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WESTINGHOUSE 3-LOOP OTHER TRANSIENTS FAILURE MODE AND EFFECTS ANALYSIS AND REJECTED SYSTEMS JUSTIFICATION REPORT

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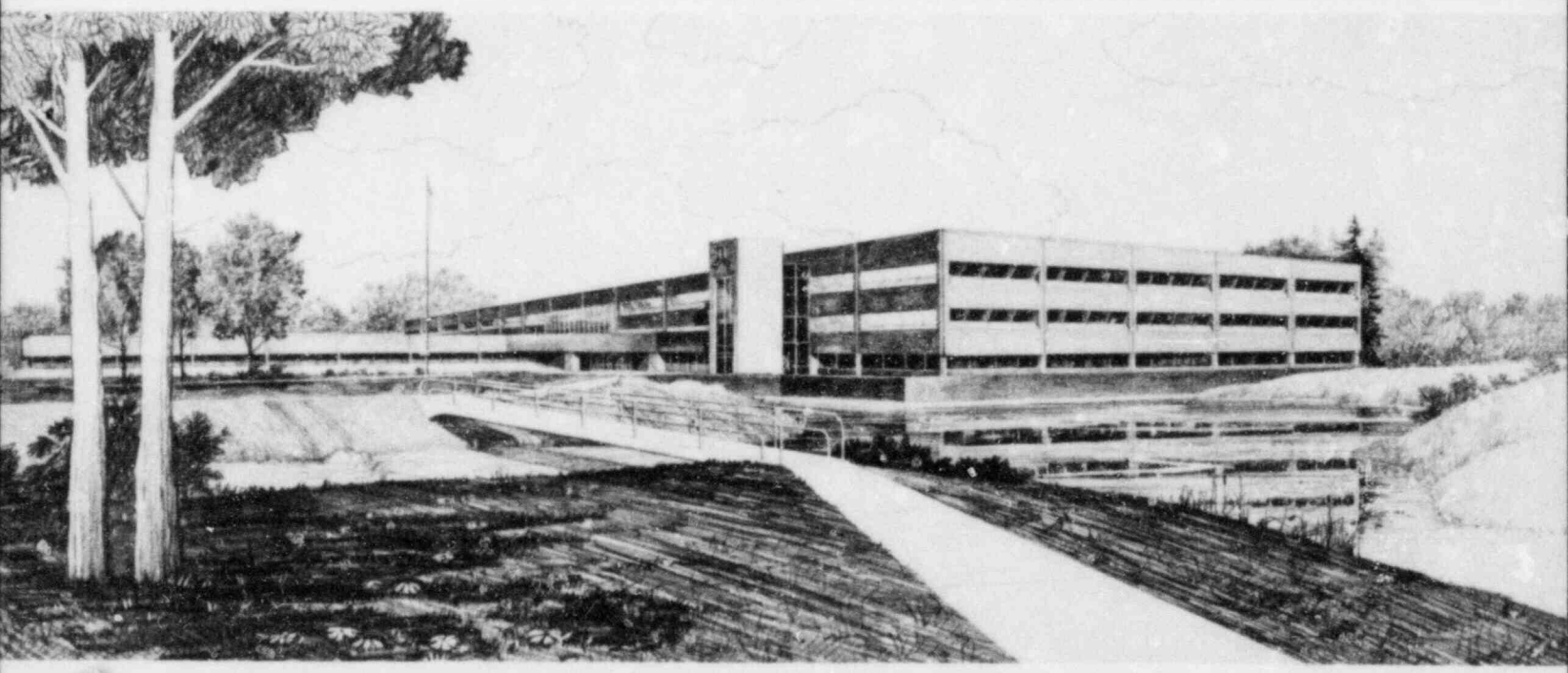
Idaho National Engineering Laboratory
Operated by the U.S. Department of Energy



This is an informal report intended for use as a preliminary or working document

Prepared for the
U. S. NUCLEAR REGULATORY COMMISSION
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EG&G Idaho

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ABSTRACT

Recently concerns dealing with the possibility that certain accidents or transients could be made more severe by control system failures or malfunctions have been raised. These concerns have been documented under Unresolved Safety Issue (USI) A-47, Safety Implications of Control Systems. This EG&G Idaho, Inc., report represents the first phase of a detailed study being performed to evaluate the effects of control system failures on anticipated transients and accidents. This first phase consists of the Failure Mode and Effects Analysis (FMEA) for the H. B. Robinson other transients.

The FMEA has been performed on all the major control grade systems identified in the H. B. Robinson Final Safety Analysis Report (FSAR). This report also contains the postulated transient scenarios for the systems that have been selected for further in-depth reviews and the justification report for those systems selected as not being capable of creating or contributing to these transients.

SUMMARY

The purpose of this study was to determine which system or systems at commercial Pressurized Water Reactor (PWR) units could cause or contribute to any other transients. The other events of concern are those transients and accidents that have been analyzed in the Final Safety Analysis Report (FSAR) with the exception of the steam generator overfill and reactor coolant system overcooling transients and accidents.

A study of the Nuclear Power Experiences and Licensee Event Reports for the years of 1980 to 1982 was performed in an attempt to identify all other events that have actually occurred. An independent nonmechanistic Failure Mode and Effects Analysis (FMEA) was performed on the major control systems utilized at PWRs to determine which system failures or normal operations could result in any of the other events.

The results of these reviews have indicated a need to perform in-depth detailed reviews of 37 of the 54 major control systems to determine the total extent to which they can cause or contribute to any of the other events. The postulated basic scenarios of system failures or operations are included in this report to better define why a system has been selected for the in-depth reviews. The in-depth reviews will determine which systems will require computer modeling and the specific event scenarios of concern and will be documented in a later report.

FOREWORD

This report is supplied as part of the "Safety Implications of Control System Failures A-47" study being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Safety Technology by EG&G Idaho, Inc., NRC Licensing Support Section, Special Projects Group.

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CONTENTS

WESTINGHOUSE 3-LOOP OTHER TRANSIENTS FAILURE MODE AND EFFECTS ANALYSIS AND REJECTED SYSTEMS JUSTIFICATION REPORT

1. INTRODUCTION

EG&G Idaho, Inc., is technically supporting the Nuclear Regulatory Commission in their efforts to resolve the generic issue on the Safety Implications of Control System Failures A-47. The concern of the A-47 study is to determine if any accidents or transients can be initiated or made more severe than previously analyzed as a result of control system failures or malfunctions. This report addresses the analysis performed to determine if nonmechanistic system failures have the potential to cause or contribute to the severity of any other transients. By use of a Failure Mode and Effects Analysis (FMEA) and postulated scenarios, the systems are processed and placed in a further review status or rejected from further review. Systems identified as requiring further review will be subjected to a detailed study to determine if any mechanistic failure potential exists to cause the undesired failure. These systems will be evaluated and if necessary will be computer modeled. Transients of significant concern will be analyzed and the results evaluated to provide recommendations for the resolution of Unresolved Safety Issue (USI) A-47, Safety Implications of Control System Failures.

2. METHOD OF ANALYSIS

A Failure Mode and Effects Analysis was performed to determine which systems would require more detailed analysis.

The FMEA is a qualitative analysis which identifies possible nonmechanistic system failure modes and postulates the effect of the failures on plant performance relating to the transients of concern; the FMEA tables are contained in Appendix B.

3. ASSUMPTIONS

The following criteria were established to identify potential problems with system failures or operation that result in transients that are more severe than those previously analyzed in the H. B. Robinson Final Safety Analysis Report. For the preliminary portion of this study, these criteria have been simplified to include any failures or operations that are associable to these criteria to ensure all systems of concern are identified. In a later phase of this study, the systems identified during this phase will be computer modeled, the transient scenarios of concern analyzed and the results documented in a final report.

A complete listing of the A-47 selection criteria is included as Appendix A for correlation with Appendix B.

1. Any control grade system or component failure, either initiating or aggravating, which results in an undesired increase in reactor coolant inventory beyond the bounds of the present Final Safety Analysis Report (FSAR) analysis will be recommended for further review.

2. Any control grade system or component failure, either initiating or aggravating, which results in an undesired nuclear system pressure increase beyond the bounds of the present Final Safety Analysis Report (FSAR) analysis results will be recommended for further review.

3. Any control grade system or component failure, either initiating or aggravating, which results in an undesired positive reactivity increase beyond the bounds of the present FSAR analysis results will be recommended for further review.

4. Any control grade system or component failure, either initiating or aggravating, which results in an undesired reactor vessel inventory decrease beyond the bounds of the present FSAR analysis results will be recommended for further review.

5. Any control grade system or component failure, either initiating or aggravating, which results in an undesired reactor core coolant flow decrease beyond the bounds of the present FSAR analysis results will be recommended for further review.

6. Any control grade system or component failures which are projected to cause transients identified as incidents of moderate frequency to occur at a rate significantly more frequent than once per year, or failures which are projected to cause transients identified as infrequent incidents to occur more than once during the lifetime of a plant, or failures which are projected to cause limiting faults will be recommended for further review.

7. Any control grade system or component failures which adversely affect any assumed or anticipated operator action during the course of a particular transient will be recommended for further review.

8. Any control grade system or component failures which result in manual or automatic actuation of Engineered Safety Features including the Reactor Protection System, will be recommended for further in-depth review.

9. Any control grade system or component failures which result in exceeding any Technical Specification Safety limit will be recommended for further review.

4. SYSTEM DESCRIPTION

The systems which were evaluated in the FMEA tables were extracted from the systems as identified in the H. B. Robinson Final Safety Analysis Report (FSAR). These systems represent the major control grade (nonsafety) systems which are used for reactor plant control. Many systems have several subsystems or support systems associated with them which were not

specifically listed in the FMEA. However, failures of these systems were factored into the analysis by considering a support or subsystem failure to result in a nonmechanistic failure of the major control system.

