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System Analyses for Elimination of Selected Response Time Testing Requirements

BWR Owners' Group Licensing Topical Report

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BWR OWNERS' GROUP
LICENSING TOPICAL REPORT

SYSTEM ANALYSES FOR THE ELIMINATION OF SELECTED RESPONSE TIME TESTING REQUIREMENTS

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ABSTRACT

This document supersedes and replaces NEDC-32013P, "System Analyses for Elimination of Selected Response Time Testing Requirements", dated March 1992. This document provides the technical justification for the elimination of selected response time tests in : (1) Reactor Protection System (RPS) instrumentation, (2) Isolation System Actuation instrumentation, and (3) Emergency Core Cooling System (ECCS) instrumentation. The document has been revised to address NRC comments and to provide more information on the safety significance of the proposed improvement.

1.0 EXECUTIVE SUMMARY

The BWR Owners' Group (BWROG) has proposed the elimination of the requirements for performance of response time tests (RTTs) of selected instrumentation in the Reactor Protection System (RPS), Emergency Core Cooling System (ECCS), and Isolation System. Because this licensing change improves plant safety and reduces plant operation and maintenance costs, the proposed change qualifies as a Cost Beneficial Licensing Action (CBLA) and should be reviewed by the NRC on a priority basis. Based on a conservative reduction of 1500 man-hours per outage and the potential reduction in outage length, cost savings are estimated to range from $50,000 to $100,000 per unit per year.

This generic Licensing Topical Report has been revised in response to NRC questions and to more clearly demonstrate that the elimination of selected response time tests is of no safety significance. While the BWROG has enhanced the approach to justify the elimination of specific response time testing, the FMEA results remain valid and these analyses of instrumentation failure modes confirm with reasonable assurance that failures which affect response times can be detected during other surveillance tests required by current Technical Specifications. Note that the EPRI report (Reference 1) which justifies the elimination of sensor response time testing has been updated to respond to questions from instrument vendors, GE, Westinghouse, and the NRC. The plant-specific data from the previous submittal are unchanged.

The report concludes that response times are maintained with the current practices and that response time testing is unnecessary based on plant operating history and experience. The other existing Technical Specification required surveillance tests (calibration tests, functional tests, and logic system functional tests) ensure instrumentation health. Results of this BWROG evaluation confirm that response time tests are of no safety significance, cause unnecessary personnel exposure, reduce availability of safety systems during shutdown, and are a significant burden to utility resources.

As a supplement to the above evaluations, participants will update test procedures and training (if required) to assure that the instrument technicians recognize response time delays in instrumentation. A BWROG survey has concluded that instrument response time delays of 5 seconds can be reasonably detected by instrument technicians. A safety evaluation has confirmed that a 5 second increase in the response time of individual specific trip functions has a very low safety significance. The 5 second delay in response time represents a factor of fifteen (15) increase in the specified response time of the fastest trip function selected for elimination. This realistic bases evaluation showed that significant margin exists in the licensing analysis. Within a trip function, redundancy exists in individual instrument channels (e.g., 1 out of 2 twice) and diversity exists in most safety trip functions (e.g., neutron flux, water level, drywell pressure). Also, for most of these instruments the response times are insignificant compared to the safety system actuation times.

2.0 INTRODUCTION

Current Standard Technical Specifications require certain BWR plants to periodically perform response time tests, as defined in ISA Standard 67.06, (Reference 4), for instrument channels in the RPS, Isolation Actuation System and ECCS. The purpose of these tests is to ensure that changes in response time beyond acceptable limits assumed in safety analyses are detected. It is not necessary to demonstrate that the response time design value is met. The instrumentation response time tests provide measurement of specific sensor, trip unit and/or loop response time. The information obtained from these tests is compared to Technical Specification requirements to demonstrate that the specified performance is met. Operational history has shown that degradation of instrumentation response times beyond acceptable limits are being detected during the performance of calibrations and other surveillance tests. The performance of conventional response time tests has proven to be of little value in assuring that instrumentation will perform as required or for determining the health of the instrument. The majority of allowable instrumentation response times are much longer than instrument circuits require for signal processing from sensor input to final output signal. Additionally, the instrument response time is insignificant compared to safety system actuation times. Therefore, the continued performance of instrument time testing may actually detract from safety by: 1) increasing the time when safety systems are unavailable to perform their safety function, 2) increasing the potential for inadvertent safety system actuations, 3) adding to refuel outage complexity thereby increasing the shutdown risk, 4) increasing the exposure of plant personnel to radiation, and 5) diverting resources from other tasks which are important to safety. Based on the above five attributes, it has been determined that the elimination of response time testing is a Cost Beneficial Licensing Action. A discussion of the safety benefits is provided in Section 3.0.

The proposed elimination of selected RTTs is also consistent with the current Maintenance Rule implementation. The Maintenance Rule is performance based and permits specific instrumentation monitoring or calibration methodology to be set by the licensee based on: 1) safety significance of the instrumentation; and 2) whether performance or condition of instrumentation is effectively controlled by appropriate preventive maintenance (PM). This report will show that response time changes beyond acceptable limits, including the detection of maintenance preventable functional failures (MPFFs), can be detected during other periodic tests.

The BWR Owners' Group formed a Response Time Testing Committee in late 1990. The principal objective of this BWROG program was to eliminate unnecessary Technical Specification response time testing requirements that could potentially degrade plant safety. This objective was accomplished by conducting failure mode analyses to show with reasonable assurance that there is no failure mode which affects response time or, when a response time failure mode exists, show it can be detected during surveillances or other testing before the response of the instrument degrades beyond acceptable limits. Section 4.0 provides a more detailed discussion of the analysis approach.

Most of the instrumentation response time testing targeted for elimination involves tests where the instrumentation loop response time is a small fraction of the total allowable system response time requirement. This typically occurs when the total allowable system response time is equal to or greater than ten seconds. In addition, selected pressure and differential pressure sensor response time testing can be eliminated on the basis of work done by EPRI (References 1 and 9) and supplemented by the BWR Owners' Group.

On this basis, the following response time tests were considered for elimination:

(1) All ECCS actuation instrument loops (entire channel).

(2) All Isolation System actuation instrument loops (entire channel) except for Main Steam Isolation Valves (MSIVs).

(3) Sensors only, for selected RPS actuation.

(4) Sensors only, for selected MSIV closure actuation.

Section 5 provides a complete listing of the selected response times considered in this study.

Two representative BWR plants were chosen for detailed analysis: Fermi-2 (BWR 4) and River Bend (BWR 6). The response time requirements for the other BWR plants participating in this study were verified against the analyses of the two lead plants. The overall approach used to justify the elimination of the selected response time surveillance requirements was based on the analysis of the failure modes of the components in the instrumentation loop. Failure modes that can affect instrumentation loop response time were further analyzed to determine what other surveillance or other techniques would reasonably ensure detection of response time failure beyond acceptable limits. Section 6 provides a discussion of the routine periodic tests that are used to detect changes in instrument response.

Section 7 describes the results from the analysis of the two lead plants and their application to the other BWR participating plants.

3.0 BENEFITS OF RESPONSE TIME TEST ELIMINATION

By the elimination of response time testing, safety benefit is gained while still maintaining the capability to detect degradation prior to the time when instrument performance degrades beyond acceptable limits. This section describes the improvement in plant safety which can be gained by the elimination of response time testing where calibrations and other surveillances can adequately detect response time degradation. In addition to the safety benefits, significant cost savings are realized due to reductions in manpower and outage days which makes the RTT elimination a Cost Beneficial Licensing Action.

3.1 SAFETY BENEFITS

Elimination of response time tests will result in significant improvement in plant safety by:

(1) Minimizing the Time When Safety Systems are Out of Service or Otherwise Incapable of Responding to a Degraded Plant Condition. Performance of response time testing requires the instruments being tested to be isolated and thus unable to provide an automatic actuation signal to the affected system. Therefore, the affected system is considered Inoperable in accordance with Standard Technical Specification Definitions of Operability. According to a BWR survey, the time required to conduct these RTTs ranges from one to three days per division. Elimination of unnecessary response time tests will improve plant safety by reducing the time safety systems are out of service for testing.

(2) Reducing the Potential for Inadvertent Essential Safety Function (ESF) Actuations. A significant number of ESF actuations occur due to response time activities. A high potential for error is present during the installation and removal of temporary circuit alterations required to realign plant safety systems to a configuration which will allow response time testing. Therefore, elimination of unnecessary RTTs reduces the potential of plant transients caused by ESF actuations.

(3) Reducing the Complexity of Refuel Outages and thus Reduce Shutdown Risk. This concern deals with the extension of ECCS inoperability windows and the complexity of having more than one safety system incapable of performing its safety function. In general, each ECCS divisional window is extended by one to three days to accommodate response time testing. This increases the total time that ECCS makeup capabilities to the reactor or fuel pools are not available. For a plant with three ECCS divisions, this time could add three to nine days to an outage. During refuel activities, the ECCS and major piping are realigned frequently to support a wide variety of maintenance tasks, leading to some increased probability of draindown events. Although Technical Specifications contain specific minimum requirements for makeup capabilities which must always be met, it is now widely accepted that outage activities affect the core damage frequency (shutdown risk). Elimination of unnecessary response time testing activities reduces the shutdown risk due to the unavailability of safety systems.

(4) Reducing Personnel Radiation Exposure (ALARA). Complex response time testing requires stationing personnel at the location of instrument sensors which are often in radiation areas. The BWROG survey results show an estimated dose reduction of 0.5 to 3.0 man-rem per outage.

(5) Allow Critical Personnel To Be Used For More Significant Tasks. A survey performed by the BWROG showed that the elimination of response time testing on select systems will result in a savings of 1500 to 2600 man-hours per outage. This estimate does not include additional man-hours needed for support personnel such as health physics, engineering and outage planning personnel. These personnel can be utilized to perform other tasks which have a greater impact on plant safety.

Based on the above, the elimination of response time testing for the selected instrumentation listed in this submittal provides significant benefits in the availability and operation of safety systems as well as providing the opportunity to reduce dose and utilize plant resources more effectively. Therefore, it can be concluded that response time testing should be eliminated as a Cost Beneficial Licensing Action.

3.2 COST SAVINGS

Based on the BWROG survey, the savings in man-hours are 1500 to 2600 per outage. This represents at least $50,000/year/plant savings in manpower alone. This is a very conservative estimate since additional cost savings will be realized in reduced personnel radiation exposure and the potential reduction in outage days which contribute to the loss of power generation. This estimated savings could be conservatively increased by a factor of two when these additional factors are considered (i.e., $100,000/year/plant).

4.0 APPROACH

The fundamental approach developed in this study is consistent with Regulatory Guide 1.118, Revision 2 (Reference 2), which endorses IEEE 338-1977 (Reference 3), and is stated as follows:

> "Response time testing of all safety-related equipment, per se, is not required if, in lieu of response time testing, the response time of the safety equipment is verified by functional testing, calibration checks or other tests, or both. This is acceptable if it can be demonstrated that changes in response time beyond acceptable limits are accompanied by changes in performance characteristics which are detectable during routine periodic tests."

The analysis flow process is presented in Figure 4-1. Fermi-2 and River Bend were selected as lead plants to represent a typical BWR/4 and a BWR/6 plant, respectively. Technical Specification response time testing requirements ("RTT Trip Functions") for these lead plants are listed in Tables 4-1 and 4-2, respectively.

After the Technical Specification trip functions were identified for the lead plants, a detailed listing of specific loop components was compiled for each loop. Typically, there are 20 to 24 trip functions per plant. All components in the affected instrumentation loops which could potentially affect the loop response time were identified. These components include transmitters, relays, trip units, switches, indicator trip units (radiation), trip auxiliary units (radiation), log rad monitors (radiation); and Bailey/GMAC alarm units, summers, and square root extractors.

Detailed failure mode evaluations were then conducted for all instrumentation loop components in order to determine whether failures could affect response time. When it was determined that failure modes could affect instrument loop response times, the consequences of such failure were evaluated. An analysis was then made to determine whether other surveillance testing would identify these potential response time degradations. As part of the failure mode evaluations, component experts and vendors were contacted to assist with and verify the analysis.

A review of component failure experience was performed by conducting BWR-specific surveys, and by researching the Nuclear Plant Reliability Data System (NPRDS), NRC Bulletins, NRC Information Notices, and GE Service Information Letters (SILS). This review was used to determine if actual RTT failures could be reasonably detected by surveillance testing other than RTT.

The BWR Owners' Group RTT program also takes advantage of the work performed by EPRI (Reference 1) which evaluated failure modes and effects analyses (FMEAs) for most of the sensors employed in the applicable BWR instrumentation loops. The EPRI report covered both field data and macroscopic FMEAs. Approximately 4200 RTT data points from 39 utilities were analyzed. This document was reviewed and in a few cases supplemental evaluations were conducted to include the analyses of sensors not covered in the EPRI study.

Following completion of the lead plant baseline response time testing analyses, a plant-specific verification was performed for each of the other participating plants. Component and instrumentation loop differences were identified and dispositioned either by showing that the baseline analyses adequately covers the differences or by conducting additional failure mode and effects analyses. Response time tests of individual components within instrument loops were identified for elimination based on the above analyses. Individual plant Technical Specifications were marked-up to reflect the proposed elimination of response time tests.

Following NRC approval of this generic BWR Owners' Group Licensing Topical Report, each participating utility will prepare a plant-specific license change request using the guidance provided in Appendix I.

Table 4-1

FERMI-2 RTT REQUIREMENTS SELECTED FOR ANALYSES

	Fermi-2 RTT Trip Functions	Tech. Spec. Table Number	Response Time (sec) (e)
Reactor Protection System Response Times:			
3.	Reactor Vessel Steam Dome Pressure - High	3.3.1-2	≤ 0.55
4.	Reactor Vessel Water Level - Low Level 3	3.3.1-2	≤ 1.05
1. Primary Containment Isolation:			
a.1	Reactor Vessel Low Water Level - Level 3	3.3.2-3	≤ 13.0(a)
a.2	Reactor Vessel Low Water Level - Level 2	3.3.2-3	≤ 13.0(a)(d)
a.3	Reactor Vessel Low Water Level - Level 1	3.3.2-3	≤ 1.0(c) ≤ 13.0(a)(d)
b.	Drywell Pressure - High	3.3.2-3	≤ 13.0(a)
1. Main Steam Line:			
c.1	Main Steam Line Radiation - High	3.3.2-3	≤ 13.0(a)(b)(d)
c.2	Main Steam Line Pressure - Low	3.3.2-3	≤ 13.0(a)(d)
c.3	Main Steam Line Flow - High	3.3.2-3	≤ 13.0(a)(d)
2. Reactor Water Cleanup System Isolation:			
e.	Reactor Vessel Water Level - Level 2	3.3.2-3	≤ 13.0(a)
3. Reactor Core Isolation Cooling System Isolation:			
a.	RCIC Steam Line Flow - High	3.3.2-3	≤ 13.0(a)
b.	RCIC Steam Supply Pressure - Low	3.3.2-3	≤ 13.0(a)
4. High Pressure Coolant Injection System Isolation:			
a.	HPCI Steam Flow - High	3.3.2-3	≤ 13.0(a)
b.	HPCI Steam Supply Pressure - Low	3.3.2-3	≤ 13.0(a)
6. Secondary Containment Isolation:			
a.	Reactor Vessel Low Water Level - Level 2	3.3.2-3	≤ 13.0(a)
b.	Drywell Pressure - High	3.3.2-3	≤ 13.0(a)
c.	Fuel Pool Ventilation Exhaust Radiation - High	3.3.2-3	≤ 13.0(a)(b)
Emergency Core Cooling System (ECCS):			
1. Core Spray System:			
a.	Reactor Vessel Low Water Level - Level 1	3.3.3-3	≤ 30.0
b.	Drywell Pressure - High	3.3.3-3	≤ 30.0

Table 4-1

FERMI-2 RTT REQUIREMENTS SELECTED FOR ANALYSES
(Continued)

	Fermi-2 RTT Trip Functions	Tech. Spec. Table Number	Response Time (sec)
2.	Low Pressure Coolant Injection Mode of RHR System:		
a.	Reactor Vessel Low Water Level - Level 1	3.3.3-3	≤ 55.0
b.	Drywell Pressure - High	3.3.3-3	≤ 55.0
3.	High Pressure Coolant Injection System:		
a.	Reactor Vessel Low Water Level - Level 2	3.3.3-3	≤ 30.0

NOTES:

(a) Isolation System instrumentation response time shall be measured and recorded as part of the ISOLATION SYSTEM RESPONSE TIME. Isolation system instrumentation response time specified includes diesel generator starting and sequence loading delays.

