reactor recirculation system pump speed runbacks. The alarm logic is being changed to initiate the alarm when the cavitation setpoint is exceeded, rather than the current design of after the time delay.

Although original evaluations resulted in a setpoint of 10.7 degrees Fahrenheit, it was determined based on initial power ascension testing results that 9.9 degrees Fahrenheit was acceptable. Subsequent increased core flow and power uprate analyses concluded that the original evaluations remain valid and no setpoint changes were required. Based on followup assessments, the setpoint is being changed to 10.7 degrees Fahrenheit.

The allowable 10-minute time for operating under cavitation conditions at WNP-2 is based on the measured test results during a cavitation event at a BWR-4 plant with a 251-inch diameter vessel, and additional conservatisms to allow for the test results being consistent with a BWR-5. It was concluded from testing and calculations that the cumulative time allowable for cavitations would be 15 minutes (cumulative for each pump for the remaining life of the plant), taking into account the presence of jet pumps with set screw gaps in the past.

The recirculation flow control system does not perform any active safety function. The primary relation of the system to the licensing basis analysis is as an initiator of events. The proposed modification changes provide adequate equipment protection against cavitation damage.

The proposed change does not alter assumptions made in the licensing basis documents pertaining to reactor recirculation system pump response during transients or accidents. The jet pumps are part of the reactor recirculation system and are designed to provide forced circulation through the core to remove heat from the fuel. Because the jet pump suction elevation is at two-thirds core height, the vessel can be reflooded and coolant level maintained at two-thirds core height even with the complete break of the recirculation loop pipe that is located below the jet pump suction elevation.

The capability of reflooding the core to two-thirds core height is dependent upon the structural integrity of the jet pumps. Structural failure or system degradation could adversely affect the water level in the core during the reflood phase of a

Loss of Coolant Accident (LOCA), as well as the assumed blowdown flow during a LOCA.

However, a malfunction of a jet pump is considered in the Technical Specifications. The Technical Specifications include daily surveillance requirements which are designed to detect jet pump failure and provide action statements should a jet pump failure be indicated. The presence of cavitation would not impact the ability of the surveillance to detect a jet pump failure.

The changes, which were proposed and accepted by the Supply System and endorsed by General Electric, provide for avoiding recirculation pump runbacks caused by false indication of cavitation conditions or by a setpoint that is inappropriate during some operating conditions. This will also allow Control Room Operators time to validate the alarm and determine if it is the result of an actual condition or the result of spurious component failures or other problems.

In conclusion, this situation does not result in a condition where 1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased, or 2) a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created, or 3) the margin of safety as defined in the basis for any technical specification is reduced. Therefore, prior NRC review would not be required.

Item 6 **"Will the reactor feedwater pump trip test be rerun? If yes, then at what initial conditions and on what schedule?"**

The Supply System plans to rerun the feedwater pump trip test. Initial conditions will be consistent with those from the WNP-2 Power Ascension Test Program, i.e., greater than 95 percent of thermal power. The testing is planned to be performed as a part of power ascension testing at the completion of the R-12 Maintenance and Refueling Outage and in accordance with Plant Procedure (PPM) 8.3.339, "Test Instruction - Reactor Recirculation Adjustable Speed Drive and Reactor Digital Feedwater Control Power Ascension Test Program."

The current sequence in the power ascension testing schedule for this test is as soon as practical after the completion of stable full power operation and required 100-percent-power calibrations and tests.

The listing below contains all EET and IET recommendations. In all cases the recommendations have been accepted and entered into the Plant Tracking Log. Completed actions have been identified as well as those which will be completed prior to reactor startup (RXSU). Other actions will be completed after startup (ARXSU).

The criteria for completion before startup include items that would adversely affect plant safety or clearly decrease plant reliability or capability. Corrective actions that met this criteria are identified as items that require completion before the end of the R12 outage.