5. CONCLUSIONS

Utilizing the nonmechanistic, qualitative FMEA format, many of the major control systems indicated a need for further, more detailed review in conjunction with one or more of the other transient investigations. These systems, with a brief discussion indicating failure mode of concern, plant conditions at which the failures would be most limiting and the postulated effects of the failures are listed in Appendix C.

The justifications for system rejection from further review for a specific transient or transients are contained in Appendix D.

APPENDIX A

SAFETY IMPLICATIONS OF CONTROL SYSTEMS (A-47)
SIGNIFICANT SYSTEMS SELECTION CRITERIA

APPENDIX A

SAFETY IMPLICATIONS OF CONTROL SYSTEMS (A-47)

SIGNIFICANT SYSTEMS SELECTION CRITERIA

1. Any control grade system or component failure, either initiating or aggravating, which results in an undesired increase in steam generator water level beyond the bounds of the present FSAR analysis will be recommended for further review. For this study, the point of overfill is defined as that level which, if exceeded, could cause carryover into the main steam system.

   There is no limiting transient identified in the H. B. Robinson FSAR for the steam generator overfill event.

   There is no design basis accident identified in the H. B. Robinson FSAR for the steam generator overfill event.

2. Any control grade system or component failure, either initiating or aggravating, which results in an undesired reactor coolant system temperature decrease beyond the bounds of the present FSAR analysis will be recommended for further review.

   The bounding transient analysis in the H. B. Robinson FSAR for this overcooling event is the "Large steam line break outside of containment with offsite power available."

   The design basis accident for this overcooling event is also the "Large steam line break outside of containment with offsite power avaiable," even though it meets all of the requirements of a bounding transient.

3. Any control grade system or component failure, either initiating or aggravating, which results in an undesired nuclear system pressure increase, positive reactivity increase or increase in reactor coolant inventory beyond the bounds of the present Final Safety Analysis Report (FSAR) analysis will be recommended for further review.

The limiting transient for a nuclear pressure increase event in the H. B. Robinson FSAR analysis is the "Instantaneous loss of steam load (turbine trip) without automatic steam dump or reactor trip."

The design basis accident for the increase in nuclear system pressure event is the "Loss of reactor coolant flow due to reactor coolant pump shaft seizure (Locked rotor).

The limiting transient for a positive reactivity increase is the "Uncontrolled Rod Control Cluster Assembly (RCCA) bank withdrawal from full power with minimum reactivity feedback (80 pcm/s withdrawal rate).

The design basis accident for the increase in positive reactivity event is a "Rod Control Cluster Assembly (RCCA) ejection near the end of core life.

The limiting transient for an increase in reactor coolant inventory is an "Inadvertent start of a Safety Injection (SI) pump with the plant in a cold shutdown condition.

There is no design basis accident identified for the increase reactor coolant inventory event.

4. Any control grade system or component failure, either initiating or aggravating, which results in an undesired reactor core coolant flow decrease or reactor vessel inventory decrease beyond the bounds of the present FSAR analysis results will be recommended for further review.

The limiting transient for a decrease in reactor coolant flow is a "Simultaneous loss of power to all reactor coolant pumps at full power."

The design basis accident for the decrease in reactor coolant flow is the "Instantaneous shaft seizure (locked rotor) of the reactor coolant pumps."

The limiting transient for the decrease in reactor coolant inventory is the "Steam generator tube rupture at full power."

The design basis accident for this event is the "Double-Ended cold leg guillotine (DECLG) pipe break.

5. Any control grade system or component failures which are projected to cause transients identified as incidents of moderate frequency (Anticipated Operational Occurrences) to occur at a rate significantly more frequent than once per year, or failures which are projected to cause transients identified as infrequent incidents to occur more than once during the lifetime of a plant, or failures which are projected to cause limiting faults (Design Basis Accidents) will be recommended for further review.

6. Any control grade system or component failures which would adversely affect any assumed or anticipated operator action during the course of a particular event or result in manual or automatic actuation of Engineered Safety Features, including the Reactor Protection System or result in exceeding any Technical Specification Safety limit will be recommended for further review.

APPENDIX B

OTHER TRANSIENTS FAILURE MODE AND EFFECTS ANALYSIS

APPENDIX B. OTHER TRANSIENTS FAILURE MODE AND EFFECTS ANALYSIS

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
1. Reactor Coolant System and Pumps	Provides coolant flow to the reactor vessel for core cooling.	High flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-1 and F-1)
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,5,6 (App. C Items D-1, E-1, and F-1)
2. Pressurizer Over-pressure Protection System	Provides reactor coolant system overpressure protection.	Inadvertent opening of a power operated or safety relief valve.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,5,6 (App. C Items D-2 and F-2)
		Failure of a power operated or safety relief valve to open when required.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
3. High Head Safety Injection System	Provides reactor coolant inventory makeup during a small leak, while system pressure is high.	Inadvertent initiation when not required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items A-1, B-1, and F-3)
		Failure to initiate when required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but should not as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
4. Residual Heat Removal System	Provides a long term decay heat removal system and a low head high volume inventory makeup system for a large reactor coolant system break.	High flow or inadvertent initiation when not required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3 (App. C Item B-2)
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,4 (App. C Items B-2, D-3, and E-2)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
5. Chemical and Volume Control System	Provides a means of maintaining reactor coolant chemistry and normal reactor coolant inventory makeup.	High makeup flow rate or low letdown flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items A-2, B-3, and F-4)
		Low makeup flow rate, or high letdown flow rate or adding non-borated water.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items C-2, D-4, and F-4)
6. Coolant Sampling System	Provides a means of sampling the reactor coolant system for chemical analysis.	High flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but the contribution would be insignificant.	None
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but the contribution would be insignificant.	None
7. Pressurizer Pressure Control System	Provides a means of controlling reactor coolant system pressure and provides pressurizer pressure indication.	Pressure is higher than indicated or is controlling high.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-4, D-5, and F-5)
		Pressure is lower than indicated or is controlling low.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items A-3 and F-5)
8. Accumulator Tank System	Provides coolant inventory makeup to the reactor coolant system in the event of a large coolant system pressure boundary breach.	Inadvertent coolant injection.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations even though the system is safety grade.	3,6 (App. C Items A-4 and F-6)
		Failure to inject when required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but should not as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
9. Reactor Protection System	Provides protection to the reactor coolant system and core to prevent plant parameters from going outside of design conditions.	Inadvertent reactor trips.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	5,6 (App. C Item F-7)
		Failure to trip the reactor when required.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
10. Control Rod Drive System	Provides a means of moving the control rods for gross reactivity control.	Uncontrolled rod withdrawal or rod ejection.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,4,6 (App. C Items B-5, C-3, D-6, and F-8)
		Inadvertent rod insertion or a dropped rod.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	5,6 (App. C Item F-8)
11. Pressurizer Level Control System	Provides level indication and control signals for the chemical and volume control system.	Level is higher than indicated or is controlling high.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations even though the system is safety grade.	6 (App. C Items A-5 and F-9)
		Level is lower than indicated or is controlling low.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items D-7 and F-9)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
12. Engineered Safety Feature Actuation System NOTE: Failures are evaluated within individual systems.	Provides Engineered Safety Feature (ESF) actuation of specific systems or components to mitigate the consequences of postulated accidents.	Inadvertent ESF initiation.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
		Fails to initiate ESF when required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but should not as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
13. Incore Instrumentation System	Provides core power distribution and core temperature indications.	Provides higher than actual condition indications.	Failures of this type should not have the potential to meet or exceed any of the selection criteria as this system is not used by the operators as an indication for immediate operations or corrective actions.	None
		Provides lower than actual condition indications.	Failures of this type should not have the potential to meet or exceed any of the selection criteria as this system is not used by the operators as an indication for immediate operations or corrective actions.	None
14. Excore Instrumentation System	Provides reactor power indication and protective trips for power levels from the source range to 120% of full rated power.	Provides higher than actual condition indications.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatons.	6 (App. C Item F-10)
		Provides lower than actual condition indications.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-10)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
15. Reactor Containment Structure and Containment Isolation System NOTE: Failures are evaluated within individual systems.	Provides reactor core and reactor coolant isolation from the environment.	Fails to maintain the required isolation.	Failures of this type should not have the potential to meet or exeed any of the selection criteria established for other transients or undesired situations as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
		Inadvertent containment isolation when not required.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
16. Feedwater and Condensate System	Provides feedwater to the steam generators and collects and stores the condensate water for return to the steam generators as feedwater.	Feedwater/condensate flow fails high or condensate/feedwater. heating fails low.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-4 and F-11)
		Feedwater/condensate flow fails low.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-6 and F-11)
17. Reactor Coolant System Leak Detection System	Provides indication of a reactor coolant to atmosphere leak within the reactor containment.	Inadvertent leak indication.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-12)
		Failure to indicate when a leak exists.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items D-8 and F-12)
18. Process Computer	Monitors and records plant parameters.	Provides a lower than actual indication.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-13)
		Provides a higher than actual indication.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-13)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
19. Steam Generator Water Level Control	Provides level indication, and feedwater control for each steam generator.	High feedwater flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items C-6 and F-14)
		Low feedwater flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-7 and F-14)
20. Steamline Overpressure Protection System	Provides main steam system overpressure protection.	Inadvertent operation of a power operated or safety relief valve.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-5 and F-15)
		Failure to relieve pressure when required.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
21. Main Steam System	Transfers steam from the steam generators to the turbine or steam dump.	High steam flow rate or inadvertent main steam isolation valve opening.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatons.	3,6 (App. C Items C-7 and F-16)
		Low steam flow rate or inadvertent main steam isolation valve closure.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,4,6 (App. C Items B-8, D-9, and F-16)
22. Turbine Electro-hydraulic Control System (EHC)	Controls steam flow to the turbine.	Inadvertent opening of a turbine governor valve or failure to trip.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-8 and F-17)
		Inadvertent closing of a turbine governor valve.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-9 and F-17)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
23. Auxiliary Feedwater System	A safety grade system which provides steam generator inventory makeup when the main feedwater system is unavailable.	High feedwater flow rate or inadvertent operation.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-9 and F-18)
		Low feedwater flow rate or loss of flow.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
24. Steam Generator	Provides a mechanical barrier to separate the reactor coolant and secondary coolant systems while permitting thermal energy transfer between them and thus producing high quality steam.	Failure to keep the systems separate from each other.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items D-10 and F-19)
		Failure to allow heat transfer.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-10 and F-19)
25. Steam Generator Blowdown System	Provides a method of removing unwanted chemicals or contaminants from the steam generator water for chemistry control.	High flow rate or inadvertent flow.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3 (App. C Item C-10)
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but the contribution would be insignificant.	None
26. Steam Generator Sampling System	Provides a method of removing liquid from the steam generator for chemical analysis.	High flow rate or inadvertent flow.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but the contribution would be insignificant.	None
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations but the contribution would be insignificant.	None