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

(c) Isolation System instrumentation response time for MSIVs only. No diesel generator delays assumed for MSIVs.

(d) Isolation System instrumentation response time for associated valves except MSIVs.

(e) Isolation System instrumentation response time specified for the Trip Function actuation of each valve group shall be added to isolation time shown in Tables 3.6.3-1 and 3.6.5.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve (applies to Table 3.3.2-3 trip functions only).

Table 4-2

RIVER BEND RTT REQUIREMENTS SELECTED FOR ANALYSES

River Bend RTT Trip Functions	Tech. Spec. Table Number	Response Time (sec) (d)
Reactor Protection System Response Times:		
1. Reactor Vessel Steam Dome Pressure - High	3.3.1-2	≤ 0.35
2. Reactor Vessel Water Level - Low, Level 3	3.3.1-2	≤ 1.05
3. Reactor Vessel Water Level - High, Level 8	3.3.1-2	≤ 1.05
1. Primary Containment Isolation:		
a. Reactor Vessel Water Level - Level 2	3.3.2-3	≤ 10.0(a)
b. Drywell Pressure - High	3.3.2-3	≤ 10.0(a)
2. Main Steam Line Isolation:		
a. Reactor Vessel Water Level - Level 1	3.3.2-3	≤ 1.0(b)/ ≤ 10.0(a)(c)
b. Main Steam Line Radiation - High	3.3.2-3	≤ 1.0(b)/ ≤ 10.0(a)(c)
c. Main Steam Line Pressure - Low	3.3.2-3	≤ 1.0(b)/ ≤ 10.0(a)(c)
d. Main Steam Line Flow - High	3.3.2-3	≤ 0.5(b)/ ≤ 10.0(a)(c)
3. Secondary Containment Isolation:		
a. Reactor Vessel Water Level - Level 2	3.3.2-3	≤ 10.0(a)
b. Drywell Pressure - High	3.3.2-3	≤ 10.0(a)
4. Reactor Water Cleanup System Isolation:		
a. Delta Flow - High	3.3.2-3	≤ 10.0(a)(e)
e. Reactor Vessel Water Level - Level 2	3.3.2-3	≤ 10.0(a)
5. Reactor Core Isolation Cooling System Isolation:		
a. RCIC Steam Line Flow - High	3.3.2-3	≤ 10.0(a)(f)
b. RCIC Steam Supply Pressure - Low	3.3.2-3	≤ 10.0(a)
6. RHR System Isolation:		
c. Reactor Vessel Water Level - Level 3	3.3.2-3	≤ 10.0(a)
d. Reactor Vessel Water Level - Level 1	3.3.2-3	≤ 10.0(a)

Table 4-2

RIVER BEND RTT REQUIREMENTS SELECTED FOR ANALYSES
(Continued)

River Bend RTT Trip Functions	Tech. Spec. Table Number	Response Time (sec)
Emergency Core Cooling System (ECCS):		
1. Low Pressure Core Spray System (LPCS)	3.3.3-3	≤ 37.0
2. Low Pressure Coolant Injection Mode of RHR System		
a. Pumps A and B	3.3.3-3	≤ 37.0
b. Pump C	3.3.3-3	≤ 37.0
3. High Pressure Core Spray System (HPCI)	3.3.3-3	≤ 27.0

NOTES:

(a) Isolation System instrumentation response time specified includes the diesel generator starting and sequence loading delays.

(b) Isolation System instrumentation response time for MSIVs only. No diesel generator delays assumed.

(c) Isolation System instrumentation response time for associated valves except MSIVs.

(d) Isolation System instrumentation response time specified for the Trip Function actuation of each valve group shall be added to isolation time shown in Tables 3.6.4-1 and 3.6.5.3-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve (applies to Table 3.3.2-3 trip functions only).

(e) Time delay of 45-47 seconds.

(f) Time delay of 3-13 seconds.

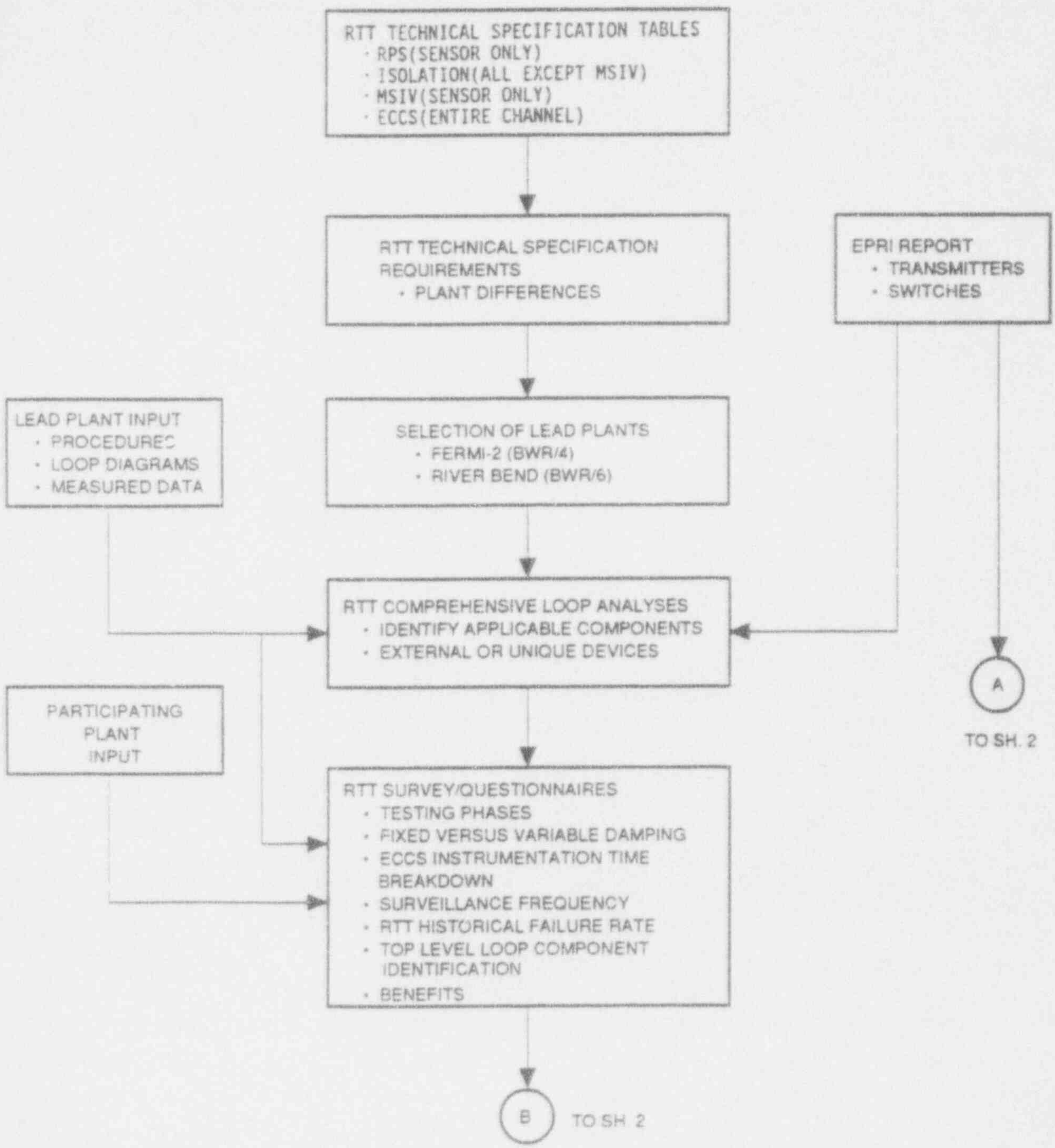


Figure 4-1. Response Time Testing Elimination Analysis Flow Process Sh. 1)

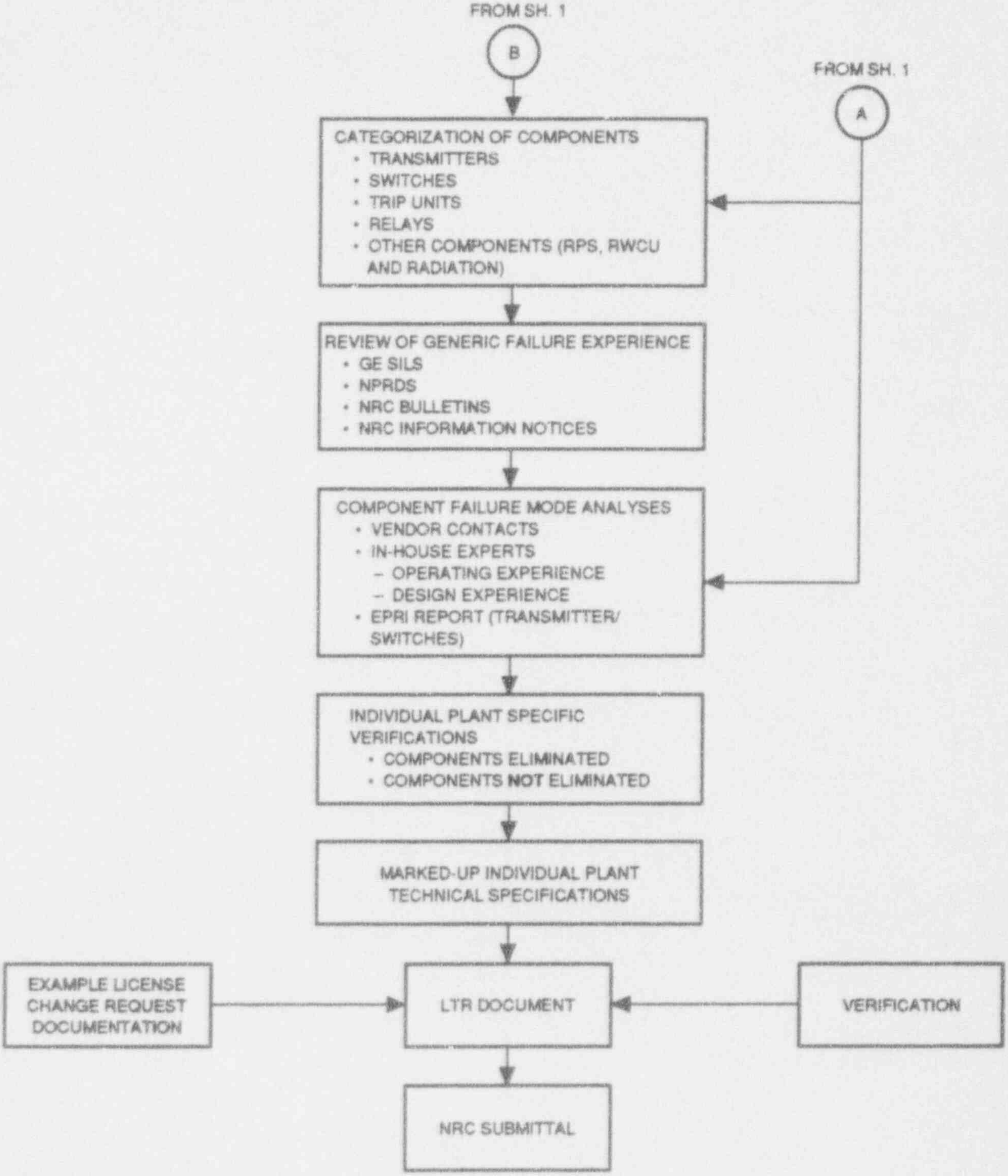


Figure 4-1. Response Time Testing Elimination Analysis Flow Process (Sh.2)

5.0 DESCRIPTION AND LISTING OF SELECTED RESPONSE TIME TESTS TO BE ELIMINATED

5.1 INTRODUCTION

This section provides overall background information concerning the current response time test (RTT) requirements. It provides insights into the basis for selecting certain RTT requirements for elimination and identifies the margins available in affected systems. Analyses have determined that a small increase in instrumentation response will not adversely affect system safety functions. A small increase in response time on the order of 5 seconds can be reasonably detected during periodic surveillance tests.

5.2 SYSTEMS REQUIRING RESPONSE TIME TESTING

The response time testing (RTT) Technical Specification tables for the participating plants are provided in Appendix B. The two BWR product lines (BWR 4s and BWR 6s) have been grouped separately. These tables reveal that the RTT Technical Specification requirements fall into three systems: (1) Reactor Protection System (RPS), (2) Isolation Actuation Instrumentation, and (3) Emergency Core Cooling system (ECCS).

5.3 RESPONSE TIME TESTS SELECTION FOR ELIMINATION

The RTT requirements for Isolation Actuation and ECCS instrumentation, are proposed to be eliminated for the entire instrumentation loops. For RPS and MSIV Actuation instrumentation, justification is provided for only the sensor in the loop based on the EPRI report for sensor RTT elimination (Reference 1). The response times for the Isolation Actuation and ECCS instrumentation are a small fraction of the total system response time requirements (Isolation Actuation 10 to 13 sec., and ECCS 27 to 64 sec.). Instrumentation components that may experience response time degradation will continue to respond in the microsecond-to-millisecond range prior to complete failure. Therefore, such response time degradation would have no significant adverse effect and the instrumentation would continue to meet the overall system requirements. If the response time should degrade to as much as 5 seconds, this degradation would with reasonable assurance be detected during periodic surveillance tests (functional tests, calibrations, and channel checks).

Conversely, in RPS and MSIV actuation instrumentation loops the overall Technical Specification response time requirements are much shorter (0.33 to 2.0 sec.). For the same component, the response time degradation before failure can be significant in relation to the overall system response time requirement. As a result, changes in instrumentation response time beyond acceptable limits given in Technical Specifications may not be readily detected for all components during other surveillance tests. Analyses of selected instrumentation sensors performed by EPRI (Reference 1) indicate that failure modes that affect sensor response times beyond acceptable limits can be detected during calibrations or other surveillance tests. The BWR Owners' Group decided to use these analyses as a basis for elimination of selected sensor RTTs but not to extend the analyses to the remaining instrumentation components (trip units, relays, etc.) for RPS and MSIV Actuation loops. Therefore, only the selected sensor RTTs are proposed for elimination in the RPS and MSIV Actuation instrumentation loops.

Table 5-1 shows the range of participating BWR instrumentation RTT requirements for (1) RPS, (2) Isolation Actuation Instrumentation, and (3) ECCS. The following is a discussion of the individual trip functions where RTTs are proposed to be eliminated. The discussion includes an assessment of the effect of a 5 second delay in instrumentation response time beyond the normally acceptable Technical Specification response time value (see Appendix J for detailed discussion). This assessment provides added assurance that there is sufficient time within existing safety margins for an I&C technician to reasonably detect a failure or degradation in the instrumentation response time. The 5 second delay was chosen based on a survey of I&C technicians from participating BWR plants.