Recommendations

Item	Recommendations	Date
1.	ΔT Cavitation Setpoint and Methodology	RXSU

The GE Factory Automatic Numeric Controls (FANUC) system compares inputs from the four RTD's suction temperatures with inputs from two reactor steam dome pressure inputs. The FANUC determines the differential temperature (ΔT) by selecting the highest temperature input and the lowest pressure input. The following actions are recommended with respect to the 9.9°F setpoint and the methodology :

a. Given the capability inherent in the ASD system, evaluate whether a more effective ΔT cavitation protection method can be designed and implemented.

b. If a more effective ΔT cavitation protection method cannot be provided, then evaluate through analysis whether to use the 10.7°F setpoint recommended by GE or the 9.9°F setpoint determined by the Supply System in the interim and document the basis for this decision. Further, determine whether or not a higher setpoint can be implemented to provide greater operating margin while still providing protection to the jet pumps.

c. Need to decide or clarify whether the setpoint is a trip setpoint or an analytical limit.

d. If it is a setpoint, the analytical limit and the accuracy/drift for the temperature and pressure loops need to be defined.

e. If it is an analytical limit, a calculation needs to be performed to determine the trip setpoint.

2. 15 Second Time Delay RXSU

Analysis needs to be performed to evaluate increasing the time delay and provide justification that the resulting time delay is short enough to prevent excessive damage to the jet pumps from cavitation and long enough for the system to stabilize following a transient which could activate the cavitation interlock.

3. Alarm Logic RXSU

The alarm logic should be changed to annunciate the alarm when the time delay timer starts, not when the time out is completed. This will give Operations some warning of a potential runback. The alarm coupled with a longer time delay could also allow Operations time to insert control rods and possibly avoid Region A should the runback occur after the time delay. Add the operator response when the alarm is received in the annunciator response procedure (e.g., is the alarm real or due to a human error).

4. Runback Value of 15 Hz ARXSU

The runback value of 15 Hz should be reviewed for possible revision based on the issue of core stability. The original cavitation logic was developed prior to the concern over core instability in regions of high power and low core flow. The present logic allows for a spurious or unnecessary runback to place the reactor into such a condition. Varying these parameters may allow avoidance of Region A. This evaluation should also consider single loop operation.

5. Cavitation Logic Change ARXSU

Recommend considering a modification to allow the logic to vary the time delay (dependent upon sensed conditions) as a long term approach to improve the cavitation interlock. The current cavitation logic has a number of issues that together indicate that assessment of a change to the logic would be beneficial to the plant. Issues identified during this review are :

a. Adding setpoint margin to the interlock setpoint will make it necessary to achieve a higher thermal power in power ascension before the speed can be increased above 15 Hz. This will make it more difficult to avoid the stability increased awareness zone at the low end of the thermal power core flow map (see Figure 1) during power ascension.

b. The interlock is based on the differential temperature conditions that exist at high core flow and low thermal power. The single setpoint causes the interlock to be excessively conservative at lower core flows and thermal powers making it necessary to raise thermal power to high values before speed can be increased.

c. The interlock setpoint is based on two loop operation and does not initiate a runback when needed for a region of the thermal power -

core flow map in single loop operation. Operator action is needed in single loop operation to avoid entry into the region not covered by the cavitation interlock.

d. Increasing the allowable time for cavitation although it may be acceptable in that it will not cause excessive equipment damage is conceptually the non-conservative direction. Analyses should establish acceptable limits and recommendations for minimizing this risk.

An interlock change that would allow changing the setpoint of the interlock versus core flow, thermal power (e.g., feedwater flow) and the number of operating loops would be more accurate and allow increasing speed at lower rod lines during power ascension.

The possibility of a flow biased delta temperature interlock trip should be evaluated as another means of avoiding a delta temperature trip during a transient.

6. TR 650 Temperature Values — Complete

As indicated in Figure 12, the values recorded on TR 650 are significantly lower than the RTD values due to the MV/I converter. The calibration of the converter should be adjusted to provide values that are more consistent with the actual RTD readings.