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
27. Turbine Generator Support Systems	Provides the required lubrication and cooling for generator operation.	Fails to provide the required lubrication or cooling.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatins. However, these failures should cause the turbine governor valves to close. This was analyzed in the EHC evaluation and, therefore, won't be evaluated again.	None
28. Auxiliary Steam System	Provides low pressure steam for air ejectors, turbine gland seals and other auxiliary systems.	High steam flow or inadvertent flow.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatons.	3,6 (App. C Items C-11 and F-20)
		Low flow or loss of flow.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatins.	6 (App. C Items B-11 and F-20)
29. Main Condenser and Evacuation Systems	Provides a low pressure collection point for the unused steam from power generation operations.	Failure to maintain a vacuum.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-12 and F-21)
		Increase vacuum.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-12 and F-21)
30. Steam Dump System	Provides a method for removing steam from the steam generators when the turbine generator is unavailable or a load rejection has been initiated.	Inadvertent operation when not required or valves fail open.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-13 and F-22)
		Fails to operate when required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-13 and F-22)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
31. Service Water System	A safety grade system which provides cooling water to components necessary for plant safety under all conditions.	High flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations, however, the contribution should be insignificant.	None
		Low flow rate.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
32. Component Cooling Water System	A safety grade, intermediate heat transfer system that separates the reactor coolant system and the service water system.	High flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4,6 (App. C Items D-11 and F-23)
		Low flow rate.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations as the system is safety grade and would require multiple failures which is beyond the scope of this task.	None
33. Condenser Circulating Water System	Provides a heat sink for the unused steam from power generation operations.	High flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items C-14 and F-24)
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items B-14 and F-24)
34. Primary and Demineralized Water Makeup System	Provides makeup water for the reactor coolant and secondary coolant system.	High flow rate.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
		Low flow rate.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	4 (App. C Item D-12)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
35. Station and Instrument Air Systems NOTE: Failures are evaluated within individual systems.	Provides air for plant use.	High air header pressure.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
		Low air header pressure.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
36. Communications Systems	Provides normal and emergency inter- and intra-plant communications.	Fails to operate when required.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
37. Fire Protection System NOTE: Failures are evaluated within individual systems.	Protects equipment and personnel in the event of a fire.	Inadvertent system operation.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
38. Nitrogen Supply System	Provides nitrogen gas for pressurizing the safety injection accumulators and is a backup source to the instrument air compressors.	High nitrogen header pressure.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Items A-6 and F-25)
		Low nitrogen header pressure.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable 10 CFR 50 Appendix A Selection Criteria (Scenario Discussion)
39. Diesel Generator and Support Systems NOTE: Failures are evaluated within individual systems.	Provides emergency ac power to selected equipment.	Fails to provide power when required.	Failures of this type may have the potential to meet or exceed selection criteria established for other transients, however, connected systems were rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
40. Heating, Ventilation and Air Conditioning Systems NOTE: Failures are evaluated within individual systems.	Provides the plant with the necessary heating ventilating and air conditioning.	Fails to provide sufficient H&V or air conditioning.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
		Provides excessive H&V air conditioning.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
41. 125 Volt DC Busses and 125 Volt Battery NOTE: Failures are evaluated within individual systems.	Provides power to the 125 volt dc busses.	Fails to provide power when required.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
42. 120 Volt AC Instrument System NOTE: Failures are evaluated within individual systems.	Provides 120 volt ac power to the general use instrumentation and control power.	Failure to provide the necessary power to the designated equipment.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
43. Lighting System	Provides normal and emergency lighting throughout the plant.	Fails to provide lighting.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
44. Station Normal Auxiliary Power NOTE: Failures are evaluated within individual systems.	Provides the power for the unit auxiliaries through various transformers.	Fails to provide the required power.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
45. Station Emergency Auxiliary Power NOTE: Failures are evaluated within individual systems.	Provides safety grade power to the station auxiliaries in the event normal sources fail.	Fails to provide power when required.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
46. New Fuel Storage	Provides for the dry storage of new fuel until time for its loading.	Fails to store the new fuel safely and effectively.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
47. Spent Fuel Storage	Provides for the storage of spent fuel until time for shipment.	Fails to store the spent fuel safely and effectively.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
48. Spent Fuel Pool Cooling and Cleanup Systems	Provides for cooling and cleanup of the spent fuel pool water.	Fails to maintain water temperature or purity.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
49. Fuel Handling System	Provides for the handling of fuel assemblies during core loading and unloading.	Failure to provide movement when required.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None
		Failure to prevent movement or inadventent movement.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	3,6 (App. C Item C-15)
50. Radioactive Waste Management Systems	Provides for the collecting, treating, and storage of radioactive solids, liquids, and gases.	Fails to provide safe storage or disposal of radioactive materials.	Failures of this type should not have the potential to meet or exceed none of the selection criteria established for other transients or undesired situations.	None
51. Radiation Monitoring System	Provides for sitewide radiation level monitoring.	Indicates higher than actual levels.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situatins.	6 (App. C Item F-26)
		Indicates lower than actual levels.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-26)
52. Annunciator System	Provides alarm indication for out of tolerance parameters.	Inadvertent alarms.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-27)
		Fails to alarm when required.	Failures of this type have the potential to meet or exceed one or more of the selection criteria established for other transients or undesired situations.	6 (App. C Item F-27)

APPENDIX B. (continued)

System	System Function	System Failure Mode	Effect of Failure	Applicable A-47 Selection Criteria Appendix A (Scenario Discussion)
53. Dedicated Shutdown System	Provides the capability of shutting down the reactor from locations outside the control room in the event the control room is inaccessible. Also provides controls and indications for equipment necessary to ensure safe shutdown conditions are maintained.	Inadvertent reactor shutdowns or operation of safe shutdown equipment from remote locations.	Failures of this type may have the potential to meet or exceed the selection criteria established for other transients, however, the system was rejected because normal operation or failure to supply components is covered during individual component system reviews.	None
		Inability to shut down the reactor from remote locations.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations as the system is safety grade, redundant, and would require multiple failures which is beyond the scope of this task.	None
54. Equipment and Floor Drainage System	Provides for the collecting and storage of potentially radioactive drains for transfer to the liquid waste disposal system.	Fails to provide safe storage and transfer of drains.	Failures of this type should not have the potential to meet or exceed any of the selection criteria established for other transients or undesired situations.	None

APPENDIX C

OTHER TRANSIENTS SCENARIOS

APPENDIX C

OTHER TRANSIENTS SCENARIOS

SECTION A--INCREASE IN REACTOR VESSEL INVENTORY

1. High Head Safety Injection System:

   Failure Mode: Inadvertent initiation

   Plant Conditions: Any power level

   Discussion: Inadvertent initiation of the High Head Safety Injection system will cause an increase in reactor vessel inventory and if allowed to operate long enough it could fill the pressurizer and result in a solid system at high pressure. This condition may challenge design limits of the primary coolant system.

2. Chemical and Volume Control System:

   Failure Mode: High makeup flow or low letdown flow

   Plant Conditions: Any power level

   Discussion: High makeup flow may cause the inventory of the primary system to increase, likewise a lower letdown flow versus makeup flow may cause the inventory to increase beyond acceptable limits.

3. Pressurizer Pressure Control System:

   Failure Mode: Actual pressure lower than indicated or pressurizer is pressure controlling low.

   Plant Conditions: Any power level

Discussion: A low pressurizer pressure could result in an increase makeup rate or the initiation of high head safety injection which could result in an increasing inventory transient.

4. Accumulator Tank System:

Failure Mode: Inadvertent injection

Plant Conditions: Shutdown, depressurized

Discussion: If the plant is shutdown, depressurized and the accumulator tanks are inadvertently injected into the primary system an inventory increase could result that may exceed allowable design limits.

5. Pressurizer Level Control System:

Failure Mode: Level is higher than indicated or is controlling high.

Plant Conditions: Any power level

Discussion: An increasing reactor coolant inventory with the pressurizer level high could have an effect on the rate at which limits are reached or exceeded.

6. Nitrogen Supply System:

Failure Mode: High nitrogen header pressure

Plant Conditions: Any power level

Discussion: If the nitrogen supply system were to fail with high header pressure, it may be possible to pressurize the Accumulator Tanks sufficiently to

cause them to inject into the primary system when not required and cause an inventory increase.

SECTION B--INCREASE PRESSURE TRANSIENTS

1. High Head Safety Injection System:

   Failure Mode: Inadvertent initiation

   Plant Conditions: Any power level

   Discussion: Inadvertent initiation of the High Head Safety Injection system could cause pressure to increase and if allowed to operate long enough, fill the pressurizer. This may cause a condition more severe than previously analyzed.

2. Residual Heat Removal System:

   Failure Mode: Inadvertent initiation or low flow

   Plant Conditions: Shutdown

   Discussion: Inadvertent initiation of the RHR system when not required during cold shutdown, could cause an increase in pressure beyond allowable limits. Low flow when required for decay heat removal, could result in a temperature increase and a resultant pressure increase beyond allowable limits.