5.3.1 Reactor Protection System

The three selected trip functions in the RPS area considered for elimination of response time testing are:

- Reactor Vessel Steam Dome Pressure - High

- Reactor Vessel Water level - Low, Level 3

- Reactor Vessel Water Level - High, Level 8

The typical instrumentation response time requirements for these RPS trip functions range from 0.33 to 1.05 seconds. These RPS circuits have more restrictive response time requirements than the Isolation Actuation System and ECCS. Therefore, for the RPS, only the sensors analyzed by EPRI were considered for response time testing elimination (Reference 1).

A 5 second delay in the sensors for the above RPS trip functions was determined to have no significant impact on plant safety. For the level 3 sensors, a slight delay in the scram actuation would not affect plant thermal limits or fuel integrity and the core cooling function. A delay in the Level 8 scram sensors would cause a slight increase in reactor water level but would not result in cold water intrusion into the main steam lines. A delay in the reactor high steam dome pressure sensors would not affect the integrity of the reactor vessel or core thermal limits. A detailed discussion of the effect of a delay in these RPS trip functions is provided in Appendix J.

5.3.2 Isolation Actuation Instrumentation

The Isolation Actuation System instrumentation response time requirements given in typical plant specifications are in the range of $\leq$ 10 sec. to $\leq$ 13 sec. (MSIV actuation instrumentation response time requirements are typically between $\leq$ 0.5 to $\leq$ 2.0 sec.). The actual instrumentation circuits typically operate in a fraction of a second.

The following Isolation Actuation instrumentation Technical Specification response time requirements were considered for elimination:

Main Steam Isolation Valve (MSIV) Closure

- Reactor Water Level 1 or 2
- MSL Radiation High
- MSL Low Pressure

Remaining Isolation Actuation

- Reactor Core Isolation Cooling (RCIC) System
- High Pressure Coolant Injection (HPCI) System
- High Pressure Coolant Spray (HPCS) System
- Reactor Water Cleanup (RWCU) System

- Primary Containment
- Secondary Containment
- Residual Heat Removal (RHR) Shutdown Cooling/Head Spray

Because the Isolation Actuation instrumentation logic functions are in parallel with the startup of the diesel generators, the response time requirements (≤ 10 sec. to ≤ 13 sec.) are not critical for the majority of the isolation circuits. This is consistent with the recommendations of Generic Letter 93-05 (Reference 5) and NUREG-1366 (Reference 6) relating to the deletion of response time testing where the required time corresponds to the diesel start time. The main steam isolation valves (0.5 sec. to 2.0 sec.) are an exception. Hence, elimination of response time testing for the MSIV actuation circuits covers only the sensors.

A 5 second delay in the sensors that initiate MSIV closure (Reactor Water Level 1 or 2, Main Steam Line (MSL) Radiation High and MSL Low Pressure) will not significantly affect plant safety. The only purpose of the MSIV closure for low reactor water level events is to limit the potential increase in the offsite dose. No fuel damage would occur even if there is a slight delay (5 seconds) in the MSIV closure under these conditions.

The MSIV closure on high radiation level is required when fuel failure has occurred. The increase in radioactivity will not occur in the first several minutes of the event and will be contained in the steam lines.

MSIV closure on low MSL pressure is provided to protect the reactor system during normal power generation against transients that could cause uncontrolled depressurization. A 5 second delay in this sensor trip would not affect vessel integrity or plant safety since the reactor vessel is designed to accommodate even more rapid depressurizations than for this event.

A 5 second delay in the sensors that isolate the remaining systems listed above does not have any effect on the plant safety. This delay is a small fraction of the required 10 to 13 seconds actuation time assumed in the safety analysis.

A more detailed discussion of the isolation actuation instrumentation delays is provided in Appendix J.

5.3.3 Emergency Core Cooling System (ECCS)

Response time testing requirements for the following systems were considered for elimination:

- Low Pressure Core Spray (27 to 43 sec.)
- Low Pressure Coolant Injection (37 to 64 sec.)
- High Pressure Core Injection/Spray (27 to 35 sec.)

Unlike the isolation system; for ECCS the diesel generator, emergency cooling pumps, and the injection valves response times are in series with the instrumentation response time. For these loops, only the instrumentation will be eliminated from response time testing. The overall ECCS system response time requirement, which includes diesel generator, injection valves, pumps, and other components, still applies. Furthermore, the diesel generator and the injection valve Technical Specification response time requirements are not eliminated. The instrumentation response time requirements are a very small fraction of the total ECCS actuation times.

A 5 second delay in ECCS sensor actuation does not affect plant safety. This is supported by GE analyses performed for various design basis events. A more detailed discussion of the effect of a delay in ECCS instrumentation is provided in Appendix J.

Table 5-1

BWR INSTRUMENTATION RESPONSE TIME TEST REQUIREMENTS

Reactor Protection System

0.33 to 1.05 sec.

Isolation Actuation Instrumentation

MSIV Closure - 0.5 to 2.0 sec.
Remaining - 10 to 13 sec.

ECCS Actuation Instrumentation

LPCS - 27 to 43 sec.
LPCI - 37 to 64 sec.
HPCI/HPCS - 27 to 35 sec.

6.0 ROUTINE PERIODIC TESTS USED TO DETECT CHANGES IN INSTRUMENT RESPONSE

BWROG Analysis has determined that changes in instrument response are detectable prior to the response degradation beyond acceptable limits without the performance of conventional response time testing. Therefore, no additional testing or surveillance tests are required. This section discusses the current testing being performed, the frequency at which the activity is presently performed and the advantages over conventional response time testing.

Current testing which is presently required by Technical Specifications includes calibrations, functional testing, logic system functional testing and channel checks. A description of each test, including Standard Technical Specification definitions and the relative advantages of each method appears in Appendix B to this report. Figure 6-1 shows a typical example of the relative frequency at which each activity is performed. From this figure it can be determined that performance of response time testing of individual instrument channels results in the longest time interval (36 months) between performance of surveillance activities. Response time degradation is more likely to be detected during calibrations, functional tests, or channel checks which are performed at the same or more frequent surveillance intervals (18 months, quarterly or monthly, and once/shift respectively) than RTTs.

Response time degradation beyond acceptable limits is readily detectable by I&C technicians when performing calibrations and functional tests based on the following:

(1) By inputting a standard value over the operating range, the technician can observe any abnormal changes in calibration/functional span and operational range of the instrumentation.

(2) By observing the expected output when an input signal is injected, the technician can determine that the instrumentation is responding properly.

(3) By checking calibration/functional points between zero and 100% of span,

(a) the technician ensures that the instrumentation responds instantaneously with the injection of a test signal and,

(b) the technician ensures the instrumentation performs in accordance with the instruments design characteristics (i.e., linear or logarithmic).

(4) By observing the response from a trip signal initiated during a functional test, the technician is able to detect a response time delay in the actuation of an alarm, light, or relay contact status.

An evaluation of the affected components that exhibit degraded response time during calibrations and functional tests is performed before it is returned to service.

The BWROG has surveyed instrumentation departments at participating plants and selected PWR plants and has determined that a technician can typically qualitatively detect an instrument with a sluggish response prior to the time the response time reaches 5 seconds. To assure that a degradation in response of this magnitude will not affect the margin of safety of affected systems, a realistic bases safety evaluation was made assuming a 5 second delay in sensing a degraded condition. The details of this evaluation are included in Section 5.0 and Appendix J. Participating utilities will make provisions to assure operators and technicians are aware of the consequences of instrument response degradation. Applicable procedures may need to be revised by individual plants to assure that technicians monitor for response time degradation during the performance of calibrations and functional tests.

In addition to testing currently being performed to satisfy Technical Specification requirements, other means are available to evaluate instrument performance. The following is a discussion of two supplementary methods:

(1) **Assessment of as found calibration data.** This method utilizes data obtained during instrument calibrations and compares a trend of as found calibration data to establish a trend of instrument drift. This technique has been used in the past to detect degradation of Rosemount transmitters due to a loss of

fill oil. Because this failure mode may not be detected during response time testing.

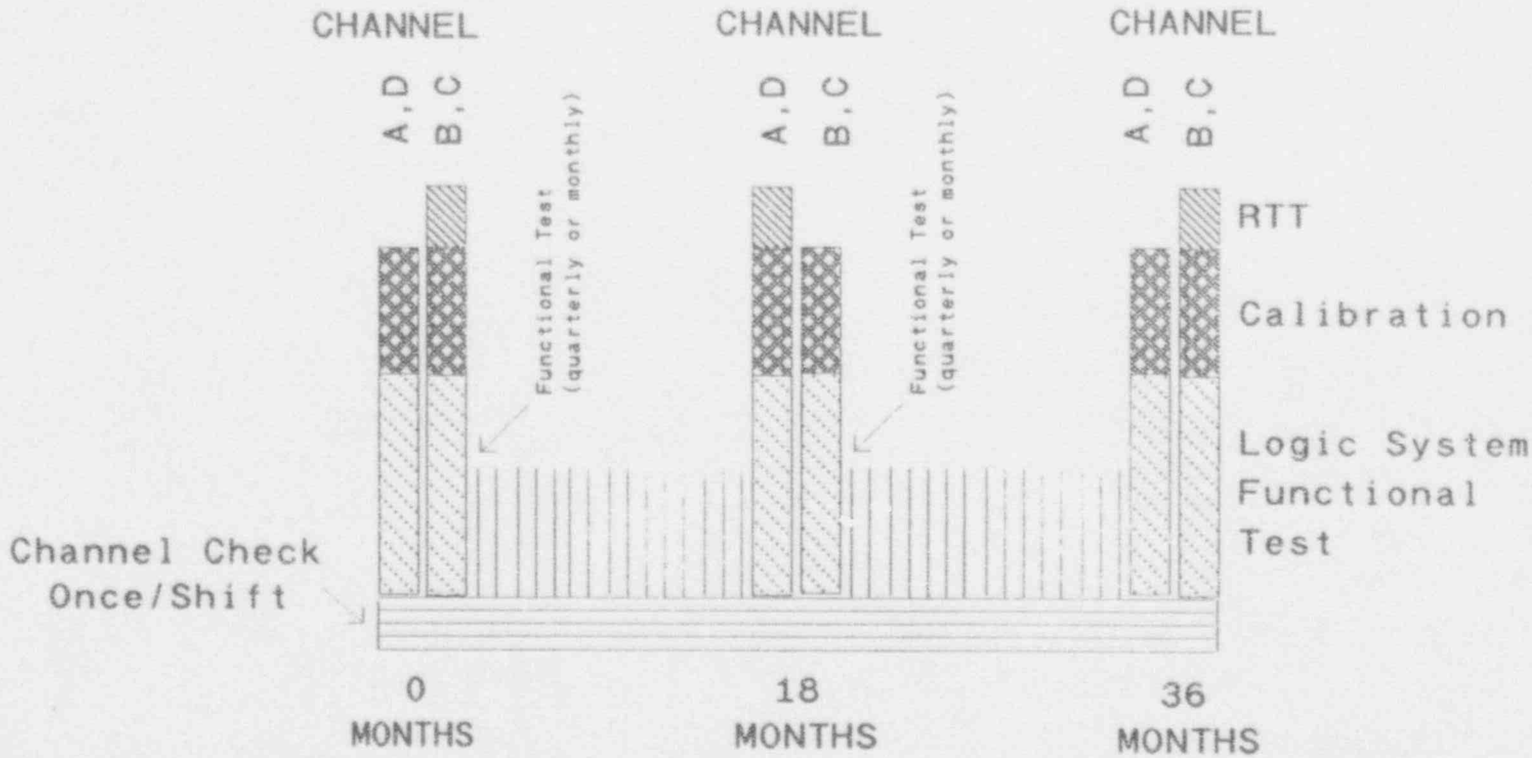
(2) **Operator and technician awareness.** Awareness of the potential for degradation is the first line of defense in monitoring the health of instruments or any equipment. Although this method is qualitative and does not provide any documented data, this type of monitoring is a significant contributor to maintaining instrument health. Operators monitor plant parameters routinely and are the first line of defense in determining if instrumentation does not perform as expected.

Industry activities are currently underway to extend the existing 18-month calibration interval to as long as 36 months. This proposed change does not affect the basis for RTT elimination which relies on calibration tests since the proposed longest calibration frequency extension is identical to the existing channel RTT frequency (36 months).

It can be concluded from the above discussion and analyses summarized in this report that response time degradation can detected by other surveillance techniques prior to the instrument response degrading beyond acceptable limits. Therefore, the BWROG has concluded that the performance of response time testing is not necessary to detect degradation in instrumentation response.

Figure 6-1

Frequency (Typical) of Instrumentation Surveillance Required By BWR Technical Specifications



7.0 ANALYSES RESULTS

This section summarizes the results of the two lead plant-specific analyses and the application of these analyses to other BWR plants participating in this study. These results include plant-specific analyses of all applicable trip functions identified in their respective Technical Specifications.

7.1 LEAD PLANT RTT INSTRUMENTATION LOOP COMPONENT IDENTIFICATION

A comprehensive instrumentation loop component identification was performed for each of the selected trip functions in the Technical Specifications listed in Tables 4-1 and 4-2. The identification included a description of each component, its corresponding function and model/Master Parts List (MPL) or Plant Identification System (PIS) number. The plant drawing numbers and their latest revisions used in the analyses were compiled. Loop devices not covered by lead plant analyses were also addressed. Annunciators, seal-in circuits, recorder pens, alarms etc. that are not required for response time testing were excluded from this evaluation.

A comprehensive listing of loop components for both Fermi-2 and River Bend plants are contained in Appendices C.1 and C.2, respectively.

7.2 CATEGORIZATION OF MAJOR COMPONENTS

Upon completion of the compilation of instrumentation loop components, all the potential response time sensitive components were grouped by component type. Some components (e.g., radiation detectors, logic cards) are exempt from response time testing per Technical Specifications. The response time components were categorized into the following generic component groups:

- Trip Units
- Relays
- Time Delay Relays
- Signal Conditioning Devices (Summer, Square Root Extractor, etc.)
- Radiation Devices (NUMAC, Auxiliary Trip Unit etc.)
- Transmitters/Switches

- Loop Devices (Capacitors for filtering, Alarm Units, power supplies, optical isolators)

A comprehensive listing of vendor models for these component groups is included in Table 7-1. From this extensive database, a generic response time failure mode analysis was performed for each vendor model of the above components.

7.3 COMPONENT FAILURE MODES ANALYSES

This section summarizes the results of the failure modes analyses for the generic components that could potentially affect the instrumentation loop response time. These analyses are based on detailed engineering evaluations including vendor contacts, operating experience, and design experience to investigate the potential failure modes of the specific loop instrumentation. Several instrument vendors were contacted during the component failure modes analyses, and major suppliers, such as General Electric and Westinghouse, have concurred with respect to the acceptability of eliminating conventional response time testing. Additionally, EPRI working closely with various sensor vendors has developed justification for elimination of sensor response time testing. Several of these vendors provided formal comments on the EPRI report (Reference 1) and none of these vendors expressed concern with respect to elimination of RTT.

It is difficult for instrument vendors to state a definitive position on RTT since they do not have a thorough knowledge of the requirements for RTT or how this testing is performed at the various plant sites. Because this may extend their liability, vendors are reluctant to formally document their concurrence with respect to the elimination of RTT. However, Rosemount has commented on the ability of instrument technicians to detect degradation in instrument response time during normal surveillance tests. Rosemount has stated that "... degradation of unit response time in the range of 5 seconds should be recognizable to instrument technicians during normal surveillance testing" (reference 14). A more detailed discussion of the analysis results is provided in Appendix K.