7. A further review of the Simulator model is required to determine why it did not sufficiently model the feedwater flow rates, temperatures and reactor water level controller. Recommend that the Simulator staff fully review these differences. — ARXSU

8. The 5% / second rate limiter in the ASD speed control logic did not limit the ASD speed increase during the January 1997 flow transients which resulted from the Phase Lock Loop (PLL) faults. Mechanisms independent of the ASD to limit RRC pump runback should be evaluated. — ARXSU

9. Document the basis for the 1% / second and 5% / second rate limiter setting. — ARXS

10. Simulator Staff evaluate the simulator ASD model versus the plant ASD for the Delta-T cavitation logic. Additionally, evaluate the simulator recirc loop temperature and dome pressure/temperature response to this transient. Develop and implement corrective actions as necessary. — ARXSU

11. Engineering General Manager work with the Nuclear Training Manager to enhance existing procedures for design and system engineering to provide information to the Simulator group to identify deficiencies and improve the fidelity of the Simulator — ARXSU

12. To provide clear guidance for the Simulator group, the Engineering General Manager and the Nuclear Training Manager, need to develop a procedure, or enhance existing procedures such as P.P.M. 1.4.1, with acceptance guide lines for who is responsible for gathering the plant data and provide an acceptable time frame for updating the Simulator. Currently ANSI standard 3.5 allows 1 year to up grade the Simulator — ARXSU

after change in the plant is made. This guidance should also address that in preparing for a special test, engineering should provide and the Simulator group should implement the necessary information to allow the Simulator to correctly model the proposed test.

13. The Simulator group and Operations should set up a "priority meeting" which would allow setting the priorities for which Simulator up grades should be made immediately and those that are not as important, can be delayed. This meeting could be incorporated in into the TAG meeting or be separate. ARXSU

14. Discuss with operations trainers, that when providing training for evolution's of this type, Nuclear Training should enhance the quality of the training by conducting a refresher of all the trips and interlocks for the component being tested. ARXSU

15. The Engineering General Manager should develop a task force, consisting of an Operations representative, a System Engineer, a Design Engineer, and a Training representative to review P.P.M. 4.12.4.7 for possible instrumentation, procedure, and training enhancements to provide the operators improved guidance and greater flexibility in maximizing plant operations while avoiding stability region "A". ARXSU

16. Implement Corrective Actions associated with PER 297-0246 (Feedturbine trip following SCRAM). PER 297-0246 tracks to completion. ARXSU

17. Perform Feed Turbine test again to demonstrate the integrated plant response. ARXSU

18. Develop an appropriate method of properly identifying critical parameters to compare, before and after conditions of systems that are to be modified. Consider adding this guidance to Engineering document PDS-9 when developed. ARXSU

19. Develop a better means of establishing clear design bases for new modifications and provide a means to compare the new bases with older bases. Add this guidance to the appropriate Engineering Instruction. ARXSU

20. Develop more comprehensive modeling systems to better predict test results, prior to running the actual tests when practicable. When not practicable, model limitations must clearly be defined and understood. Consider the following: ARXSU

    Know what parameters are going to change.
    Know what interlocks are influenced by these parameters.
    Know if we can accurately predict that the interlocks will be activated during the test and if they cannot be modeled.
    Know how we will manage the issue in the test.

    Review and consider the benefits of developing a tool such as flow/tree diagrams that would list potential system interactions during PMT. The diagrams could be used to brainstorm all predicted system responses and then determine what steps should be taken to revise the design or mitigate transients.

21. Ensure that testing is completed for both the grounding scheme (FCR 87-0244-0-20) and the watt transducer (FCR 87-0244-6-43) modifications. RXSU

22. The impact of the DFWLC setpoint modification (Work Order #DDN2) on plant operation should be reviewed by reactor engineering and operations to determine whether a revision to these setpoints is needed) — Complete

23. Recommend that engineering ensure that all ASD/DFW modifications planned for this outage (identified in section 7, Analysis) are thoroughly reviewed using PDS-9 guidance including consideration of the recommendations from this Event Evaluation Report. — ARXSU

24. Discuss the impact of the causal factors of this event at an Engineering All Hands meeting. Include the following in this discussion: — ARXSU
    - An event overview including findings of cause
    - The need for comprehensive review of Vendor supplied modifications,
    - How our mind set and other factors impacted our ability to challenge certain assumptions during the ASD/DFW design phase,
    - Impact of the recent improvements in expectations for creating a challenging environment including positive reinforcement for staff response to date,
    - Any changes to various Engineering Instructions or policies resulting from this review, and

    Any other recommendations deemed appropriate by management.