3. Chemical and Volume Control System:

   Failure Mode: High makeup flow or low letdown flow

   Plant Conditions: Any power level

   Discussion: If the CVCS system were to have a higher makeup flow than letdown flow or vice versa, the pressurizer could slowly fill and pressure would

increase. This may cause a pressure transient and result in the allowable pressure limits being exceeded.

4. Pressurizer Pressure Control System:

Failure Mode: Pressure is higher than indicated or is controlling high

Plant Conditions: Any power level

Discussion: This condition could result in making an increase pressure transient more severe than previously analyzed as the transient could be initiated from a higher pressure.

5. Control Rod Drive System:

Failure Mode: Uncontrolled rod withdrawal or rod ejection

Plant Conditions: Any power level

Discussion: An uncontrolled rod excursion could cause a power increase. This coupled with a given steam flow from the S/G may cause the pressure in the primary system to increase and may exceed design limits.

6. Feedwater and Condensate Systems:

Failure Mode: Feedwater/condensate flow fails low

Plant Conditions: Any power level

Discussion: A loss of feedwater flow to the steam generators whether caused by low feedwater or condensate flow could result in a loss of heat transfer

capabilities at the steam generator. This could result in a pressure increase in the primary system.

7. Steam Generator Water Level Control System:

Failure Mode: Low feedwater flow

Plant Conditions: Any power level

Discussion: Low feedwater flow rate due to a malfunction of the SGWLC system may result in a loss of heat transfer capabilities and an increase in primary system pressure.

8. Main Steam System:

Failure Mode: Main steam isolation valve closure

Plant Conditions: Any power level

Discussion: Inadvertent main steam isolation valve closure could result in a lower steam flow, less heat transfer between the primary and secondary systems and a pressure increase in the primary system.

9. Turbine Electrohydraulic Control System (EHC):

Failure Mode: Inadvertent closing of a turbine governor or stop valve

Plant Conditions: Any power level

Discussion: Inadvertent closing of the turbine governor or stop valve(s) could cause steam flow to decrease,

heat transfer between the primary and secondary systems to decrease and the pressure in the primary system to increase.

10. Steam Generator:

Failure Mode: Failure to allow heat transfer

Plant Conditions: Any power level

Discussion: A reduction or stopping of heat transfer inside of a steam generator could cause reactor coolant system pressure to increase.

11. Auxiliary Steam System:

Failure Mode: Low flow or loss of flow

Plant Conditions: Any power level

Discussion: A low flow or loss of flow in the auxiliary steam system could cause a loss of vacuum and a turbine trip, which would cause reactor coolant pressure to increase.

12. Main Condenser and Evacuation Systems:

Failure Mode: Loss of Vacuum

Plant Conditions: Any power level

Discussion: Loss of condenser vacuum may cause a reduction in steam flow and subsequent turbine trip. This could result in a loss of heat transfer between the primary and secondary systems and result in a primary system pressure increase.

13. Steam Dump System:

Failure Mode: Failure to operate when required

Plant Conditions: Any power level

Discussion: Failure of the steam dump system to operate when required could result in a loss of heat transfer between the primary and secondary systems and result in a pressure increase in the primary system.

14. Condenser Circulating Water System:

Failure Mode: Low flow

Plant Conditions: Any power level

Discussion: A low flow condition would cause a loss of vacuum and turbine trip. This results in a reactor coolant pressure increase.

SECTION C--POSITIVE REACTIVITY INCREASES

1. Reactor Coolant System and Pumps:

   Failure Mode: High flow rate

   Plant Conditions: Any power level

   Discussion: Inadvertent startup of an idle reactor coolant loop could inject cold water into the reactor vessel and may cause a positive reactivity increase.

2. Chemical and Volume Control System:

   Failure Mode: Addition of nonborated water

   Plant Conditions: Any power level

   Discussion: The addition of nonborated water to the primary system could create a positive reactivity transient.

3. Control Rod Drive System:

   Failure Mode: Uncontrolled rod withdrawal or ejection

   Plant Conditions: Any power level

   Discussion: Uncontrolled rod withdrawal or ejection could cause a positive reactivity increase transient. This may result in exceeding one or more design limits.

4. Feed and Condensate System:

Failure Mode: High flow rate or loss of feed water heating

Plant Conditions: Any power level

Discussion: High feedwater flowrate or cold feedwater could result in a cooldown of the primary coolant system and subsequent positive reactivity increase.

5. Steamline Overpressure Protection System:

Failure Mode: Inadvertent operation of a power operated or safety relief valve(s)

Plant Conditions Any power level

Discussion: Inadvertent operation of a power operated or safety relief valve(s) could cause a cooldown of the primary coolant system and a subsequent positive reactivity increase.

6. Steam Generator Water Level Control System:

Failure Mode: High feedwater flow rate

Plant Conditions: Any power level

Discussion: High feedwater flow rate caused by the steam generator water level control system, could cause a cooldown of the primary coolant system and result in a positive reactivity increase transient.

7. Main Steam System:

Failure Mode: Inadvertent main steam isolation valve opening

Plant Conditions: Any power level

Discussion: Inadvertent opening of a main steam isolation valve could cause steam flow to increase This could cause a reduction in primary coolant system temperature and subsequent positive reactivity increase.

8. Turbine Electrohydraulic Control System:

Failure Mode: Inadvertent opening of a governor valve or failure to trip

Plant Conditions: Any power level

Discussion: The inadvertent opening of a governor valve could cause increased steam flow with a resultant cooling of the primary coolant system and positive reactivity increase. The failure to trip when required could cause a cooldown of the primary system and be a contributing factor to a positive reactivity increase transient.

9. Auxiliary Feedwater System:

Failure Mode: Inadvertent operation

Plant Conditions: Any power level

Discussion: Inadvertent startup of the auxiliary feedwater system could introduce cold water to the steam generators and result in a cooldown of the primary coolant which could result in a positive reactivity increase transient.

10. Steam Generator Blowdown System:

Failure Mode: High flow rate or inadvertent flow

Plant Conditions: Any power level

Discussion: Inadvertent initiation of a steam generator blowdown or higher flow than required may cause an increased feedwater flow. This could cause a cooling of the primary coolant system and result in a positive reactivity increase transient.

11. Auxiliary Steam System:

Failure Mode: Inadvertent flow

Plant Conditions: Any power level

Discussion: Inadvertent steam flow to auxiliary equipment may cause an increased heat removal rate from the primary coolant system and a positive reactivity increase transient.

12. Main Condenser and Evacuation System:

Failure Mode: Increased vacuum

Plant Conditions: Any power level

Discussion: If the vacuum in the condenser were to increase, it may cause increased steam flow or more condensate depression, either of which could contribute to an increased positive reactivity transient.

13. Steam Dump System:

Failure Mode: Inadvertent operation or valve(s) fail open

Plant Conditions: Any power level

Discussion: Inadvertent operation or valve(s) failing open during operation, could cause an increased heat removal rate from the primary coolant system and result in a positive reactivity increase transient.

14. Condenser Circulating Water System:

Failure Mode: High flow rate

Plant Conditions: Any power level

Discussion: This type of failure could cause an increase in condenser vacuum and may cause increased steam flow or more condensate depression either of which could contribute to an increased positive reactivity transient.

15. Fuel Handling System:

Failure Mode: Failure to restrict fuel handling movements

Plant Conditions: Shutdown

Discussion: Failures of the fuel handling system to prevent fuel movements could contribute to a positive reactivity transient by allowing for improper loading of fuel or inadvertent withdrawal of control rod assemblies.

SECTION D--INVENTORY DECREASE TRANSIENTS

1. Reactor Coolant System and Pumps:

   Failure Mode: Low flow rate

   Plant Conditions: Any power level

   Discussion: A decrease in flow will cause RCS pressure to increase. The increase pressure could cause a reduction in the makeup rate and a relief valve to open, both of which are contributors to a decreasing inventory transient.

2. Pressurizer Overpressure Protection System:

   Failure Mode: Inadvertent opening of a power operated or safety relief valve

   Plant Conditions: Any power level

   Discussion: The inadvertent opening of a power operated or safety relief valve could result in a loss of inventory to the primary coolant system.

3. Residual Heat Removal System:

   Failure Mode: Low flow or loss of flow

   Plant Conditions: Any power level; shutdown

   Discussion: The RHR is used to supply high volume makeup to the primary coolant system during a large break, loss of coolant accident, loss of this flow could be a contributor to a loss of inventory

transient. Failures within the system during decay heat removal operations when shutdown may result in a loss of inventory transient.

4. Chemical and Volume Control System:

Failure Mode: Low makeup or high letdown flow

Plant Conditions: Any power level

Discussion: If the CVCS allows lower makeup than letdown or higher letdown than makeup, it may be contributing to an inventory decrease transient.

5. Pressurizer Pressure Control System

Falure Mode: Pressure is higher than indicated or is controlling high.

Plant Conditions: Any power level

Discussion: If the pressure is high during a decreasing inventory transient, the inventory could be lost at a faster rate.

6. Control Rod Drive System:

Failure Mode: Control rod ejection

Plant Conditions: Any power level

Discussion: An ejection of a control rod may cause a breech of the primary coolant system boundary and a subsequent primary coolant inventory decrease.

7. Pressurizer Level Control System:

Failure Mode: Pressurizer level is controlling low

Plant Conditions: Any power level

Discussion: If the pressurizer level control system is maintaining the level lower than it should be, the low level could be a contributing factor during a loss of inventory transient.

8. Reactor Coolant System Leak Detection System:

Failure Mode: Failure to indicate when a leak exists

Plant Conditions: Any power level

Discussion: Failure to indicate a leak when it exists could result in this system contributing significantly to an inventory decrease transient.

9. Main Steam System:

Failure Mode: Main steam isolation valve closure

Plant Conditions: Any power level

Discussion: Inadvertent closure of a main steam isolation valve could cause a primary coolant system relief valve to open and result in a decrease in reactor coolant inventory. This could be a significant contribution to this transient.