Trip Units

The following can be concluded from the failure mode analyses of the trip units:

(1) No failure modes were identified that could potentially increase the response time above the millisecond range.

(2) No failure modes that delay the normal response time were identified without also affecting calibration or causing misoperation detected in functional tests.

(3) Failure modes (resistance increase) which can extend the response time, can be detected by loss of DC performance and misoperation during functional tests.

Relays

Relay failure modes normally result in a functional failure of the relay or a gross degradation in relay performance. Either of these conditions is readily detectable through functional testing, inspection or observations of abnormalities during routine operation before the response time exceeds required operational limits (≥ 10 seconds).

Time Delay Relays

Time delay relays require calibration for response verification and to assure setpoint accuracy. The time delay relays are also tested as part of Logic System Functional Tests in most BWRs.

Signal Conditioning Devices

Any response time degradation beyond acceptable limits can readily be detected by other surveillance tests.

Radiation Devices

Trip Auxiliary Unit response time failures can be detected during functional tests similar to the relay devices discussed above. Component failures that affect response time in the NUMAC Log Rod Monitor would be in the microsecond range and therefore would not significantly affect the required response time. For the Log Radiation

Monitor (238 x 660 Series), the potential failure modes which could change response time is difficult to justify without extensive testing. For this reason the elimination of response time testing for this device was not recommended.

Transmitter/Switches

Transmitters and switches can be eliminated from response time testing based on analyses performed by EPRI (Reference 1) and additional BWROG Analyses for sensors not included in the EPRI analysis.

(1) Transmitters/Switches Included in EPRI Analysis

Only two failure modes and two manufacturing/handling defects were identified in Reference 1 as affecting response time without concurrently affecting sensor output. These failure modes and defects apply only to sensors utilizing a fill fluid to transfer the process pressure to the sensing element. Rosemount sensors are the only sensors of this type identified for plants participating in this BWROG study. The two failure modes affecting response time are the slow loss of fill fluid during pressurized operations and variable damping potentiometer misadjustments during maintenance. For sensors that are susceptible to the slow loss of fill-oil, Drift Analysis is the preferred method to detect the change in instrument performance. Other diagnostic techniques such as sluggish response and process noise analysis may be used to supplement Drift Analysis. When enough fluid (Reference 10-13) is lost to cause a significant response time degradation, the sluggish response of the leaking sensor will be detected during transmitter calibration.

For transmitters with variable damping, measures must be taken to ensure that the potentiometer is at the required setting at the time of installation and after major maintenance.

The two manufacturing and handling defects are low sensor fill fluid during manufacturing and crimped fill capillaries due to manufacturing or mishandling during installation/maintenance. Since November 1989, vendor testing has been implemented to ensure acceptable fill and capillaries. In addition, when low fill fluid or crimped capillaries affect response time, the degradation can be detected during pre-installation calibration.

(2) Transmitters/Switches Not Included in EPRI Analysis

Two switch models used in BWR plants were not part of the EPRI report. The analysis of the failure modes that could potentially affect the response time of these components indicate that response time testing is not required.

Loop Devices

The analysis of several other components used in the instrumentation loops of participating BWR plants indicate either response time is not affected or the degradation in response time beyond acceptable limits would be detected by other surveillance tests.

7.4 FAILURE EXPERIENCE REVIEW

A review of industry failure experience provides valuable insight to potential failure modes. The sources of this database search affecting instrumentation response times include:

- EPRI
- GE SILs (Service Information Letters)
- NPRDS
- NRC Bulletins
- NRC Information Notices
- Plant Surveys

A representative listing of the response time sensitive component failure experience, along with the Technical Specification surveillance testing that would have also identified the failure mode, is shown in Appendices D and E. Appendix D provides the results from a review of generic BWR experience. Appendix E provides the results of experience as reported in plant surveys.

FAILURE EXPERIENCE DATABASE SUMMARY:

- End-of-life component failures (approximately 15%, 9 of 70 events)

- Material property defects, which have been improved over the years by using better materials (approximately 20%, 16 of 70 events).

- Improper installations or not properly following procedures (approximately 15%, 10 of 70 events).

- Many manufacturers' defects, inadequate tolerances, and inappropriate design deficiencies have been addressed by new designs (approximately 35%, 25 of 70 events).

- Improper operation of the device, and other miscellaneous failures (approximately 15%, 10 of 70 events).

FAILURE EXPERIENCE REVIEW CONCLUSIONS:

- Function is normally lost when response time is affected.

- Failures affecting response time could have been identified by other tests and/or techniques.

- There are relatively few response time unique failures.

7.5 APPLICATION OF RESULTS TO OTHER PLANTS

The two lead plants analyses, (Fermi-2 representing BWR4s and River Bend representing BWR6s), provide the technical framework for the verification of the other participating BWRs. The majority of the components were identified as part of the lead plant analyses.

Those components that were not covered by the lead plant analyses were analyzed separately. Most of these components are in the RPS, radiation isolation instrumentation area and Reactor Water Cleanup (RWCU) Systems. Some of the components, such as radiation detectors and solid-state logic cards that have a self-test feature, are already exempt from response time testing. Components and devices such as annunciators, seal-in devices, recorder pens, alarms and lights that have no bearing on response time were excluded from these analyses.

A summary of the individual plant-specific verifications for the participating BWRs is provided in Appendix G. As a first step, all RTT components were grouped and listed for each plant. Appendix G also dentifies the type of component and whether it is a unique RPS or radiation component. This classification was necessary for reasons detailed in Section 5 (i.e., only the RPS sensor is exempt from response time testing even though other components within that channel may also qualify for exemption). Radiation channels also employ unique components, and the failure modes evaluation for the radiation channels with Log Rad Monitors (238X660 Series) revealed failures that do not allow elimination of response time testing. Similarly, time delay relays will require calibration to assure setpoint accuracy.

The lead plants analyses were supplemented by individual component failure mode analysis, failure experience reviews, and identification of other tests and/or techniques that can detect response time failure modes. The application of lead plant results, along with additional supporting analyses representing the unique components, justifies the elimination of plant specific RTT requirements identified and documented in Appendix H.

7.6 FUTURE MAINTENANCE AND DESIGN MODIFICATIONS

Plants that implement the recommendations justified in this LTR may need to revise plant procedures and/or provide training to ensure that required testing is performed properly. Although RTT is not required for the majority of the components at the time of "like for like" replacement, acceptance testing is performed as required to ensure critical design requirements are maintained.

Table 7-1

VENDOR MODELS FOR COMPONENT GROUPS

(a) Trip Units

- Rosemount 510DU
- Rosemount 710DU
- GE Trip Unit Series G100-G700

(b) Relays

- GE HFA
- GE HMA
- GE HGA
- Bourns
- Agastat GP/EGP Family
- ASEA RXMH2
- GE SAT6004
- GE Type CR105
- GE Type CR205
- GE Type CR305
- GE Type CR120A
- Potter Brumfield MOR
- Potter Brumfield MDR
- Potter Brumfield KH4690

(c) Time Delay Relays (Require Calibration)

- Agastat TR/ETR
- GE Type CR2820
- Eagle Signal HP5
- Agastat 7000/E7000

(d) Flow Devices (Bailey/GEMAC Modules)

- 752 Summer
- 750 Square Root Extractor

Table 7-1

VENDOR MODELS FOR COMPONENT GROUPS
(Continued)

(e) **Radiation Devices**

- Radiation Detector
  - Sensor/Converter 194X927 (Exempt from RTT)
  - Gamma Ion Chamber 237X731 (Exempt from RTT)

- Trip Auxiliary Unit (238X697 Series)
- Indicator Trip Unit (129B2802 Series)
- NUMAC Log Rad Monitor (304A3700 Series)
- Log Radiation Monitor (238X660 Series) (Not Eliminated from RTT)

(f) **BWR Pressure Sensors Included in the EPRI Analysis**

- Barton 288 and 289 Differential Pressure Indicating Switches
- Barton 763 Gauge Electronic Pressure Transmitter
- Barton 764 Differential Pressure Electronic Transmitter
- Rosemount Differential Pressure Transmitter Models 1151, 1152
- Rosemount Differential Pressure Transmitter Models 1153, 1154
- Rosemount Pressure Transmitter Models 1151, 1152
- Rosemount Pressure Transmitter Models 1153, 1154
- SOR Differential Pressure Switch
- SOR Pressure Switch

(g) **Sensors Included in BWROG Analysis**

- Barton 760
- Barksdale TC9622-3
- Barksdale BIT-M12SS-GE

(h) **External Devices**

- 560 Alarm Unit
- 745 Alarm Unit
- Rosemount/GE Trip Unit Noise Suppression Filter Capacitors
  - Cornell Dublier WBR 2000-50
  - Sprague 500D-35

Table 7-1

VENDOR MODELS FOR COMPONENT GROUPS
(Continued)

(i) <u>Miscellaneous Devices</u>

- Power Supply
- Hi Current Isolator 133D9947
- Optical Isolator 204B6186AA
- Optical Isolator 204B6188AA

8.0 CONCLUSIONS

The BWR Owners' Group has determined selected response time tests required by Technical Specifications can be eliminated as a Cost Beneficial Licensing Action based on improved plant safety and reduced plant operation and maintenance costs. The following is a summary of the general conclusions that support the BWROG proposed changes as a Cost Beneficial Licensing Action:

(1) Response time test elimination provides an improvement to plant safety and operation by:

- Reducing the time safety systems are unavailable
- Reducing safety system actuations
- Reducing shutdown risk
- Limiting radiation exposure to plant personnel
- Eliminating the diversion of key personnel to conduct unnecessary testing

(2) Plant operating history and experience clearly show that response times are maintained with the current practices.

(3) Existing surveillance tests (calibration tests, functional tests, channel checks, and logic system function tests) ensure instrument health based on the following:

- Analysis of instrumentation failure modes confirm with reasonable assurance that failures which affect response times can be detected during other surveillance tests required by current Technical Specifications.
- Instrument response time delays on the order of 5 seconds can be reasonably detected by instrument technicians. Test procedures and training will be revised (if necessary) as part of RTT elimination to provide additional assurance that the instrument technician recognizes response time delays in instrumentation.

(4) Individual instrument channel response time delays for specific trip functions and components (on the order of milliseconds) are a small fraction of response times assumed in safety analyses. Analyses of design basis events indicate that a 5 second delay in the fastest required response times in selected RPS and MSIV closure signals (0.33 to 2.0 seconds) would have no significant safety impact. This 5 second time delay would with reasonable assurance be detected by an instrument technician.

In addition, the following are specific conclusions resulting from the BWROG evaluations:

(1) The response time components can be categorized into the following generic component groups: (1) trip units, (2) relays, (3) time delay relays, (4) RWCU unique flow devices; (5) radiation devices, (6) transmitters and switches, and (7) loop devices. For a majority of these components, failure modes do not affect response times. For components where response time was affected, any significant response time degradation beyond acceptable limits can be readily detected by surveillance tests, except as described below:

- Log Rad Monitors (238X660 Series) have potential failure modes which could change response time. Elimination of response time tests for these components is difficult to justify without extensive testing and therefore cannot be eliminated based on analyses performed by the BWROG to date.

- Time delay relays will require calibrations to assure setpoint accuracy.

- For transmitters with variable damping, measures must be taken to ensure that the potentiometer is at the required setting at time of installation and after major maintenance.

- EPRI Report NP-7243 (Reference 1) identified cases where response time tests did not detect the slow loss of fill-oil. However, Drift Analysis and other techniques are available to detect the resulting change in instrument performance.

- Loss of fill oil in Rosemount transmitters is the subject of NRC Bulletin 90-01 and the associated supplement (Reference 7) as well as Rosemount Technical Bulletins 1 through 4 (References 10-13). Performance of response time testing is not the preferred method to detect loss of fill oil. Licensee actions to address this failure mode have been taken pursuant to NRC Bulletin 90-01 and the associated supplement.

(2) Components such as radiation detectors are exempt from response time testing in the Technical Specifications. Similarly, logic cards with a self-test feature used in solid-state plants are exempt.

(3) RTTs of instrumentation loops for the following trip functions in the Isolation Actuation System instrumentation and ECCS instrumentation can be eliminated based on other Technical Specification surveillance of the instrumentation loops and/or other techniques as required:

- All ECCS actuation instrument loops
- All Isolation System Actuation instrumentation loops except for Main Steam Isolation Valves (MSIVs) sensors

(4) RTTs of sensors for the following trip functions in the RPS and MSIV isolation surveillance requirements can be eliminated based on other required Technical Specification surveillance tests:

- Reactor Water Level 3 (RPS)
- Reactor Water Level 8 (RPS)
- Reactor High Steam Dome Pressure (RPS)
- Reactor Water Level 1 (MSIV Closure)
- Main Steam Line Radiation - High (MSIV Closure)
- Main Steam Line Pressure - Low (MSIV Closure)
- Main Steam Line Flow - High (MSIV Closure)

9.0 REFERENCES

1. EPRI Report, NP-7243, "Investigation of Response Time Testing Requirements," May 1991.

2. Regulatory Guide 1.118, Revision 2, 1978.

3. IEEE 338-1977, "Criteria for Periodic Testing of Nuclear Power Generating Station Safety Systems."

4. ISA-S67-06, "Response Time Testing of Nuclear Safety-Related Instrument Channels in Nuclear Power Plants," 1986.

5. NRC Generic Letter 93-05, "Line-Item Technical Specification Improvements to reduce Surveillance Requirements for Testing During Power Operation," September 27, 1993.

6. NUREG-1366, "Improvements to Technical Specifications Surveillance Requirements," December 1992.

7. NRC Bulletin 90-01: "Loss of Fill-Oil in Transmitter Manufactured by Rosemount," March 9, 1990 and Supplement 1 to NRC Bulletin 90-01, dated December 22, 1992.

8. NUREG/CR-5762, J.F. Gleason, "Comprehensive Aging Assessment of Circuit Breakers and Relays for Nuclear Plant Aging Research (NPAR) Program, Phase II."

9. EPRI NP-7121, Project 2409-6, "Technical Guidance for Detection of Oil-Loss Failure of Rosemount Pressure Transmitters," December 1990.

10. Rosemount Technical Bulletin No. 1, May 10, 1989.

11. Rosemount Technical Bulletin No. 2, July 20, 1989.

12. Rosemount Technical Bulletin No. 3, October 23, 1989.

13. Rosemount Technical Bulletin No. 4, December 22, 1989.

14. Rosemount Letter, "BWR Owners' Group Elimination of Response Time Testing," dated November 10, 1993.

APPENDIX A

PARTICIPATING UTILITIES/PLANTS

LIST OF UTILITIES/PLANTS PARTICIPATING IN THIS EVALUATION

UTILITY NAME	PLANT NAME	BWR PRODUCT LINE
Carolina Power & Light Company	Brunswick 1&2	4
Cleveland Electric Illuminating Co.	Perry	6
Commonwealth Edison Company	LaSalle 1&2	5
Detroit Edison Company	Fermi 2	4
Entergy Operations Inc.	Grand Gulf	6
Georgia Power Company	Hatch 2	4
Gulf States Utilities Company	River Bend	6
Illinois Power Company	Clinton	6
Niagara Mohawk Power Corporation	Nine Mile Point 2	5
Pennsylvania Power & Light Company	Susquehanna 1&2	4
Philadelphia Electric Company	Limerick 1&2	4
Public Service Electric and Gas	Hope Creek	4
Washington Public Power Supply System	WNP 2	5

APPENDIX B

DESCRIPTIONS OF TECHNICAL SPECIFICATION SURVEILLANCE TESTING AND OTHER TECHNIQUES

APPENDIX B

DESCRIPTIONS OF TECHNICAL SPECIFICATION SURVEILLANCE TESTING AND OTHER TECHNIQUES

This Appendix provides descriptions of Technical Specification surveillance testing and includes the response time Technical Specification requirements selected for elimination for the participating BWRs. The BWR 4/5 plant Technical Specification requirement tables have been separated from the BWR 6 tables. The response time testing Technical Specification requirements have been categorized separately for RPS, Isolation Actuation instrumentation and ECCS.