25. As a part of its overall Strategic Planning process, Engineering should (after the outage concludes) conduct a review session using brainstorming techniques to identify other potential mind set barriers that exist within the organization which hinder progressive thinking. This session should include various levels of engineering staff and be designed to reward both the identification of limiting assumptions and suggestions to overcome those potential barriers. The outcome should be documented and functional suggestions should be incorporated into engineering guidance documents and/or the Engineering Strategic Plan as appropriate. — ARXSU

    Following (or as a part of) the session discussed above, a review of current major modifications should be conducted to identify any impact from the mind sets identified.

26. Design Engineering should review current engineering guidance documents (especially Engineering Standards Manual PDS-9,) to ensure that adequate guidance exists for reviewing:trip setpoints of interfacing systems, and industry experience with similar modifications — ARXSU

27. While the Engineering Strategic Plan (as well as recent changes to Project Review Group and Design Scoping procedures) establishes a foundation for improved standards in this area, prior to initiating any major system tests Engineers and Operations should meet early in the design phase to identify and agree on acceptable standards for the outcome of the test. This guidance should be incorporated into applicable procedures. — ARXSU

28 PDS-9 (put in place after the time frame discussed here) addresses the current expectations for the analysis and planning of new design modifications. Elsewhere in this report are suggested changes to enhance PDS-9. Management must ensure that PDS-9 is properly applied. — ARXSU

29.	Supply System personnel have become extremely knowledgeable on ASD/DFW through research, training, and experience over the life of the project. GE personnel contacted for this report described Supply System personnel as "some of the most knowledgeable in the industry" at this point. The Team recommends sending the system engineer to ASD school at the next available opportunity.	ARXSU
30	Engineering should review the existing Engineering Instructions to ensure that adequate guidance is provided regarding Supply System involvement and oversignt of vendor modifications. To be worked in conjunction with item 24 above.	ARXSU
31	Engineering and Training management should review and agree to standards of Control Room Simulator fidelity. We recognize that the Simulator was not intended as a modeling tool, but rather as a training tool and as such needs only to provide sufficient fidelity as to support high quality training.	ARXS
32	The Engineering Support Personnel Training Advisory Group (ESP TAG) should consider the benefit of training Design/Project Engineers on the impact of and considerations for changing a component design from a low precision (or analog) design to a high precision (or digital) design.	ARXSU

Recommendations from the IET.

Item	Recommendation	Date
33	Take action to inform the nuclear industry, particularly the BWR 5 and 6 designs, of this potential via INPO networks and evaluate its reportability in accordance with regulatory requirements	ARXSU
34	The RRC pump cavitation protection requirements and any modifications need to be reviewed consistent with the plant operations requirements and the experience gained as a result of the feedwater pump trip test. The mind set that "more conservative setpoints are better" needs to be carefully evaluated on a case by case basis. Engineering should be tasked with the development of revised interlock setpoint and or the time delay values to ensure design intent is achieved.	ARXSU
35	Engineering and operations perform a review of the design features of the DFW and ASD/RRC system under similar transient conditions to ensure other operating parameters were not impacted by these changes.	ARXSU
36	Rerun Section 8.15 of PPM 8.3.339 after setpoint modifications. Response: The Supply System plans to rerun the feedwater pump trip test. Initial conditions will be consistent with those required by the WNP-2 Power Ascension Test Program, i.e. greater than 95% of thermal power. The testing is planned to be performed as a	RXSU

part of power ascension testing at the completion of Refueling Outage 12 and in accordance with PPM 8.3.339. The present sequence in the power ascension testing schedule for this test is as soon as practical after the completion of stable full power operation and required 100% power calibrations and tests.

37 Senior management should require accountability for the success of failure or functions or projects under their cognizance. This should be an element of each strategic plan as well as each short term task plan. ARXSU

Senior management must set policy and performance expectations in all areas and recognize the challenge in integrating complex changes and interfacing with outside organizations.

38 The EET should analyze the plausible causes for the event and validate their findings. RXSU