10. Steam Generator:

Failure Mode: Tube rupture

Plant Conditions: Any power level

Discussion: Rupture of a steam generator tube may result in a significant decrease in reactor coolant system inventory and exceeding one or more plant design limits.

11. Component Cooling Water System:

Failure Mode: Heat exchanger tube rupture

Plant Conditions: Any power level

Discussion: Loss of fluid separation in the heat exchanger may result in a loss of inventory from the primary coolant system which could be significant.

12. Primary and Demineralized Water Makeup System:

Failure Mode: Low flow or loss of flow

Plant Conditions: Any power level

Discussion: A loss of demineralized makeup water could be a contributing factor to a loss of inventory transient.

SECTION E--PRIMARY COOLANT FLOW DECREASE TRANSIENTS

1. Reactor Coolant System and Pumps

   Failure Mode: Low flow

   Plant Conditions: Any power level

   Discussion: Loss of flow by the reactor coolant pumps may be the major contributor to a flow decrease.

2. Residual Heat Removal System:

   Failure Mode: Low flow or loss of flow

   Plant Conditions: Shutdown

   Discussion: Low flow or loss of flow through the RHR system during decay heat removal, may be a significant contributor to a flow decrease transient.

SECTION F--FREQUENCY, OPERATOR ACTION AND ENGINEERED SAFETY FEATURES TRANSIENTS

1. Reactor Coolant System and Pumps:

   Failure Mode: High or low flow rates

   Plant Conditions: Any power level

   Discussion: Various flow perturbations either high or low could cause an Engineered Safety Features actuation.

2. Pressurizer Overpressure Protection System:

   Failure Mode: Inadvertent opening of a power operated or safety relief valve

   Plant Conditions: Any power level

   Discussion: Inadvertent opening of a power operated or safety relief valve could cause an actuation of an Engineered Safety Feature, a violation of a Technical Specification Safety Limit, or improper operator actions.

3. High Head Safety Injection System:

   Failure Mode: Inadvertent initiation

   Plant Conditions: Any power level

   Discussion: Inadvertent initiation of the high head injection system is an Engineered Safety Features actuation which could result in actuation of additional Engineered Safety Features.

4. Chemical and Volume Control System:

Failure Mode: High or low makeup or letdown flow rates

Plant Conditions: Any power level

Discussion: Improper flow rates for the operation in progress may result in Engineered Safety Features actuations.

5. Pressurizer Pressure Control System:

Failure Mode: Maintaining higher or lower than required pressure

Plant Conditions: Any power level

Discussion: Incorrect maintenance of pressurizer pressure for the operations in progress may result in actuation of one or more Engineered Safety Features.

6. Accumulator Tank System:

Failure Mode: Inadvertent initiation

Plant Conditions: Any power level

Discussion: Inadvertent initiation of the accumulator tank system is an Engineered Safety Features actuation and may result in actuations of additional Engineered Safety Features.

7. Reactor Protection System:

Failure Mode: Inadvertent reactor trips

Plant Conditions: Any power level

Discussion: Inadvertent reactor trips could result in actuation of Engineered Safety Features. This type of failure appears to occur frequently.

8. Control Rod Drive System:

Failure Mode: Inadvertent insertions or withdrawals

Plant Conditions: Any power level

Discussion: Inadvertent rod insertions may cause the operator to perform incorrect actions as well as cause actuation of Engineered Safety features. Inadvertent rod withdrawals could also cause actuation of Engineered Safety Features.

9. Pressurizer Level Control System:

Failure Mode: Level is indicating or controlling higher or lower than required

Plant Conditions: Any power level

Discussion: Incorrect level indication could cause the operator to perform incorrect actions, and incorrect level control may result in actuation of one or more Engineered Safety Features.

10. Excore Instrumentation Systems

Failure Mode: Provides higher or lower than actual condition outputs

Plant Conditions: Any power level

Discussion: By providing higher or lower than actual condition outputs this system may cause the operators to perform incorrect actions and it may also result in Engineered Safety Features actuations.

11. Feedwater and Condensate Systems:

Failure Mode: High or low feedwater/condensate flow or loss of feedwater heating

Plant Conditions: Any power level

Discussion: Failures of this type could result in actuation of one or more Engineered Safety Features and may be a cumulative type transient.

12. Reactor Coolant System Leak Detection System:

Failure Mode: False leak indication or failure to indicate a leak

Plant Conditions: Any power level

Discussion: Either of these failures may cause the operator to perform or fail to perform actions necessary to maintain the plant in a safe condition. This type of failure may also result in actuation of an Engineered Safety Features system.

13. Process Computer System:

Failure Mode: Provides higher than actual condition outputs

Plant Conditions: Any power level

Discussion: Provided the operator uses the process computer to maintain plant variables the potential exists to perform incorrect actions based on erroneous information being supplied by the process computer.

14. Steam Generator Water Level Control System:

Failure Mode: High or low feedwater flow rate

Plant Conditions: Any power level

Discussion: These failures may result in the actuation of one or more Engineered Safety Features systems.

15. Steamline Overpressure Protection System:

Failure Mode: Inadvertent opening of a power operated or safety relief valve

Plant Conditions: Any power level

Discussion: Inadvertent opening of a relief valve may result in actuation of other Engineered Safety Features systems and could become cumulative.

16. Main Steam System:

Failure Mode: Inadvertent main steam line isolation valve opening or closing

Plant Conditions: Any power level

Discussion: These failures may result in the actuation of one or more Engineered Safety Features systems and could become cumulative.

17. Turbine Electrohydraulic Control System (EHC):

Failure Mode: Inadvertent opening or closing of turbine governor or stop valves.

Plant Conditions: Any power level

Discussion: Spurious opening or closing of turbine governor or stop valves may result in actuation of one or more Engineered Safety Features systems and could become cumulative.

18. Auxiliary Feedwater System:

Failure Mode: Inadvertent actuation

Plant Conditions: Any power level

Discussion: Inadvertent operation of the auxiliary feedwater system is an Engineered Safety Features system actuation and may result in additional actuations of Engineered Safety Features.

19. Steam Generators:

Failure Mode: Tube rupture or loss of heat transfer ability.

Plant Conditions: Any power level

Discussion: Steam generator tube rupture may result in actuation of Engineered Safety Features systems, violation of Technical Specification Safety Limits, and cause an operator to take erroneous actions.

Failure of the steam generator to maintain heat transfer capabilities may result in actuation of one or more Engineered Safety Features systems and may become cumulative.

20. Auxiliary Steam System:

Failure Mode: High or low steam flow

Plant Conditions: Any power level

Discussion: Failures of this type may cause actuation of one or more Engineered Safety Features systems and could become cumulative.

21. Main Condenser and Evacuation System:

Failure Mode: Loss or increase of condenser vacuum

Plant Conditions: Any power level

Discussion: Failures of this type may cause actuation of one or more Engineered Safety Features systems and could become cumulative.

22. Steam Dump System:

Failure Mode: Inadvertent operation or failure to operate

Plant Conditions: Any power level

Discussion: Failures of this type may result in actuation of one or more Engineered Safety Features systems and could become cumulative.

23. Component Cooling Water System:

Failure Mode: Heat exchanger tube rupture

Plant Conditions: Any power level

Discussion: Failures of this type may cause actuation of one or more Engineered Safety Features and could become cumulative.

24. Condenser Circulating Water System:

Failure Mode: High or low flow rates

Plant Conditions: Any power level

Discussion: Failures of this type may cause actuation of one or more Engineered Safety Features systems and could become cumulati

25. Nitrogen Supply System:

Failure Mode: High header pressure

Plant Conditions: Any power level

Discussion: Excessive header pressure may cause actuation of one or more of the Engineered Safety Features and could become cumulative.

26. Radiation Monitoring System:

Failure Mode: Provides higher or lower than actual conditions

Plant Conditions: Any power level

Discussion: Failure to provide correct indications to the operators may result in erroneous operator actions and actuation of one or more Engineered Safety Features systems.

27. Annunciator System:

Failure Mode: Inadvertent alarms or loss of alarms

Plant Conditions: Any power level

Discussion: Failures of this type may cause incorrect operator actions and may result in actuation of one or more of the Engineered Safety Features systems.

APPENDIX D

H. B. ROBINSON OTHER TRANSIENTS STUDY REJECTED SYSTEMS JUSTIFICATION

APPENDIX D

H. B. ROBINSON OTHER TRANSIENTS

STUDY REJECTED SYSTEMS JUSTIFICATION

1. INTRODUCTION

During this phase a study of the Nuclear Power Experiences and Licensee Event Reports for the years of 1980 to 1982 was performed on the Westinghouse 3 loop plants in an attempt to identify all other transients that have actually occurred. An independent nonmechanistic Failure Mode and Effects Analysis (FMEA) was performed during an earlier phase on the major control systems utilized at PWRs to determine which system failures or normal operations could result in any of the other transients. The LERs and NPEs reviewed produced several cases of other transients of concern. The FMEA also identified the same systems as well as other systems as potential problems. The remaining systems were subsequently rejected from this study and the reason or reasons are documented within this section of this report.

2. ASSUMPTIONS

The following assumptions were used to assist in justifying system rejection from further review.

2.1 Noncapable System

Any system which through normal operation or failure has no apparent capability to cause or contribute to any of the other transients was rejected.

2.2 Safety Grade System

Any safety grade system which would require multiple failures to cause or contribute to any of the other transients was rejected as multiple failures of safety systems is beyond the scope of this task.

2.3 Insignificant Contribution System

Any system which through normal operation or failure could contribute an insignificant amount to any of the other transients was rejected from that transient review.

3. SYSTEM DISCUSSIONS

3.1 Reactor Coolant System and Pumps

Failures causing a high reactor coolant flow rate were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not affect RCS pressure or makeup flow rate, therefore, should have a negligible effect on an increasing inventory transient.