B.1 Channel Calibration

B.1.1 Standard Technical Specification Definition

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel, including the sensor and alarm and/or trip functions and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

B.1.2 Standard Channel Calibration Description

Channel calibrations are typically conducted once every eighteen months, although calibrations may be performed more or less frequently in some applications/plants. Channel calibrations contain more instruments/devices than those required for Technical Specification operability and normally will contain all instruments/devices in the loop. Engineering design calculations are the source of input values, as found (leave alone) and as left tolerances, required limit values and test equipment accuracy. Calibrations are performed by a technician removing the instrument from service and applying a known input. Output is compared to the input at several (typically 9) points over the instrument's range. Degradation in instrument response can be easily detected during calibration.

B.2 Channel Checks

B.2.1 Standard Technical Specification Definition

A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. The determination shall include, where possible, comparisons of channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

B.2.2 Standard Channel Check Description

Channel checks are routinely conducted once per shift or daily. Channel checks are qualitative assessments of channel behavior during operation by observation and comparison of the channel indications and/or status from independent instrumentation channels measuring the same parameter. Redundant channel readings are compared to each other and to the acceptance criteria; hence, a channel check is a judgment as to whether an instrument properly reflects the conditions it is monitoring rather than a simple comparison of readings. The operator performing the channel check must determine if the instrument being checked is acceptable or unacceptable based on plant conditions, instrument behavior and/or past experience.

B.3 Channel Functional Test

B.3.1 Standard Technical Specification Definition

A CHANNEL FUNCTIONAL TEST shall include:

- Analog Channels - the injection of simulated signal into the channel as close to the primary sensor as practicable to verify OPERABILITY including alarm and/or trip functions and channel failure trips.

- Bistable Channels - the injection of a simulated signal into the channel sensor to verify OPERABILITY including alarm and/or trip functions.

The Channel Functional Test may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is tested.

B.3.2 Standard Channel Functional Test Description

Channel functional tests are normally performed once every month or quarter. A signal above a trip setpoint will typically be applied and the proper output functions will be verified. Functional test input may be applied at the trip unit input in lieu of testing the sensor. These are qualitative tests which test instrument function but not necessarily setpoints. A functional test will test as much of the channel as possible without interfering unacceptably with the normal plant operations. This test requires testing from as close to the sensor/transmitter as practicable to the point where a channel loses its identity. In order to verify proper contact operation (whenever possible), functional tests will take credit for installed plant equipment such as lights, alarms, etc. Where a direct indication of contact operation is not available, a voltage test is performed. For circuits which de-energize to actuate logic or contacts OPEN to trip, a visual verification of contact operation may be performed in lieu of a voltage check where the gap between contacts is readily observable.

B.4 Logic System Functional Test

B.4.1 Standard Technical Specification

A LOGIC SYSTEM FUNCTIONAL TEST as defined in existing Standard Technical Specifications is a test of all relays and contacts of a logic circuit, from a sensor to actuated device, to ensure that components are OPERABLE per design requirements.

A LOGIC SYSTEM FUNCTIONAL TEST as defined in the Improved Standard Technical Specifications is a test of all logic components (i.e., all relays and contacts, all trip units, solid-state logic elements, etc.) of a logic circuit, from as close to the sensor as practicable up to, but not including the actuated device, to verify OPERABILITY. The LOGIC SYSTEM FUNCTIONAL TEST may be performed by any series of sequential, overlapping or total system steps such that the entire logic system is tested.

B.4.2 Logic System Functional Test Description

A logic system functional test is typically performed during the outage when the plant is in a cold shutdown condition. A logic system functional test will test the entire loop starting as close to the sensor as practicable all the way to the actuating device. Unlike the monthly/quarterly functional test which will test up to the point where a channel loses its identity, the logic system functional test includes the verification of the stroking of actuation devices.

The logic system functional test will ensure that all possible logic combination paths for a trip signal are tested. Test bypasses are also tests that ensure bypasses do not inhibit trip functions. Logic system functional tests make extensive use of overlap testing. Credit for testing may be taken from calibrations, functional, response time testing, or operational surveillance procedures if they have an appropriate testing frequency.

B.5 Response Time Test

B.5.1 Standard Technical Specification

The REACTOR PROTECTION SYSTEM (ISOLATION SYSTEM, ECCS) RESPONSE TIME of each trip function shall be demonstrated to be within its limit at least once per 18 months. Each test shall include at least one channel per trip system such that all channels are tested at least once every N times 18 months, where N is the total number of redundant channels in a specific trip system.

B.5.2 Response Time Test Description

Response time tests are typically performed during the outage when the plant is in a cold shutdown condition. The response time may be measured by any series of sequential, overlapping or total steps such that the entire response time is measured. The response time test requirements in BWR Technical Specifications for the Isolation Actuation, RPS, and ECCS are provided in Table B-1 for the participating plants.

Extensive review of the participating plant procedures reveals that the majority of the plant response time testing is broken down into three testing phases (Table B-2). The response time testing phases are defined as follows:

Phase I
The sensor response time test is the most complex, resource intensive and exposure dependent part of response time testing.

Phase II
In this phase, the trip unit (master trip unit and slave trip unit), along with the trip unit output relay, is response time tested.

Phase III
This phase tests the remainder of the relay logic up to the actuating device, but not including the actuating device.

Phase IV
Clinton, which is a solid-state plant, employs four testing phases. The testing phases are set up differently for Clinton such that Phase III is defined as the logic delay time constant and Phase IV as the relay logic to the actuating device.

In addition to the overall system or trip function response time Technical Specification requirements, most plants implement administrative limits for each corresponding test phase. The administrative limits are more conservative and are summed to show that the overall Technical Specification requirements are met.

The sensor response times range from as fast as 10 milliseconds to as slow as 530 milliseconds. The response requirement varies, depending on the type of sensor. Trip units, on the other hand, operate in the 2 millisecond range or instantaneous. The design response times for relays range from 15 to 85 milliseconds.

A sample of measured Fermi-2 response time testing results broken down by phase is provided in Table B-3. It can be concluded from these measurements that the instrumentation is a very small part of the overall requirement. The instrumentation tends to operate in the millisecond range as opposed to pumps, valves and the overall system requirement.

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS

ISOLATION ACTUATION (BWR6 PLANTS)

FUNCTION	BWR6 STD. PLT.	GRAND GULF	PERRY	RIVER BEND	CLINTON
PRIMARY CONTAINMENT					
Rx WATER LEVEL					
LEVEL 3					
LEVEL 2, EXCEPT MSIVs	$\leq$13	$\leq$10	NA	$\leq$10	NA
LEVEL 1, EXCEPT MSIVs		$\leq$10	NA		NA
DRYWELL PRESSURE - HIGH	$\leq$13	$\leq$10	NA	$\leq$10	NA
SGTS EXH. RAD. HIGH					
PLANT EXH PLENUM RAD HIGH	$\leq$13				
MAIN STEAM LINE RAD. HIGH					NA
CONT. & DRYWELL VENT EXH. RAD HIGH		$\leq$10	$\leq$10	NA	NA
MAIN STEAM LINE					
RADIATION HIGH	$\leq$1/10	$\leq$1/10	$\leq$1/10	$\leq$1/10	NA
PRESSURE LOW	$\leq$1/10	$\leq$1/10	$\leq$1/10	$\leq$1/10	$\leq$1
FLOW HIGH	$\leq$0.5/10	$\leq$0.5/10	$\leq$0.5/10	$\leq$0.5/10	$\leq$0.5
LEVEL 1	$\leq$1/10	$\leq$1/10	$\leq$1/10	$\leq$1/10	$\leq$1
LEVEL 2					
MSL TUNNEL TEMP HIGH					NA

N/A = Not Applicable

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ISOLATION ACTUATION (BWR6 PLANTS)

FUNCTION	BWR6 STD. PLT.	GRAND GULF	PERRY	RIVER BEND	CLINTON
SECONDARY CONTAINMENT					
Rx BUILDING EXH. RAD. HIGH				NA	NA
DRYWELL PRESSURE HIGH	≤13	≤10	NA	≤10	NA
Rx LEVEL 2	≤13	≤10	NA	≤10	NA
Rx LEVEL 3					
REFUEL FLOOR EXH. RAD. HIGH					
FUEL HANDLING AREA EXH RAD HIGH	≤13	≤ 3		NA	NA
RAILROAD ACCESS SHAFT EXH RAD HIGH					
FUEL POOL VENT EXH. RAD. HIGH		≤ 3			NA
REACTOR WATER CLEANUP SYSTEM					
DELTA FLOW HIGH	≤13	NA	NA	≤10	NA
AREA TEMP HIGH	NA	NA	NA	NA	NA
AREA VENT. TEMP DELTA TEMP HIGH	NA	NA	NA	NA	NA
Rx LEVEL 2	≤13	≤10	NA	≤10	NA
HPCI SYSTEM					
HPCI STEAM LINE FLOW HIGH	NA	NA	NA	NA	NA
HPCI STEAM SUPPLY PRESSURE LOW	NA	NA	NA	NA	NA
DRYWELL PRESSURE HIGH	NA	NA	NA	NA	NA

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ISOLATION ACTUATION (BWR6 PLANTS)

FUNCTION	BWR6 STD. PLT.	GRAND GULF	PERRY	RIVER BEND	CLINTON
RCIC SYSTEM					
RCIC STEAM LINE FLOW HIGH	≤13	≤10	NA	≤10	NA
RCIC STEAM SUPPLY PRESSURE LOW	≤13	≤10	NA	≤10	NA
DRYWELL PRESSURE HIGH		≤10	NA	NA	NA
RHR SHUTDOWN COOLING/HEAD SPRAY					
Rx LEVEL 3	≤13	≤10	NA	≤10	NA
Rx LEVEL 1	≤13			≤10	NA
DRYWELL PRESSURE HIGH	NA	NA	NA	NA	NA

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ISOLATION ACTUATION (BWR4 AND 5 PLANTS)

FUNCTION	BWR4 STD. PLT.	BRUNSWICK	FERMI 2	WNP 2	HATCH 2	HOPE CREEK	LA SALLE 1&2	LIMERICK	SUSQUEHANNA 1&2
PRIMARY CONTAINMENT									
Rx WATER LEVEL									
LEVEL 3	≤13		≤13		≤13		NA		≤10
LEVEL 2, EXCEPT MSIVs	≤13		≤13	≤13	≤13	NA	≤13	≤13	≤10
LEVEL 1, EXCEPT MSIVs		≤13	≤13		≤13	NA	≤13	≤13	≤10
DRYWELL PRESSURE - HIGH	≤13	≤13	≤13	≤13	≤13	NA	≤13	≤13	≤10
SGTS EXH. RAD. HIGH									≤10
PLANT EXH PLENUM RAD HIGH									
MAIN STEAM LINE RAD. HIGH									≤10
CONT. & DRYWELL VENT EXH. RAD HIGH	≤10								
MAIN STEAM LINE									
RADIATION HIGH	≤1/13	≤13	≤13	≤13	≤1	≤1	≤1/13	≤1/13	≤1/10
PRESSURE LOW	≤1/13	≤13	≤13	≤13	≤13	≤1	≤2/13	≤1/13	≤1/10
FLOW HIGH	≤0.5/13		≤13	≤0.5/13	≤1	≤0.5/13	≤0.5/13	≤0.5/13	≤0.5/10
LEVEL 1			NA		≤1	≤1/13	NA	NA	≤10
LEVEL 2	≤13		NA						
MSL TUNNEL TEMP HIGH		≤13	NA		≤13		NA		NA

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ISOLATION ACTUATION (BWR4 AND 5 PLANTS)

FUNCTION	BWR4 STD. PLT.	BRUNSWICK	FERMI 2	WNP 2	HATCH 2	HOPE CREEK	LA SALLE 1&2	LIMERICK	SUSQUEHANNA 1&2
SECONDARY CONTAINMENT									
Rx BUILDING EXH. RAD. HIGH		≤13		≤13	≤13	≤4	≤13		
DRYWELL PRESSURE HIGH	≤13	≤13	≤13	≤13	≤13	NA	≤13	NA	≤10
Rx LEVEL 2		≤1.0	≤13	≤13	≤13	NA	≤13	NA	≤10
Rx LEVEL 3	≤13								
REFUEL FLOOR EXH. RAD. HIGH	≤13				≤13	≤4			≤10
FUEL HANDLING AREA EXH RAD HIGH								NA	≤10
RAILROAD ACCESS SHAFT EXH RAD HIGH	≤13								≤10
FUEL POOL VENT EXH. RAD. HIGH			≤13				≤13		
REACTOR WATER CLEANUP SYSTEM									
DELTA FLOW HIGH	≤13	≤13	NA	≤13	≤13	NA	≤13	≤13	≤10
AREA TEMP HIGH	NA	≤13	NA		≤13	NA	NA	NA	NA
AREA VENT. TEMP DELTA TEMP HIGH	NA	≤13	NA		≤13	NA	NA	NA	NA
Rx LEVEL 2	≤13	≤1.0	≤13	≤13	≤13	NA	≤13	≤13	≤10
HPCI SYSTEM									
HPCI STEAM LINE FLOW HIGH	≤13	≤13	≤13		3≤T≤13	NA	NA	≤13	≤10
HPCI STEAM SUPPLY PRESSURE LOW	≤13	≤13	≤13		≤13	NA	NA	≤13	≤10
DRYWELL PRESSURE HIGH					≤13	NA	NA		≤10

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ISOLATION ACTUATION (BWR4 AND 5 PLANTS)

FUNCTION	BWR4 STD. PLT.	BRUNSWICK	FERMI 2	WNP 2	HATCH 2	HOPE CREEK	LA SALLE 1&2	LIMERICK	SUSQUEHANNA 1&2
RCIC SYSTEM									
RCIC STEAM LINE FLOW HIGH	≤13	≤13	≤13	≤13	3≤T≤13	NA	≤13	≤13	≤10
RCIC STEAM SUPPLY PRESSURE LOW	≤13		≤13	≤13	NA	NA	≤13	≤13	≤10
DRYWELL PRESSURE HIGH			NA		≤13	NA	NA		≤10
RHR SHUTDOWN COOLING/HEAD SPRAY									
Rx LEVEL 3	≤13		NA	≤13	NA	NA	≤13	≤13	≤10
Rx LEVEL 1			NA						
DRYWELL PRESSURE HIGH			NA		NA				≤10

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

RPS (BWR6 PLANTS)

FUNCTION	BWR6 STD. PLT.	GRAND GULF	PERRY	RIVER BEND	CLINTON
APRM (1)					
FLOW REF. SIMULATED THERMAL POWER-UPSCALE	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09
FIXED NEUTRON FLUX - UPSCALE	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09
Rx DOME PRESSURE - HIGH	≤0.35	≤0.35	≤0.35	≤0.35	≤0.33
Rx WATER LEVEL 3	≤0.30	≤1.05	≤1.05	≤1.05	≤1.03
Rx WATER LEVEL 8	≤0.30	≤1.05	≤1.05	≤1.05	≤1.03
MSIV - CLOSURE	≤0.06	≤0.06	≤0.06	≤0.09	≤0.04
TURBINE STOP VALVE CLOSURE	≤0.06	≤0.10	≤0.06	≤0.06	≤0.04
TURBINE CONTROL VALVE FAST CLOSURE (TRIP OIL PRESSURE LOW) (2)	≤0.07	≤0.10	≤0.07	≤0.07	≤0.05