- Increase in reactor coolant system pressure: This type of failure should not affect RCS pressure, as pressure is not affected by an increased flow rate in a closed system.

- Decrease in reactor coolant flow: This type of failure and transient are complements of each other, therefore, cannot exist at the same time.

- Decrease in reactor coolant inventory: This type of failure should not affect RCS pressure or makeup flow rate, therefore, have a negligible effect on a decreasing inventory transient.

- Frequently occurring transients: This type of failure is unlikely at power operation as it would require a decrease in system differential pressure. While the plant is in cold shutdown, there are interlocks and administrative measures initiated which have been designed its prevent to occurrence.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low reactor coolant flow rate were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should result in a reactor coolant system (RCS) pressure increase from the reduced heat transfer rate. As the RCS pressure increases, makeup flow rate could decrease and possibly a relief valve open, both of which decrease inventory making the failure results opposite to the transient.

- Increase in reactor coolant system pressure: This type of failure was analyzed in the design basis accident (DBA). In the DBA, it was found that the worst case accident is when a reactor coolant pump experiences a locked rotor. This type of failure could not be exceeded, therefore, this failure was rejected from the analysis.

- Increase in positive reactivity: This type of failure should cause an increase in reactor coolant temperature as the heat transfer is reduced. When the temperature increases, negative reactivity is added which is opposite to the transient.

- Frequently occurring transients: This type of failure did not appear in the LER's or NPE's at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.2 Pressurizer Overpressure Protection System

Failures causing an inadvertent opening of a pressurizer power operated or safety relief valve were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should cause a loss of inventory through the open valve.

- Increase in reactor coolant system pressure: This type of failure should cause a decrease in RCS pressure as the pressurizer steam bubble is vented to the drain tank.

- Increase in positive reactivity: This type of failure should be an insignificant contributor to an increasing positive reactivity transient as the reactivity change associated with pressure change is minimal.

- Decrease in reactor coolant flow: This type of failure could cause a decrease in reactor coolant pump NPSH thus decreasing flow, however, the contribution would be minimal compared to the overall effects of a decreasing flow transient.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criterion for transient frequencies.

Failures causing a power operated on safety relief valve to fail to open when required, were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not occur as this system is safety grade and, therefore, has sufficient redundancy that a single failure should

have negligible effect. It is acknowledged that multiple failures of a safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.3 High Head Safety Injection System

Failures causing an inadvertent initiation of the high head safety injection system were rejected from further review for the following transients and reasons:

- o Increase positive reactivity: This type of failure would cause an increase in negative reactivity as borated water is injected.

- o Decrease in reactor coolant inventory: This type of failure would cause inventory increase from injection flow.

- o Decrease in reactor coolant flow: This type of failure could cause an increase in reactor coolant pump NPSH which may cause an increase in flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the criteria for transient frequencies.

- o Failures adversely affecting operators actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing the high head safety injection system to fail to operate when required, were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should

have negligible effect. It is acknowledged that multiple failures of a safety grade system are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.4 Residual Heat Removal System

Failures causing RHR to be inadvertently initiated or to have a high flow rate were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not contribute to an increasing inventory transient. The RHR system cannot contribute to an increasing inventory when RCS pressure is greater than 600 psig as the RHR will be unable to overcome RCS pressure. When RCS pressure is less than 600 psig, the RHR is lined up for residual heat removal operation, where it is used for reactor coolant recirculation and becomes part of the RCS. When RHR is used for residual heat removal, the RCS is filled liquid full in which case an inadvertent operation or high flow rate can not contribute to an increase inventory transient as the RCS is already full.

- o Increase in positive reactivity: This type of failure should have a negligible effect during an increasing positive reactivity transient. When RCS pressure is less than 600 psig, which is the maximum pressure RHR can operate, RHR could add positive reactivity by recirculating cold water, however, the reactivity change associated with the cold water recirculation would be minimal at this RCS temperature and pressure.

- o Decrease in reactor coolant flow: This type of failure should have a negligible effect on a decreasing reactor coolant flow transient. When RCS pressure is above 600 psig, RHR does not have any effect on a decreasing flow transient as this system is unable to overcome RCS pressure, therefore, cannot be a contributor. When RCS pressure is less than 600 psig, RHR is lined up for

residual heat removal, in which case it is recirculating coolant through the RCS and RHR flow rate would be reactor coolant flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator action: This type of failure should not be indicated to the operator on one instrument or type of instrument such that on erroneous action is initiated.

Failures causing a low flow rate in the RHR system were rejected from further review for the following transient and reasons:

- o Increase in reactor coolant inventory: This type of failure should have a negligible effect on an increasing inventory transient. When RCS pressure is greater than 600 psig, RHR cannot contribute as it will be unable to overcome RCS pressure. When RCS pressure is less than 600 psig, the RHR system is lined up for residual heat removal, where it is used for reactor coolant recirculation and becomes part of the RCS. When RHR is used for residual heat removal, the RCS is filled liquid full in which case a low flow cannot contribute to a high inventory transient as the RCS is already full.

- o Increase in positive reactivity transients: This type of failure would cause or contribute to an increasing reactor coolant system temperature which inserts negative reactivity.

- o Frequently occurring transients: This type of failure did not appear in the NPEs or LERs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.5 Chemical and Volume Control System

Failures causing a high makeup or a low letdown flow rate in the chemical and volume control system were rejected from further review for the following transients and reasons:

- o Increase in positive reactivity: This type of failure should cause a negative reactivity addition from the borated coolant added.

- o Decrease in reactor coolant inventory: This type of failure results in more inventory being added to the RCS than is being removed, therefore, results in an increase in inventory.

- o Decrease in reactor coolant flow: This type of failure should cause an increase in reactor coolant inventory which increases reactor coolant pump NPSH. As NPSH increases, flow could also increase.

- o Frequently occurring transients: This failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low makeup flow rate, a high letdown flow rate, or the addition of non-borated water in the chemical and volume control system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should cause a decreasing inventory as more coolant would be removed from the RCS than added.

- o Increase in reactor coolant pressure: This type of failure could cause a decrease in RCS pressure from the decrease in inventory.

- o Decrease in reactor coolant system flow: This type of failure has the potential of contributing to a decreasing flow transient as a decrease in inventory will reduce reactor coolant pump NPSH. A reduction in NPSH could decrease flow, however the contribution should be minimal.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or ty e of instrument such that an erroneous action is initiated.

3.6 Coolant Sampling System

Failures causing a high flow rate in the coolant sampling system were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not have a significant contribution to any of the transients of concern as this sys em is small in comparison to the overall reactor coolant system.

Failures causing a low flow rate in the coolant sampling system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not have a significant contribution to any of the transients of concern as this system is small in comparison to the overall reactor coolant system.

3.7 Pressurizer Pressure Control System

Failures causing a lower than actual pressure indication or pressurizer pressure to control high were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should cause a decrease in reactor coolant inventory as the higher pressure could reduce the makeup rate and cause a relief valve to open, either of which would result in an inventory decrease.

- Increase in positive reactivity: This type of failure should have a minimal effect on positive reactivity as a pressure change does not cause a significant change in reactivity.

- Decrease in reactor coolant flow: This type of failure has the potential of contributing to a decreasing flow transient as it could result in a reduction of reactor coolant NPSH from the decreased inventory. However, the contribution would be insignificant to the overall transient.

- Frequently occurring transients: This type of failure did not appear in the LERs, or NPEs at a frequency in excess of the allowed rate as indentified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or one type of instrument such that an erroneous action is initiated.

Failures causing a higher than actual pressure indication or pressurizer pressure to control low were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant system pressure: This type of failure would result in a decreasing pressure transient.

- o Increase in positive reactivity: This type of failure should have a minimal effect on reactivity as the change in reactivity associated with pressure changes is insignificant.

- o Decrease in reactor coolant inventory: This type of failure should minimize a decreasing inventory transient as the inventory loss rate would be slower and the makeup rate would be higher.

- o Decrease in reactor coolant flow: This type of failure should have a minimal effect on flow as a decrease in pressure should not affect reactor coolant pump NPSH in a closed system.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.8 Accumulator Tank System

Failures causing inadvertent coolant injection were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant system pressure: This type of failure should not have the capability of contributing to an increase pressure transient. Since the accumulators are a low

head static system, they can not operate while RCS pressure is above approximately 800 psig. When RCS pressure is below injection pressure, administrative actions are initiated to prevent its operation.

- o Increase in positive reactivity: This type of failure would cause a negative reactivity addition as the injected fluid is highly borated.

- o Decrease in reactor coolant inventory: This type of failure would add coolant inventory.

- o Decrease in reactor coolant flow: This type of failure should have a minimal effect on reactor coolant pump NPSH, therefore, have an insignificant effect on flow.

- o Frequently occurring transients: This type of failure did not appear in the LER's or NPE's at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing the accumulator tank system to fail to inject when required, were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of a safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.9 Reactor Protection System

Failures causing inadvertent reactor trips were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure has the potential of contributing to an increasing inventory transient as it can reduce RCS pressure, however, the contribution should be minimized as the pressurizer will counteract the reduction.

- Increase in reactor coolant system pressure: This type of failure should cause a decrease in RCS pressure as the heat transfer rate is decreased..

- Increase in positive reactivity: This type of failure should result in control rod insertion which adds negative reactivity.

- Decrease in reactor coolant inventory: This type of failure should cause a pressure decrease which would result in a slower inventory loss rate and a minimal affect on this transient.

- Decrease in reactor coolant flow: This type of failure should not have a significant effect on reactor coolant pump NPSH in a closed system.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that in erroneous action is initiated.

Failures causing the reactor to not trip when required were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should

have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.10 Control Rod Drive System

Failures causing an uncontrolled rod withdrawal or a rod ejection were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure could cause a pressure increase from the increased heat production. The increased pressure should cause a decrease in makeup flow rate and possibly a relief valve to open both of which tend to reduce inventory.

- Decrease in reactor coolant flow: This type of failure does not have the potential of affecting reactor coolant flow.

- Frequently occurring transient: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing an inadvertent rod insertion or a dropped rod were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure would have an insignificant contribution to an increasing inventory transient.

- Increase in reactor coolant system pressure: This type of failure would tend to cause a decrease in pressure.

- Increase in positive reactivity: This type of failure would cause a negative reactivity addition from the rod insertion.

- Decrease in reactor coolant inventory: This type of failure would have an insignificant contribution to a decreasing inventory transient.

- Decrease in reactor coolant flow: This type of failure should not significantly affect reactor coolant pump flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.11 Pressurizer Level Control System

Failures causing actual pressurizer level to be higher than indicated or level to be controlling high were rejected from further review for the following transients and reasons:

- Increase in reactor coolant system pressure: This type of failure should not contribute to an increasing RCS pressure as the pressure is regulated by the pressurizer steam bubble not the level.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity as reactivity is not affected by pressurizer level.

- Decrease in reactor coolant inventory: This type of failure would not cause a decreasing inventory transient.

- Decrease in reactor coolant flow: This type of failure should cause an increase in reactor coolant pump head which would tend to increase flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing actual pressurizer level to be lower than indicated or pressurizer level to be controlling low were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should decrease the effects of an increasing inventory transient.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of affecting pressure as the pressure is controlled by the steam bubble in the pressurizer and not the water level.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity as reactivity is not affected by pressurizer level.

- Decrease in reactor coolant flow: This type of failure appears to have the capability of being a contributor to a decreasing reactor coolant flow transient by decreasing reactor coolant pump NPSH, however, the contribution made by this failure would be insignificant.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.12 Engineered Safety Feature Actuation System

Failures causing inadvertent initiation of any or all Engineered Safety Feature systems were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the selection criteria for "other transients," however, failures of this type will cause a component system failure and will be evaluated during individual system reviews.

Failures causing the Engineered Safety Features to not initiate when required were rejected from review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.13 Incore Instrumentation System

Failures causing higher than actual parameter indication in the core were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should have a minimal effect on any of the "other transients" as this system is used for core power distribution indication and not for an indication to initiate immediate operations or corrective actions.

Failures causing lower than actual parameter indication in the core were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should have a minimal effect on any of the "other transients" as this system is used for core power distribution indication aid not for an indication to initiate immediate operations or corrective actions.

3.14 Excore Instrumentation System

Failures causing a higher than actual core power indication are rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure does not have the capability to affect RCS inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure would not have the capability to affect RCS pressure and was rejected.

- o Increase in positive reactivity: This type of failure could have the capability of affecting reactivity, however, it should have an insignificant contribution and was rejected.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to affect RCS coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not have the capability to affect reactor coolant pump flow and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing a lower than actual core power indication were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to affect RCS inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should not have the capability to affect RCS pressure and was rejected.

- o Increase in positive reactivity: This type of failure could have the capability to affect reactivity, however, it should have an insignificant contribution and was rejected.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to affect RCS coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not have the capability to affect reactor coolant pump flow and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as indentified in the selection criteria for transient frequencies.

3.15 Reactor Containment Structure and Containment Isolation System

Failures causing the reactor containment to fail to maintain a required isolation are rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and,

therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

Failures causing containment isolation when not required were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the selection criteria for "other transients," however, failures of this type will cause a component system failure and will be evaluated during individual system reviews.

3.16 Feedwater and Condensate System

Failures causing feedwater and condensate systems to have a high flow rate or feedwater heating to have a low flow rate were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding or removing RCS coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of adding or removing RCS coolant and was rejected.

- Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low feedwater or condensate flow rate were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure could not cause an increase in RCS inventory and was rejected.

- o Increase in positive reactivity: This type of failure should cause a negative reactivity addition as it would cause reactor coolant temperature to increase.

- o Decrease in reactor coolant inventory: This type of failure should not cause a reactor coolant decrease inventory transient.

- o Decrease in reactor coolant flow: This type of failure does not have the potential of contributing to a decreasing flow transient and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.17 Reactor Coolant Leak Detection System

Failures causing an inadvertent reactor coolant leak indication were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure.

- Increase reactivity transient: This type of failure should not have the capability of adding positive reactivity and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing the reactor coolant leak detection system to fail to indicate when a leak exists were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory transient: This type of failure should not have the capability of adding reactor coolant and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- o Increase reactivity transient: This type of failure should not have the capability of adding reactivity and was rejected.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of removing coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.18 Process Computer System

Failures that cause the process computer to indicate plant parameters lower than actual were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- o Increase in positive reactivity: This type of failure should not have the ability of adding reactivity and was rejected.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing the process computer to indicate plant parameters higher than actual were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing coolant inventory.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.19 Steam Generator Water Level Control System

Failures in the steam generator water level control system causing a high feedwater flow rate were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding RCS coolant inventory.
- Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease.
- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing RCS coolant inventory.
- Decrease in reactor coolant flow: This type of failure should not affect reactor coolant pump flow.
- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.
- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing the steam generator water level control system to initiate a low feedwater flow rate were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not cause a direct increase in RCS inventory.

- Increase in positive reactivity: This type of failure should cause a negative reactivity addition as it would cause reactor coolant temperature to increase.

- Decrease in reactor coolant inventory: This type of failure should not have the potential of contributing to a decreasing inventory transient.

- Decrease in reactor coolant flow: This type of failure should not have the potential of contributing to a decreasing flow transient.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.20 Steamline Overpressure Protection System

Failures causing inadvertent operation of a power operated or safety relief valve in the main steam system were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing the steamline overpressure protection system to fail to operate when required were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.21 Main Steam System

Failures causing a high flow rate or an inadvertent opening of a main steam isolation valve were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low main steam flow rate or an inadvertent main steam isolation valve closure were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory directly and was rejected.

- Increase in positive reactivity: This type of failure should cause a negative reactivity addition as it would cause RCS temperature to increase.

- Decrease in reactor coolant flow: This type of failure should not have the potential of contributing to a decreasing flow transient and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.22 Turbine Electrohydraulic Control System (EHC)

Failures in the EHC causing the turbine control or governor valves to inadvertently open or fail to trip were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory.

- o Increase in reactor coolant system pressure: This type of failure should cause an RCS pressure decrease from an increased heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory.

- o Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures in the EHC causing the turbine control or governor valves to inadvertently close were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability to directly cause an increase in RCS inventory and was rejected.

- Increase in positive reactivity: This type of failure should cause a negative reactivity addition as it would cause reactor coolant temperature to increase.

- Decrease in reactor coolant inventory: This type of failure should not have the potential of directly contributing to a decreasing RCS inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the potential of contributing to a decreasing flow transient.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rates as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.23 Auxiliary Feedwater System

Failures causing an inadvertent operation or a high flow rate in the auxiliary feedwater system were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure would result in a reactor coolant system pressure decrease due to the increased heat transfer.

- Decrease in reactor coolant inventory: This type of failure should not have the capability to directly remove reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the potential to cause or contribute to a decreasing reactor coolant flow and was rejected.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low flow rate or a loss of flow from the auxiliary feedwater system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.24 Steam Generator

Failures in the steam generator allowing mixing of the reactor coolant and secondary coolant are rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure would cause a decrease in inventory as the reactor coolant pressure is higher than secondary pressure and reactor coolant will leak into the secondary coolant.

- Increase in reactor coolant system pressure: This type of failure would cause a pressure decrease as reactor coolant is lost.

- Increase in positive reactivity: This type of failure should not have a significant affect on reactivity as the reactivity change associated with pressure is minimal.

- Decrease in reactor coolant flow: This type of failure has the potential of affecting reactor coolant pump NPSH, however, the affect would be insignificant to the overall transient and was rejected.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing the steam generator to fail to allow heat transfer were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- o Decrease in positive reactivity: This type of failure could cause a negative reactivity addition as the RCS temperature should increase from reduced heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to directly remove reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not cause a change in the reactor coolant pump flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.25 Steam Generator Blowdown System

Failures causing a high flow rate or inadvertent operation of the steam generator blowdown system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low flow rate in the steam generator blowdown system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the transients, however, the contribution should be insignificant to the overall transient effects. Therefore, this type of failure was rejected.

3.26 Steam Generator Sampling System

Failures causing a high flow rate or inadvertent operation of the steam generator sampling system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the transients, however, the system is small enough that the contribution should be insignificant.

Failures causing a low flow rate in the steam generator sampling system were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the transients, however, the system is small enough that the contribution should be insignificant.

3.27 Turbine Generator Support Systems

Failure in the turbine generator support systems causing the required cooling or lubrication to not be provided were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure has the potential of contributing to one or more transients, however, these failures should cause the turbine control or governor valves to trip and this type of failure will be evaluated in the Turbine Electrohydraulic Control system.

3.28 Auxiliary Steam System

Failures causing a high steam flow rate or an inadvertent flow in the auxiliary steam system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low steam flow rate or a loss of flow in the auxiliary steam system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- o Increase in positive reactivity: This type of failure would cause an increase in negative reactivity as a result of the reduction in heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to directly remove reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not contribute to decreasing flow transient and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.29 Main Condenser and Evacuation Systems

Failures in the main condenser or evacuation systems resulting in a loss of vacuum were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- o Increase in positive reactivity: This type of failure would cause an increase in negative reactivity as a result of the reduction in heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not contribute to decreasing flow transient and was rejected.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing an increase in vacuum in the main condenser were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant invertory and was rejected.

- o Increase in positive reactivity: This type of failure could cause an increase in negative reactivity as a result of the reduction in heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to directly remove reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure could not contribute to decreasing flow transient.

- o Frequently occurring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.30 Steam Dump System

Failures causing an inadvertent operation or the steam dump valves to fail open were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing the steam dump system valves to fail to operate when required, were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- o Increase in positive reactivity This type of failure should cause a negative reactivity addition as it would cause RCS temperature to increase.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability to directly remove reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure does not have the potential of contributing to a decreasing flow transient.