(1) NEUTRON DETECTORS ARE EXEMPT FROM RTT. RESPONSE TIME TO BE MEASURED FROM DETECTOR OUTPUT OR FROM THE INPUT OF FIRST ELECTRONIC COMPONENT IN THE CHANNEL

(2) TYPICALLY MEASURED FROM ACTUATION OF FAST-ACTING SOLENOID (SEE APPLICABLE TECHNICAL SPECIFICATIONS)

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

RPS (BWR4/5 PLANTS)

FUNCTION	BWR4 STD. PLT.	BRUNSWICK	FERMI-2	WNP 2	HATCH	HOPE CREEK	LA SALLE	LIMERICK	SUSQUEHANNA
APRM (1)									
FLOW BIASED SIMULATED THERMAL POWER - HIGH	≤0.09		6 ± 1	6 ± 1	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09
FIXED NEUTRON FLUX - HIGH	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09	≤0.09
Rx DOME PRESSURE - HIGH	≤0.55	≤0.55	≤0.55	≤0.55	≤0.55	≤0.55	≤0.55	≤0.55	≤0.55
Rx WATER LEVEL 3	≤1.05	≤1.05	≤1.05	≤1.05	≤1.05	≤1.05	≤1.05	≤1.05	≤1.05
Rx WATER LEVEL 8									
MSIV - CLOSURE	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06
TURBINE STOP VALVE CLOSURE	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06	≤0.06
TURBINE CONTROL VALVE FAST CLOSURE (TRIP OIL PRESSURE LOW) (2)	≤0.08	≤0.06	≤0.08	≤0.08	≤0.08	≤0.06	≤0.08	≤0.08	≤0.08

(1) NEUTRON DETECTORS ARE ELIMINATED FROM RTT. RESPONSE TIME TO BE MEASURED FROM DETECTOR OUTPUT OR FROM THE INPUT OF FIRST ELECTRONIC COMPONENT IN THE CHANNEL

(2) TYPICALLY MEASURED FROM ACTUATION OF FAST-ACTING SOLENOID (SEE APPLICABLE TECHNICAL SPECIFICATIONS)

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

ECCS (BWR4, 5 AND 6 PLANTS)

ECCS SYSTEM	BWR/4 STD. PLT.	BWR/6 STD. PLT.	HATCH 2	SUSQ 1&2 LIMERICK 1	FERMI 2	HOPE CREEK	GRAND GULF	RIVER BEND CLINTON	LA SALLE 1&2	PERRY	WNP 2	Brunswick
LPCS	≤27	≤40	≤34	≤27	≤30	≤27	NA	≤37	≤40	≤37	≤43	≤27
LPCI	≤40	≤65 & 40	≤64	≤40	≤55	≤40	NA	≤37	≤40	≤37	≤43	≤40
HPCI (HPCS)	≤30	≤27	≤30	≤30	≤30	≤35	≤27	≤27	≤27	≤27	≤27	≤30
ADS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	KA
ARM LL SET			1	---	---	---	---	---	---	---	---	---

Table B-1

RESPONSE TIME (SEC) TEST REQUIREMENTS IN BWR TECHNICAL SPECIFICATIONS
(Continued)

END-OF-CYCLE RECIRCULATION PUMP TRIP SYSTEM (BWR4, 5 AND 6 PLANTS)

FUNCTION RESPONSE TIME (MILLISECONDS)	GRAND GULF	LA SALLE	SUSQUEHANNA
1. TURBINE STOP VALVE - CLOSURE	≤ 190	≤ 97	≤ 175
2. TURBINE CONTROL VALVE - FAST CLOSURE	≤ 190	≤ 97	≤ 175

Table B-2

RTT TESTING BROKEN DOWN BY TESTING PHASES

	Brunswick**	Clinton++	# Fermi-2	Grand Gulf	Hanford	Hatch*	## Hope Creek	## LaSalle	Limerick	Perry***	River Bend	Susquehanna+
Phase I	X	X	X	X	X	X	X	X	X	X	X	X
Phase II	X	X	X	X	X	X	X	X	X	X	X	X
Phase III	X	X	X	X	X	NA	X	X	X	X	X	X
Phase IV	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

Phase I - Sensor
Phase II - Trip Unit and MTU output relay
Phase III - Relay logic to actuating device

+ ECCS RTT has two phases.
++ Clinton has Phase III defined as logic delay time constant and Phase IV has relay logic to actuating device.
* Some trip functions in HPCI, MSL - Radiation Hi Fuel Pool Ventilation, RWCU are tested together.
** RPS testing is done in different combinations of Phases I and II. Phase III testing is rolled into these tests.
*** Although Perry does not specify testing phases, Phases I and II are combined to provide a loop response. The results from this combined testing are incorporated within select system performance tests to complete the entire response time test.
# Fermi-2 has one phase for the radiation monitors.
Hope Creek and LaSalle perform Phase I testing, but Phases II and III are combined into a single phase of testing.

Table B-3

FERMI-2 RTT MEASUREMENT DATA AND RESULTS

RTT Loops	Sensor Number	RTT Procedure Number	RTT Procedure Revision	Phase I (msec)	Phase II (msec)	Phase III (msec)	Total (msec)
MSL PRESS. LOW	B21N076 A	44.020.031	23	27	61	82	170.0
	B	44.020.032	22	30	64.5	80	174.5
	C	44.020.033	22	17	53	94	164.0
	D	44.020.034	21	30	52	94	176.0
RPS STEAM DOME HI	B21N078 A	44.010.009	21	150	53	19	222.0
	B	44.010.010	21	150	59	19.5	228.5
	C	44.010.011	21	62.5	56.5	29.5	148.5
	D	44.010.012	21	23.4	54	28	105.4
RPS LEVEL-3	B21N080 A	44.010.021	21	425	67	81 (NS4)	573.0
NS4 LEVEL-3						41 (RPS)	533.0
	B	44.010.022	21	400	62	72 (NS4)	534.0
						26 (RPS)	488.0
	C	44.010.023	21	435	55	81.6 (NS4)	571.6
						32 (RPS)	522.0
	D	44.010.024	21	360	61	79 (NS4)	500.0
						38 (RPS)	459.0

Table B-3

FERMI-2 RTT MEASUREMENT DATA AND RESULTS (Continued)

RTT Loops	Sensor Number	RTT Procedure Number	RTT Procedure Revision	Phase I (msec)	Phase II (msec)	Phase III (msec)	Total (msec)
PCI LEVEL-2	B21N081 A	44.020.011	21	130	57	72.2 (RxL1)	259.2
RX WTR LEVEL-1						107.2 (RxL2)	294.2
	B	44.020.012	21	70	110	69 (RxL1)	249.0
						95 (RxL2)	275.0
	C	44.020.013	21	200	110	89 (RxL1)	399.0
						100 (RxL2)	410.0
	D	44.020.014	21	220	53	78.6 (RxL1)	351.6
						85.6 (RxL2)	358.6
						RHR CS HPCI	
ECCS	B21N094 E	44.030.307	20	400	20	98 68 80	578*
DRYWELL PRESS. HI	F	44.030.308	21	420	17	95 80 83	532
	G	44.030.309	20	350	19	67 59 61	436
	H	44.030.310	21	530	16	67 67 67	613
DRYWELL PRESS. HI	C71N050 A	44.020.015	22	152	49.5	113	314.5
	B	44.020.016	22	127	61	110.7	298.7
	C	44.020.017	22	85	55	155	295.0
	D	44.020.018	22	100	53	105	258
RCIC FLOW HI	E41N057 A	44.020.261	21	32	20	2.9 sec	2.952 sec
	B	44.020.262	21	20	21	3.2 sec	3.241 sec

Table B-3

FERMI-2 RTT MEASUREMENT DATA AND RESULTS (Continued)

RTT Loops	Sensor Number	RTT Procedure Number	RTT Procedure Revision	Phase I (msec)	Phase II (msec)	Phase III (msec)	Total (msec)
HPCI PRESS. Low	E41N058 A	44.020.215	21	10	19	125	154.0
	B	44.020.216	21	20	22	110	152.0
	C	44.020.217	21	10	19	86	115.0
	D	44.020.218	22	12	23	74	109.0
RCIC PRESS. Low	E51N057 A	44.020.259	22	70	21	2.325 sec	2.416 sec
	B	44.020.260	21	90	20	3.07 sec	3.16 sec
HPCI	E51N058 A	44.020.255	20	28	22	76	126.0
	B	44.020.256	21	27	21	91	139.0
	C	44.020.257	21	30	20	67	117.0
	D	44.020.258	21	30	20	75	125.0
MSL FLOW HI	B21N086 A	44.020.043	21	30	80	113	223.0
	B	44.020.044	21	26	62	72	160.0
	C	44.020.045	21	30	56	76	162.0
	D	44.020.046	21	25	50	77	152
MSL FLOW HI	B21N087 A	44.020.043	21	20	85	113	218.0
	B	44.020.044	21	30	54	72	156.0
	C	44.[illegible].045	21	24	54	76	154.0
	D	44.020.046	21	23	51	77	151.0

Table B-3

FERMI-2 RTT MEASUREMENT DATA AND RESULTS (Continued)

RTT Loops	Sensor Number	RTT Procedure Number	RTT Procedure Revision	Phase I (msec)	Phase II (msec)	Phase III (msec)	Total (msec)
MSL FLOW HI	B21N088 A	44.020.043	21	24	95	113	232.0
	B	44.020.044	21	27	57	72	156.0
	C	44.020.045	21	28	63	76	167.0
	D	44.020.046	21	30	45	77	152.0
MSL FLOW HI	B21N089 A	44.020.043	21	25	100	113	238.0
	B	44.020.044	21	27	65	72	164.0
	C	44.020.045	21	25	53	76	154.0
	D	44.020.046	21	24	56	77	157.0
						LPCI CS HPCI	
ECCS	B21N091 A	44.030.259	23	50	23	140 55 55	213
LPCS	B	44.030.260	23	70	19	120 60 20	209
	C	44.030.261	22	161	20	121 54 60	302
	D	44.030.262	22	135	19	119 68 19	273

NPP	Rev	INS No.	Phase II INS No.	Phase II RT (sec)	
44.020.019	22	D11N006A	D11K603A	0.615	Main Steam Line Radiation
44.020.020	21	D11N006B	D11K603B	0.64	
44.020.021	22	D11N006C	D11K603C	0.652	
44.020.022	22	D11N006D	D11K603D	0.67	
44.020.109	22	D11N010A	D11K609A	0.0333	Fuel Pool Ventilation Exhaust Radiation
44.020.110	23	D11N010B	D11K609B	0.172	
44.020.111	23	D11N010C	D11K609C	0.14	
44.020.112	22	D11N010C	D11K609D	0.123	

* Limiting Values Corresponding to LPCI and RHR.

APPENDIX C
LEAD PLANT RTT INSTRUMENTATION LOOP COMPONENTS

APPENDIX C.1

FERMI-2 LEAD PLANT RTT INSTRUMENTATION LOOP COMPONENTS

APPENDIX C.1
LEAD PLANT RTT INSTRUMENTATION LOOP COMPONENTS

This Appendix details the Fermi-2 Lead Plant instrumentation loop components, their corresponding functions in the respective loops, and their model and MPL [Master Parts List/Plant Identification System (PIS)] numbers. The top heading for each instrumentation loop identifies the trip function, system description, table and item number, and the response time requirement. The drawings used in the analyses, and their revision and sheet numbers are listed at the bottom of each loop description. This comprehensive loop analysis was conducted for each of the trip functions for both lead plants.

C.1.1 Bases and Assumptions for the RTT Instrumentation Loop Component Identification (Fermi-2 and River Bend)

The following bases and assumptions were made in the RTT analyses:

- Drawing numbers reflect the most current revisions identified and verified by the plants.
- RTT instrumentation trip functions specified in the technical specifications have considerable overlap due to common instrumentation branches. Therefore, each RTT trip function separately identifies components reflecting only the most pertinent branch under consideration.
- One out of the four identical channels have been analyzed (typically, Channel A).
- Seal-in circuits, annunciators, computer points, alarms/lights, recorder pens etc. that have no sensitivity with respect to response time have been excluded from the loop analyses.
- All response time sensitive components starting from the sensor up to the actuating device (but not including the actuating device) have been identified. Actuating devices are excluded because they are not considered part of instrumentation response time tests. However, for some loops, actuating devices have been listed only for identification purposes indicating the loop termination point.

- In most cases, balance-of-plant (BOP) components such as exhaust fans, supply fans, etc. have not been considered. Components that perform primary functions and can potentially affect response times with respect to a given loop have been considered.

- A list of Fermi-2 response time testing procedures that were reviewed or referenced is provided in Table B-3 of Appendix B..

- For River Bend, confirmation of GE drawings against the plant drawings was conducted by the plant personnel and any modifications or differences were resolved.

- It is assumed that the complementing channel is in such a state as to allow the analyzed channel to perform that action. For this reason one-out-of-two twice and two-out-of-two logic has not been noted in the loops.

RTT TRIP FUNCTION TABLE NO: 3.3.1-2 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.0
SYSTEM DESCRIPTION : Reactor Protection System Response Times
TRIP FUNCTION DESCRIPTION : Rx Vessel Steam Dome Pressure High
T/S RTT REQUIREMENT (Sec) : <= 0.55

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses excessive Dome Pressure.	B21-N078A Rosemount 1153
Master Trip Unit	Provides trip signal for RPS.	B21-N678A Rosemount 510DU
Testability Relay	Opens on Reactor High Pressure.	C71-K206A Agastat GP
RPS scram Relay	De-energizes on High Dome Pressure Trip Unit signal.	C71A-K5A GE HFA
Scram Contactors	De-energizes the Scram Solenoids.	C71A-K14A, E CR105

Reference Drawing Numbers:-

6I721-2155-16 Rev. F   6I721-2155-04 Rev. K
6I721-2155-08 Rev. J
6I721-2155-15 Rev. H
6I721-2155-06 Rev. M

RTT TRIP FUNCTION TABLE NO: 3.3.1-2 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.0
SYSTEM DESCRIPTION : Reactor Protection System Response Times
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Water Level - Level-3
T/S RTT REQUIREMENT (Sec) : <= 1.05

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level Transmitter	Senses Water Level-3.	B21-N080A Rosemount 1153
Master Trip Unit	Provides trip signal for RPS.	B21-N680A Rosemount 510DU
Testability Relay	Opens on Reactor Low Water Level-3.	C71-K207A Agastat GP
RPS scram Relay	De-energizes on Level-3 Trip Unit signal.	C71A-K6A GE HFA
Scram Contactors	De-energizes the Scram Solenoids.	C71A-K14A,E CR105

Reference Drawing Numbers:-

6I721-2155-15 Rev. H 6I721-2155-16 Rev. F
6I721-2155-06 Rev. M 6I721-2155-08 Rev. J
6I721-2155-04 Rev. K

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.a.1
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low water Level- Level-3
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level-3 Transmitter	Senses level and provides analog signal to the MTU.	B21-N080A Rosemount 1153
Master Trip Unit	Trips at preset level to de-eneregize output Relay.	B21-N680A Rosemount 510DU
MTU Output Relay	Opens on Reactor Water Level below Level-3.	C71-K207A Agastat GP
Interfacing Relay	Opens contacts on Low Water Level-3.	C71A-K6A GE HFA
Interfacing Relay	Opens contacts on Low Water Level-3	A71B-K6A GE HFA
Initiation Relay	Permissive to close valve E11-F015A.	A71B-K17 CR120A
Interfacing Relay & Initiating Relay	Closes valvs G11-F019, G11-F003 Drywell Drain Outbd Isol valve and TIP Ball valve isolation.	A71B-K59 CR120A
Interfacing Relay	Actuates RHR Inbd Solenoid valve Logic.	A71B-K76 Agastat GP
Initiation Relay	Closes valves E11-F009, E11-F022 & RHR Shutdown Cooling & Head Spray Inbd Isolation valves.	A71B-K29 CR120A

Reference Drawing Numbers:-

6I721-2155-16 Rev. F	6I721-2095-14 Rev. L
6I721-2155-15 Rev. H	6I721-2095-33 Rev. N
6I721-2155-06 Rev. M	6I721-2201-15 Rev. N
6I721-2155-04 Rev. K	6I721-2205-17 Rev. O

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 2)
RTT TRIP FUNCTION ITEM NO: 1.a.2
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level-2 Transmitter	Senses level and provides analog signal to the Master Trip Unit.	B21-N081A Rosemount 1153
Master Trip Unit	Trips at preset level to de-energize the MTU output Relay.	B21-N681A Rosemount 510DU
MTU Output Relay	Opens below water Level-2.	C71-K208A Agastat GP
Interfacing Relay	De-energizes to open contacts on Low water Level-2.	A71B-K1A HFA
Interfacing Relay	De-energizes on High Drywell Pressure or Reactor water Level-2.	A71B-K37 CR120A
Initiation Relay	Actuates Recirc Pump Seal inboard Isolation valve F014A.	A71B-K101A Agastat GP
Initiation Relay	Actuates Recirc Pump Seal inboard Isolation valve F014B.	A71B-K101B Agastat GP
Initiation Relay	Actuates PCRMS valve T50-F450 and T50-F451.	A71A-K900 CR120A
Initiation Relay	Actuates valves T48-F455, T48-F457, and T48-F404.	A71B-K103A Agastat GP
Initiation Relay	Actuates valves T48-F601, T48-F602.	A71B-K103B Agastat GP
Initiation Relay	Actuates valves T46-F400.	A71B-K103C Agastat GP

Reference Drawing Nos:-

6I721-2155-22 Rev. I	6I721-2611-10 Rev. P	6I721-2155-06 Rev. M
6I721-2155-15 Rev. H	6I721-2671-15 Rev. G	6I721-2155-04 Rev. K
6I721-2095-14 Rev. L	6I721-2451-04 Rev. N	6I721-2451-04 Rev. N
6I721-2095-33 Rev. N	6I721-2658-07 Rev. F	6I721-2105-13 Rev. H
6I721-2105-14 Rev. J		

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (2 of 2)
RTT TRIP FUNCTION ITEM NO: 1.a.2
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Initiation Relay	Actuates B31-F019, Reactor water Sample valve.	A71B-K77 Agastat GP
Initiation Relay	Opens Permissive for system T49-F601 & F465 Isolation valves Division-I.	T41M079 CR120A
Interfacing Relay	Primary containment isolation.	T41M085 CR120A
Initiation Relay	Actuates valves G51-F600 and G51-F602	G51-M405A Agastat EGPD
Initiation Relay	Actuates valves G51-F604 and G51-F606	G51-M405B Agastat EGPD

Reference Drawing Nos:-

6I721-2155-22 Rev. I	6I721-2611-10 Rev. P	6I721-2155-06 Rev. M
6I721-2155-15 Rev. H	6I721-2671-15 Rev. G	6I7?1-2155-04 Rev. K
6I721-2095-14 Rev. L	6I721-2451-04 Rev. N	6I721-2451-04 Rev. N
6I721-2095-33 Rev. N	6I721-2658-07 Rev. F	6I721-2105-13 Rev. H
6I721-2105-14 Rev. J		

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.a.3
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low water Level- Level-1
T/S RTT REQUIREMENT (Sec) : <= 1.0* & <= 13.0**

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level-1 Transmitter	Senses level and provides analog signal to the MTU & STU.	B21-N081A Rosemount 1153
Slave Trip Unit	Receives analog signal from MTU & trips at preset value to activate valve closure.	B21-N684A Rosemount 510 & 710DU
STU Output Relay	Opens on Reactor Water Level below Level-1 & closes RWCU & Drain valves.	C71-K260A Agastat GP
Interfacing Relay	De-energizes to activate the valve closure.	A71B-K7A GE HFA
Initiation Relay	De-energizes to close Main Steam Line Drain valves B21-F016.	A71B-K56 CR120A
Initiation Relay	De-energizes to close Main Steam Line.	A71B-K52 GE HFA
Initiation Relay	De-energizes to close Main Steam Isolation valves.	A71B-K14 GE HFA

Reference Drawing Numbers:-

6I721-2155-22 Rev. I	6I721-2095-15 Rev. M
6I721-2155-15 Rev. H	6I721-2091-01 Rev. S
6I721-2095-14 Rev. L	6I721-2095-17 Rev. O
6I721-2095-33 Rev. N	6I721-2095-18 Rev. N

Remarks:

* Isolation system instrumentation response times for MSIVs only.

** Isolation system instrumentation response times for associated valves except MSIVs.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 2)
RTT TRIP FUNCTION ITEM NO: 1.b
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses Pressure and provides analog signal to the MTU.	C71-N050A Rosemount 1153
Master Trip Unit	Trips at preset level to de-eneregize output Relay.	C71-N650A Rosemount 510DU
MTU Output Relay	De-energizes when Drywell Pressure is above setpoint.	C71-K216A Agastat GP
Interfacing Relay	Opens on Drywell Hi-Pressure.	C71A-K4A GE HFA
Interfacing Relay	De-energizes upon receiving signal from Relay C71A-K4A.	A71B-K5A GE HFA
Initiation Relay	Actuates Reactor Water Sample valve B31-F019.	A71B-K77 Agastat GP
Initiation Relay	Actuates TIP Ball valves Permissive for A71B-K40 and A71B-K42.	A71B-K59 CR120A
Interfacing Relay & Initiating Relay	Actuates valve G11-F019, F003 Drywell Drain Outbd Isol valve.	A71B-K42 CR120A A71B-K40 CR120A
Interfacing Relay	De-energizes upon receiving signal from Relay A71B-K5A.	A71B-K37 GE HFA
Initiation Relay	Actuates Recirc Pump Seal inboard isolation valve F014A.	A71B-K101A Agastat GP
Initiation Relay	Actuates Recirc Pump Seal inboard isolation valve F014B.	A71B-K101B Agastat GP

Reference Drawing Numbers:-

6I721-2155-22 Rev. I	6I721-2095-14 Rev. L
6I721-2155-15 Rev. H	6I721-2095-33 Rev. N
6I721-2155-06 Rev. M	6I721-2105-10 Rev. J
6I721-2155-04 Rev. K	6I721-2205-17 Rev. O

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (2 of 2)
RTT TRIP FUNCTION ITEM NO: 1.b
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Initiation Relay	Actuates PCRMS valve T50-F450 and T50-F451.	A71A-K900 CR120A
Initiation Relay	Actuates valves T48-F455, T48-F457 and T48-F404.	A71B-K103A Agastat GP
Initiation Relay	Actuates valves T48-F601 & T48-F602.	A71B-K103B Agastat GP
Initiation Relay	Actuates valve T46-F400.	A71B-K103C Agastat GP
Initiation Relay	Opens Permissive for system T49-F601 and T49-F465.	T41M079 CR120A
Initiation Relay	Actuates TWMS valves G51-F600, G51-F602, G51-F604 and G51-F606.	G51-M405A, B Agastat EGPD

Reference Drawing Numbers:-

6I721-2155-22 Rev. I
6I721-2155-15 Rev. H
6I721-2155-06 Rev. M
6I721-2155-04 Rev. K
6I721-2095-14 Rev. L
6I721-2095-33 Rev. N
6I721-2105-10 Rev. J
6I721-2205-17 Rev. O

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.c.1
YSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line radiation - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Gamma Ion Chamber Steam Line Detector	Senses Radiation level & activat^s Scram & MSIV closure sequence.	D11-N006A (237X[illegible]1G001)
Logarithmic Radiation Monitor (NUMAC)	Activates trip circuits upon signal from Gamma Ion Chamber.	D11-K603A (304A3700G005)
Trip Auxiliary Unit	Output Relays and Contacts to activate MSIV Closure.	C51A-Z2A
Interfacing Relay	De-energizes to actuate the Main Steam Isolation Valve closure.	C71A-K7A GE HFA
Interfacing Relay	De-energizes to activate the Main Steam Isolation Valves.	A71B-K44A GE HFA
Initiation Relay	De-energizes to activate the Main Steam isolation Valves.	A71B-K7A GE HFA
Initiation Relay	Actuates B21-F016 Main Steam Line Drain valves.	A71B-K56 CR120A
Initiation Relay	Actuates MSIV valves.	A71B-K52 GE HFA
Initiation Relay	Actuates MSIV valves.	A71B-K14 GE HFA
Initiation Relay	Actuates Reactor Water Sample Isolation valve B31-F019.	A71B-K77 Agastat GP

Reference Drawing Numbers:-

6I721-2185-03 Rev. J
6I721-2185-01 Rev. M
6I721-2155-06 Rev. M
6I721-2155-04 Rev. K
6I721-2095-14 Rev. L
6I721-2105-10 Rev. J
6I721-2095-17 Rev. O
6I721-2095-33 Rev. N
6I721-2095-18 Rev. N

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.c.2
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line Pressure - Low
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses pressure in MSL and provides analog signal to the MTU.	B21-N076A Rosemount 1151
Master Trip Unit	Trips at preset value to activate MSIV Closure.	B21-N676A Rosemount 510DU
MTU Output Relay	De-energizes when Steamline Pressure is below setpoint.	C71-K205A Agastat GP
Interfacing Relay	De-energizes to activate MSIV Drain valve logic and Annunciator.	A71B-K4A GE HFA
Interfacing Relay	De-energizes to activate MSIVs.	A71B-K7A GE HFA
Initiation Relay	Actuates B21-F016 Main Steam Line Drain valve.	A71B-K56 CR120A
Initiation Relay	Closes Outboard MSIV's.	A71B-K52 GE HFA
Initiation Relay	Closes Outboard MSIV's.	A71B-K14 GE HFA

Reference Drawing Numbers:-

6I721-2155-16 Rev. F
6I721-2095-14 Rev. L
6I721-2095-18 Rev. N
6I721-2095-33 Rev. N
6I721-2095-17 Rev. O
6I721-2095-11 Rev. J
6I721-2155-15 Rev. H

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.c.3
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line Flow - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Differential Pressure Transmitter	Senses MSL Flow (Delta-P) and provides signal to the MTU.	B21-N086A, N087A, N088A and N089A Rosemount 1151
Master Trip Unit	Trips at preset value to activate MSIV closure.	B21-N686A, N687A, N688A and N689A Rosemount 510DU
MTU Output Relay	De-energizes to close MSIVs & Drain valve logic, Annunciator & Computer point.	C71-K201, K202A, K203A and K204A. Agastat GP
Interfacing Relay	De-energizes to activate MSIV closure.	A71B-K3A GE HFA
Interfacing Relay	De-energizes to activate MSIV closure.	A71B-K7A GE HFA
Initiation Relay	Actuates B21-F016 Main Steam Line Drain valve.	A71B-K56 CR120A
Initiation Relay	Closes Outboard MSIV's.	A71B-K52 GE HFA
Initiation Relay	Closes Outboard MSIV's.	A71B-K14 GE HFA

Reference Drawing Numbers:-

6I721-2155-16 Rev. F
6I721-2095-14 Rev. L
6I721-2095-33 Rev. N
6I721-2095-17 Rev. O
6I721-2155-15 Rev. H
6I721-2095-18 Rev. N

Remarks:

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 2.e
SYSTEM DESCRIPTION : Reactor Water Cleanup isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level-2 Transmitter	Senses level and provides analog signal to the MTU.	B21-N081A Rosemount 1153
Master Trip Unit	Trips at preset level to de-eneregize output Relay.	B21-N681A Rosemount 510DU
MTU Output Relay	Opens on Reactor Water Level below Level-2.	C71A-K208A Agastat GP
Interfacing Relay	Opens contacts on Low Level-2 for RWCU Isolation valve.	A71B-K1A GE HFA
Initiation Relay	Actuates G33-F001 RWCU Isolation valve.	A71B-K26 CR120A

Reference Drawing Numbers:-

6I721-2155-22 Rev. I
6I721-2155-15 Rev. H
6I721-2095-14 Rev. L
6I721-2265-03 Rev. M

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.a
SYSTEM DESCRIPTION : RCIC System Isolation
TRIP FUNCTION DESCRIPTION : RCIC Steamline Flow - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Differential Pressure Transmitter.	Senses High Steam Flow (Delta-P) and provides analog signal to trip Unit.	E51-N057A Rosemount 1151
Master Trip Unit	Trips at preset Flow setpoint to de-energize the output Relay.	E51-N657A Rosemount 510DU
MTU Output Relay	Closes on High Steam Flow.	E51-K202A Agastat GP
Slave Trip Unit	Trips at preset High Steam Flow value.	E51-N660A, B Rosemount 510DU
Interfacing Relay	Closes on High Negative differential Pressure.	E51-K203A Agastat GP
Time Delay Relay	Time Delay pickup for RCIC Isolation.	E51A-K12 Agastat TR
Initiation Relay	Activates valve E51-F008.	E51A-K15 GE HFA

Reference Drawing Nos:-

6I721-2235-11 Rev. J
6I721-2235-02 Rev. 0
6I721-2235-01 Rev. 0

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.b
SYSTEM DESCRIPTION : RCIC System Isolation
TRIP FUNCTION DESCRIPTION : RCIC Steamline Pressure - Low
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses Low Steamline Pressure.	E51-N058A Rosemount 1151
Master Trip Unit	Trips at preset Flow setpoint to de-energize the output Relay.	E51-N658A Rosemount 510DU
MTU Output Relay	Closes when Steam Pressure is below set point for vaccuum breaker, steam line Outboard isolation valve.	E51-K204A Agastat GP
Interfacing Relay	Steamline Outboard Isolation valve Logic.	E51A-K58 GE HMA
Interfacing Relay	Steamline Outboard Isolation valve Logic.	E51A-K59 CR120A
Initiation Relay	Opens valve E51-F008	E51A-K15 GE HFA
Initiation Relay	Opens valve E51-F062	E51A-K63 GE HFA

Reference Drawing Nos:-

6I721-2235-11 Rev. J
6I721-2235-10 Rev. B
6I721-2235-2 Rev. O
6I721-2235-01 Rev. O
6I721-2235-3 Rev. R