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.31 Service Water System

Failures causing a high flow rate in the service water system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the transients in "other transients", however the contribution should be insignificant to the overall transient and was rejected.

Failures causing a low flow rate in the service water system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have a negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.32 Component Cooling Water System

Failures causing a high flow rate or a failure to maintain an isolation between the RCS and component cooling water system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: A failure causing a leak between systems should cause a decrease in reactor coolant inventory as the RCS pressure is greater and coolant would leak into the component cooling water system. The failure that causes a high flow rate in the component cooling water system was rejected as it should not have the capability of aduing reactor coolant inventory.

- o Increase in reactor coolant system pressure: A failure causing a leak between systems should cause a decrease in RCS pressure from the inventory loss. A high flow rate failure was rejected as it should not have the capability of changing RCS pressure.

- o Increase in positive reactivity: A failure causing a leak between systems should not have a significant contribution as the reactivity change associated with pressure change is minimal.

- o Decrease in reactor coolant flow: A failure causing a leak between systems has the potential of contributing to a decreasing flow transient as it will decrease reactor coolant pump NPSH, however, the contribution should be insignificant to the overall transient and was rejected. A high flow rate failure was rejected as it should not have the capability of changing reactor coolant pump NPSH or flow and was rejected.

- o Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low flow rate in the component cooling water system were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.33 Condensor Circulating Water System

Failures causing a high flow rate in the condensor circulating water system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should cause a RCS pressure decrease from an increased heat transfer rate.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not affect reactor coolant flow.

- o Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low flow rate in the condensor circulating water system were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability to directly add reactor coolant inventory and was rejected.

- o Increase in positive reactivity: This type of failure should cause a negative reactivity addition as it would cause RCS temperature to increase.

- o Decrease in reactor coolant inventory This type of failure should not have the capability of directly removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not have the potential of contributing to a decreasing flow transient and was rejected.

- o Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- o Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.34 Primary and Demineralized Water Makeup System

Failures causing a high flow rate in the primary and demineralized makeup water system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not have the capability of contributing to any of the "other transients," and was rejected.

Failures causing a low flow rate from the primary and demineralized makeup water system were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of directly adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the ability of changing RCS pressure and was rejected.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected.

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.35 Station and Instrument Air System

Failures causing a high air header pressure were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could cause or contribute to one or more transients identified in the "other transients," however, the failures involved would cause failures in components in systems serviced by the station or instrument air system and will be evaluated during the individual system reviews.

Failures causing a low air header pressure were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could cause or contribute to one or more transients identified in the "other transients," however, the failures involved would cause failures in systems serviced by the station or instrument air system and will be evaluated during the individual system reviews.

3.36 Communications Systems

Failures causing the communications system to fail to operate when required, were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not have the capability of contributing to any of the "other transients" as this system is used for convenience and not for control.

3.37 Fire Protection Systems

Failures causing an inadvertent operation of the fire protection system were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could cause or contribute to one or more transients identified in the "other transients," however, the failures involved would cause failures in components in systems serviced by the fire protection system and will be evaluated during the individual system reviews.

Failures causing the fire protection system to fail to operate when required were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could cause or contribute to one or more transients identified in the "other transients," however, the failures involved would cause failures in components in systems serviced by the fire protection system and will be evaluated during the individual system reviews.

3.38 Nitrogen Supply System

Failures causing a high nitrogen header pressure were rejected from further review for the following transients and reasons:

- Increase in reactor coolant system pressure: This failure has the potential of contributing to an increasing pressure transient when reactor coolant pressure is low if the accumulators are unisolated, however, it should not as administrative measures are initiated which have been designed to prevent this from occurring.

- Increase positive reactivity: This type of failure would not have the capability of contributing to an increasing positive reactivity transient, since an injection of borated water adds negative reactivity.

- Decrease in reactor coolant inventory: This type of failure would not contribute to a decreasing inventory transient. The interaction between the reactor coolant and nitrogen system is the pressurizing of the accumulator tank system which would inject at a higher pressure than required, and decrease the severity of the transient.

- Decrease in reactor coolant flow: This type of failure should not contribute to a decreasing flow transient.

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria established for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

Failures causing a low nitrogen system pressure were rejected from further review for the following reasons and transients:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the transients in "other transients," however, is not likely as it would require multiple failures of safety grade equipment or deliberate actions. The only interconnection between the reactor coolant and the nitrogen system is the pressurizing of the accumulator tank system. During normal operations, nitrogen is isolated from the accumulators and only opened when the accumulators need to be repressurized.

3.39 Diesel Generator and Support Systems

Failures in the diesel generator or support systems causing the generator to not deliver power when required, were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure in the support systems will be reviewed during the individual system reviews. A failure in the diesel generators is rejected as this system is safety grade and, therefore, would require multiple failures of safety grade components to fail to produce power. Multiple failures are beyond the scope of this task.

3.40 Heating, Ventilation, and Air Conditioning Systems

Failures causing the H&V or air conditioning to have an insufficient amount of flow were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by H&V or air conditioning systems and will be evaluated during the individual system reviews.

Failures causing excessive flow in the H&V or air conditioning systems were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by H&V or air conditioning systems and will be evaluated during the individual system reviews.

3.41 125 Volt DC Busses and 125 Volt Battery

Failures causing the 125 volt busses to not deliver power when required were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by the 125 volt DC system and will be evaluated during the individual system reviews.

3.42 120 Volt AC Instrument System

Failures causing 120 volt power to not be delivered to designated equipment were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by the 125 volt AC system and will be evaluated during the individual system reviews.

3.43 Lighting System

Failures causing lighting to not be provided when required were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not have the capability of contributing to any of the "other transients" as this system is used for convenience and not controls.

3.44 Station Normal Auxiliary Power

Failures causing station normal auxiliary power to not be provided to designated equipment were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by the station normal auxiliary power system and will be evaluated during the individual system reviews.

3.45 Station Emergency Auxiliary Power

Failures causing station emergency auxiliary power to not be provided to the designated equipment were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure could contribute to one or more transients in the "other transients", however, the failures involved would cause failures in systems serviced by the station normal auxiliary power system and will be evaluated during the individual system reviews.

3.46 New Fuel Storage

Failures causing the new fuel to be stored safely and effectively were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.47 Spent Fuel Storage

Failures preventing the spent fuel from being stored safely and effectively were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.48 Spent Fuel Pool Cooling and Cleanup Systems

Failures causing a heat up of or impure water in the spent fuel pool were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.49 Fuel Handling System

Failures causing the fuel handling system to fail to provide movement when required was rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have a negligible effect. It is acknowledged that multiple

failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

Failures in the fuel handling system causing an inadvertent movement or failing to prevent movement when required were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected.

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

- Failures adversely affecting operator actions: This type of failure should not be indicated to the operator on one instrument or type of instrument such that an erroneous action is initiated.

3.50 Radioactive Waste Management System

Failures in one or more of the radioactive waste management systems resulting in unsafe storage or disposal of radioactive material was rejected from further review for the following transients and reasons:

- All transients catogorized as "other transients": This type of failure should not have the capability of contributing to any transients in "other transients", therefore, they were rejected.

3.51 Radiation Monitoring System

Failures causing the radiation monitoring system to indicate a higher radiation level than actual were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity and was rejected.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing the radiation monitoring system to indicate a lower radiation level than actual were rejected from further review for the following transients and reasons:

- Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity and was rejected.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.52 Annunciator System

Failures causing the annunciator system to give inadvertent alarms were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- o Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- o Increase in positive reactivity: This type of failure should not have the capability of adding reactivity and was rejected.

- o Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- o Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected

- o Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

Failures causing the annunciator system to fail to give alarms when required, were rejected from further review for the following transients and reasons:

- o Increase in reactor coolant inventory: This type of failure should not have the capability of adding reactor coolant inventory and was rejected.

- Increase in reactor coolant system pressure: This type of failure should not have the capability of changing RCS pressure and was rejected.

- Increase in positive reactivity: This type of failure should not have the capability of adding reactivity and was rejected.

- Decrease in reactor coolant inventory: This type of failure should not have the capability of removing reactor coolant inventory and was rejected.

- Decrease in reactor coolant flow: This type of failure should not have the capability of changing reactor coolant pump flow and was rejected

- Frequently occuring transients: This type of failure did not appear in the LERs or NPEs at a frequency in excess of the allowed rate as identified in the selection criteria for transient frequencies.

3.53 Dedicated Shutdown System

Failures causing the dedicated shutdown system to inadvertently initiate reactor trips or cause operation of the designated equipment were rejected from further review for the following transients and reasons:

- All transients categorized as "other transients": This type of failure has the potential of contributing to one or more of the 'other transients", however, the failures involved would cause failures in individual systems controlled by this system. Therefore, these failures will be evaluated during the individual system reviews.

Failures causing the dedicated shutdown system to fail to allow remote shutdown of the reactor when required were rejected from further review for the following reasons and transients:

- o All transients categorized as "other transients": This type of failure should not happen as this system is safety grade and, therefore, has sufficient redundancy that a single failure should have negligible effect. It is acknowledged that multiple failures of safety grade systems are possible, however, multiple failures of safety grade systems are outside the scope of this task.

3.54 Equipment and Floor Drainage System

Failures causing the equipment and floor drainage system to not provide safe storage and transfer of drains were rejected from further review for the following transients and reasons:

- o All transients categorized as "other transients": Failures of this type should not have the capability of contributing to any transients in "other transients," and was rejected.

4. SUMMARY

In utilizing the nonmechanistic qualitative FMEA Format, all systems were rejected from further review for one or more of the other transient studies. Any additions or deletions of systems or transients to this list will be justified and documented in future amendments to this report.

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This is an interim report which contains the Failure Mode and Effects Analysis for the Westinghouse 3-loop other transients, the postulated transient scenarios and the rejected systems justification report.

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