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.a
SYSTEM DESCRIPTION : High pressure Coolant Injection System Isolation.
TRIP FUNCTION DESCRIPTION : HPCI Steam Flow - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Differential Pressure Transmitter.	Senses Hi differential press on Hi Stm flow & provides analog signal.	E41-N057A Rosemount 1153
External Input Capacitor	Circuit Noise suppression filter rated at 2000 Micro-Farads.	E41-C1A CDE WBR 2000-50 MFD
Master Trip Unit	Trips at preset High Steam Flow value.	E41-N657A Rosemount 510DU
Slave Trip Unit	Trips at preset High steam Flow value.	E41-N660A Rosemount 510DU
Interfacing Relay	Closes on High Steam Flow.	E41-K202A Agastat GP
Interfacing Relay	Closes on High Negative differential Pressure.	E41-K203A Agastat GP
Time Delay Relay	Opens after a specified time delay	E41A-K43 Agastat TR
Initiation Relay	Close Stm supply line Inbd Iso valve E41-F002, Supp Pool Inbd valve E41-F042.	E41A-K44 GE HFA
Initiating Relay	Inhibits opening of Steam supply line Inbd Iso valve, Suppression Pool Inboard Isolation valves E41-F002 & F042.	E41A-K36 GE HMA

Reference Drawing Nos:-

6I721-2225-09 Rev. B	6I721-2221-04 Rev. U
6I721-2221-08 Rev. R	6I721-2225-04 Rev. N
6I721-2225-12 Rev. K	6I721-2221-09 Rev. M

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.b
SYSTEM DESCRIPTION : High pressure Coolant Injection System Isolation.
TRIP FUNCTION DESCRIPTION : HPCI Steam Supply Pressure - Low
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses Low Pressure in the steam Line.	E41-N058A Rosemount 1153
Master Trip Unit	Trips at preset Low Steam Pressure value.	E41-N658A Rosemount 510DU
MTU Output Relay	Closes on Low Steam Line pressure.	E41-K201A Agastat GP
Interfacing Relay	Energizes for HPCI Auto Isolation vaccuum Breaker Isolation valve and Annunciator.	E41A-K48 GE HFA
Initiation Relay	Inhibits opening of the valves E21-F002 and E21-F042.	E41A-K36 GE HMA
Interfacing Relay	Permissive to energize E41A-K79	E11A-K10A GE HFA
Initiation Relay	Energizes to actuate valves E41-F002 and E41-F042.	E41A-K44 GE HFA
Initiation Relay	Energizes to activate valve E41-F075.	E41A-K79 GE HMA

Reference Drawing Nos:-

6I721-2225-09 Rev. B
6I721-2221-08 Rev. R
6I721-2225-04 Rev. N
6I721-2221-04 Rev. U
6I721-2221-09 Rev. M
6I721-2225-12 Rev. K

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 6.a
SYSTEM DESCRIPTION : Secondary Containment Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low water Level- Level-2
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level-2 Transmitter	Senses level and provides analog signal to the MTU.	B21-N081A Rosemount 1153
Master Trip Unit	Trips at preset level to de-eneregize output Relay.	B21-N681A Rosemount 510DU
MTU Output Relay	Opens on Reactor Water Level below Level-2.	C71A-K208A Agastat GP
Interfacing Relay	De-energizes upon receiving signal from the Master Trip Unit.	A71B-K1A GE HFA
Interfacing Relay	De-energizes on Hi Drywell Pressure and Reactor water Level-2.	A71B-K37 CR120A
Interfacing Relay	Reactor Building Secondary containment isolation.	T41-M085 CR120A
Initiation Relay	Actuates Secondary containment inboard isolation valve T41-F009	T41-M11A CR120A
Initiation Relay	Actuates Secondary containment inboard isolation valve T41-F011	T41-M11B CR120A

Reference Drawing Numbers:-

6I721-2155-22 Rev. I
6I721-2155-15 Rev. H
6I721-2095-14 Rev. L
6I721-2611-10 Rev. P
6I721-2095-33 Rev. N
6I721-2611-08 Rev. N
6I721-2611-04 Rev. O

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 6.b
SYSTEM DESCRIPTION : Secondary Containment Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses Pressure and provides analog signal to the Master Trip Unit.	C71-N050A Rosemount 1153
Master Trip Unit	Trips at preset Pressure to de-energize the MTU output Relay.	B21-N650A Rosemount 510DU
MTU Output Relay	De-eneregizes when the Drywell Pressure is above setpoint.	C71-K216A Agastat GP
Interfacing Relay	De-energizes upon receiving signal from Relay C71A-K216A.	C71A-K4A GE HFA
Interfacing Relay	De-energizes upon receiving signal from Relay C71A-K4A.	A71B-K5A GE HFA
Interfacing Relay	De-energizes upon receiving signal from Relay A71B-K5A.	A71B-K37 GE HFA
Initiation Relay	1. Trips Reactor Building Main Exhaust Fan System Division-I.	T41M085 CR120A
	2. Trips Reactor Building Main Supply Fan System Division-I.	
Initiation Relay	Actuates Secondary containment isolation valves T41-F009.	T41-M11A CR120A
Initiation Relay	Actuates Secondary containment isolation valves T41-F011.	T41-M11B CR120A

Reference Drawing Nos:-

6I721-2155-22 Rev. I	6I721-2611-10 Rev. P	6I721-2155-06 Rev. M
6I721-2155-15 Rev. H	6I721-2671-15 Rev. G	6I721-2155-04 Rev. K
6I721-2095-14 Rev. L	6I721-2451-04 Rev. N	6I721-2451-04 Rev. N
6I721-2095-33 Rev. N	6I721-2658-07 Rev. F	6I721-2105-13 Rev. H
6I721-2105-14 Rev. J		

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 6.c
SYSTEM DESCRIPTION : Secondary Containment Isolation
TRIP FUNCTION DESCRIPTION : Fuel Pool Ventilation Exhaust Radiation High
T/S RTT REQUIREMENT (Sec) : <= 13.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Sensor / Converter	Senses change in Radiation Level.	D11-N010A (194X927G11)
Indicator & Trip Unit	Activates trip circuits upon signal from Sensor & Converter.	D11-K609A (12[illegible]B2802G11)
Trip Auxiliary Unit	Contains output Relays and Contacts for initiation Loop.	C[illegible]1A-Z2A ([illegible]238X[illegible]97G[illegible])
Interfacing Relay	De-energizes to actuate radiation trip relay.	T41-M086 CR12[illegible]A
Interfacing Relay	Permissive for T41-M10A,B and A71B-K103A,B,C	T41-M084 CR120A
Initiation Relay	Actuates secondary containment valve T41-F009 and T41-F011.	T41-M10A,B CR120A

Reference Drawing Numbers:-

6I721-2185-07 Rev. F
6I721-2185-08 Rev. C
6I721-2185-01 Rev. M
6I721-2611-08 Rev. N
6I721-2658-07 Rev. F
61721-2611-10 Rev. P
6I721-2611-04 Rev. O

Remarks:-

The radiation detector (sensor/converter) is exempt from RTT.

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 **Fermi-2** (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.a
SYSTEM DESCRIPTION : Core Spray System Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-1
T/S RTT REQUIREMENT (Sec) : <= 30.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level Transmitter	Senses Level-1 Water Level & provides analog signal to the MTU.	B21-N091A, C Rosemount 1153
Master Trip Unit	Trips at preset value to energize the MTU output Relay.	B21-N691A, C Rosemount 510DU
MTU Output Relay	Receives signal from MTU.	B21-K201A, C Agastat GP
Interfacing Relay	Closes on Level-1 signal.	E21A-K7A GE HFA
Interfacing Relay	Energizes on Drywell High Pressure & Rx Low Level Logic. Activates Core Spray valves E21-F015A & E21-F015B.	E21A-K10A GE HFA
Interfacing Relay	Permissive for E21A-K13A, Reactor Low Pressure.	E21A-K9A, K19A, K20A GE HGA
Interfacing Relay	Core Spray isolation valves E21-F005A, B and E21-F004A, B.	E21A-K13A GE HFA
Time Delay Relay	Time Delay to start the Pump.	E21A-K16A CR2820TD
Initiation Relay	Starts Core Spray Pump E21-C001A	E21-K12A GE HFA
Initiation Relay	Starts Diesel Generator.	E21-K4A, B GE HMA
Initiation Relay	Starts Diesel Generator and trips Drywell Cooling equipment.	E21-K11A, B GE HFA

Reference Drawing Nos:-

6I721-2095-30 Rev. K
6I721-2215-02 Rev. U
6I721-2095-29 Rev. M
6I721N-2572-18 Rev. R
6I721-2651-16 Rev. G

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.b
SYSTEM DESCRIPTION : Core Spray System Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 30.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses High Differential pressure & provides analog signal to the MTU.	B21-N094E, G Rosemount 1153
Master Trip Unit	Trips at preset value to energize the MTU output Relay.	B21-N694E, G Rosemount 510DU
MTU Output Relay	Closes on High Drywell Pressure.	B21-K209E, G Agastat GP
Interfacing Relay	Energizes EECW Stop Valve, HPCI & Core Spray Logic.	E21A-K5A GE HFA
Interfacing Relay	Energizes on Drywell High Pressure & Rx Low Level Logic. Activates Core Spray valves E21-F015A & E21-F015B.	E21A-K10A GE HFA
Interfacing Relay	Permissive for E21-K13A Reactor Low Pressure.	E21-K9A, K19A, K20A GE HGA
Interfacing Relay	Actuates Core Spray isolation Inbd & Outbd valves E21-F005A, B and E21-F004A, B.	E21A-K13A, B GE HFA
Time Delay Relay	Time Delay to start the Pump.	E21A-K16A CR2820TD
Initiation Relay	Starts Core Spray Pump E21-C001A.	E21-K12A GE HFA
Initiation Relay	Starts Diesel Generator.	E21A-K4A, B GE HMA
Initiation Relay	Starts Diesel Generator and trips Drywell Cooling equipment.	E21A-K11A, B GE HFA

Reference Drawing Nos:-

6I721-2095-30 Rev. K
6I721-2095-29 Rev. N
6I721-2211-08 Rev. I
6I721-2211-06 Rev. K
6I721-2211-07 Rev. K

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (1 of 2)
RTT TRIP FUNCTION ITEM NO: 2.a
SYSTEM DESCRIPTION : Low Pressure Coolant Injection mode of RHR
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-1
T/S RTT REQUIREMENT (Sec) : <= 55.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level Transmitter	Senses Level-1 Water Level & provides analog signal to the MTU.	B21-N091A, B Rosemount 1153
Master Trip Unit	Trips at preset value to energize the MTU output Relay.	B21-N691A, B Rosemount 510DU
MTU Output Relay	Receives signal from MTU and closes on Level-1 signal.	B21-K201A, B Agastat GP
Interfacing Relay	Energizes on Reactor Low Level Logic.	E21A-K7A, B GE HFA
Interfacing Relay	Closes on Low Level-1.	E11A-K7A, B GE HFA
Interfacing Relay	Actuates RHR pumps.	E11A-K9A, B GE HFA
Interfacing Relay	Initiates RHR Pumps.	E11A-K78A, B, C, D. GE HFAs
Initiation Relay Initiation Relay	Actuates pumps E11-C002C, D. Actuates pumps E11-C002A, B.	E11A-K21A, B GE HFA E11A-K18A, B GE HFA
Interfacing Relay	Energizes on Hi Drywell Pressure or Level-2.	E11A-K77A GE HFA
Interfacing Relay	Energizes on pumps differential Pressure above setpoint.	E11A-K23A GE HGA E11A-K25A GE HGA
Interfacing Relay	Energizes when pump running delta-P is greater than setpoint.	E11A-K26A GE HGA
Interfacing Relay	Energizes on pump delta-P above set setpoint & Low Level or Hi Drywell Pressure.	E11A-K27A, B GE HFA
Time delay Relay	Time delay on LPCI pipe break detection.	E11A-K34A, B CR2820

Reference Drawing Nos:-

6I721-2095-29 Rev. N
6I721-2095-30 Rev. K
6I721-2215-02 Rev. U
6I721-2205-06 Rev. J
6I721-2205-03 Rev. O
6I721-2205-05 Rev. P
6I721-2205-02 Rev. R

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (2 of 2)
RTT TRIP FUNCTION ITEM NO: 2.a
SYSTEM DESCRIPTION : Low Pressure Coolant Injection mode of RHR
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-1
T/S RTT REQUIREMENT (Sec) : <= 55.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Interfacing Relay	Energizes when Riser A delta-P is greater than Riser B delta-P.	E11A-K35A, B GE HGA E11A-K36A, B GE HGA
Interfacing Relay	Closes Loop B LPCI valve	E11A-K37A, B GE HFA
Interfacing Relay	Actuates Recirculation valve B31-F031A.	E11A-K38A, B GE HFA
Interfacing Relay	Actuates LPCI valves.	E11A-K39A, B GE HFA
Interfacing Relay	Actuates E11-F015A, B.	E11A-K66A, B GE HFA

Reference Drawing Nos:-

6I721-2095-29 Rev. N
6I721-2095-30 Rev. K
6I721-2215-02 Rev. U
6I721-2205-06 Rev. J
6I721-2205-03 Rev. O
6I721-2205-05 Rev. P
6I721-2205-02 Rev. R

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (1 of 2)
RTT TRIP FUNCTION ITEM NO: 2.b
SYSTEM DESCRIPTION : Low Pressure Coolant Injection mode of RHR
TRIP FUNCTION DESCRIPTION : Drywell pressure - High
T/S RTT REQUIREMENT (Sec) : <= 55.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Pressure Transmitter	Senses Pressure and provides analog signal to the MTU.	B21-N094E, F Rosemount 1153
Master Trip Unit	Trips at preset value to De-energize the MTU output Relay.	B21-N694E, F Rosemount 510DU
MTU Output Relay	Receives signal from MTU and actuates on Hi Drywell Pressure.	B21-K209E, F Agastat GP
Interfacing Relay	Energizes on Hi Drywell Pressure.	E11A-K5A, B GE HFA
Interfacing Relay	Actuates on High Drywell Pressure and Low Water Level Logic.	E11A-K10A, B GE HFA
Interfacing Relay	Actuates RHR Pumps.	E11A-K9A, B GE HFA
Interfacing Relay	Actuates RHR Pump start Logic.	E11A-K78A, B, C, D. GE HFAs
Initiation Relay Initiation Relay	Actuates pumps E11-C002C, D. Actuates pumps E11-C002A, B.	E11A-K21A, B GE HFA E11A-K18A, B GE HFA
Interfacing Relay	Energizes on Hi Drywell Pressure or Level-2.	E11A-K77A GE HFA
Interfacing Relay	Energizes on pumps differential Pressure above setpoint.	E11A-K23A GE HGA E11A-K25A GE HGA
Interfacing Relay	Energizes when pump running delta-P is greater than setpoint.	E11A-K26A GE HGA
Interfacing Relay	Energizes on pump delta-P above set setpoint & Low Level or Hi Drywell Pressure.	E11A-K27A, B GE HFA
Time delay Relay	Time delay on LPCI pipe break detection.	E11A-K34A, B CR2820

Reference Drawing Nos:-

6I721-2095-29 Rev. N
6I721-2095-30 Rev. K
6I721-2215-02 Rev. U
6I721-2205-06 Rev. J
6I721-2205-03 Rev. O
6I721-2205-05 Rev. P
6I721-2205-02 Rev. R

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (2 of 2)
RTT TRIP FUNCTION ITEM NO: 2.b
SYSTEM DESCRIPTION : Low Pressure Coolant Injection mode of RHR
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 55.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Interfacing Relay	Energizes when Riser A delta-P is greater than Riser B delta-P.	E11A-K35A, B GE HGA E11A-K36A, B GE HGA
Interfacing Relay	Closes Loop B LPCI valve.	E11A-K37A, B GE HFA
Interfacing Relay	Actuates Recirculation valve B31-F031A.	E11A-K38A, B GE HFA
Interfacing Relay	Actuates LPCI valves.	E11A-K39A, B GE HFA
Interfacing Relay	Actuates E11-F015A, B.	E11A-K66A, B GE HFA

Reference Drawing Nos:-

6I721-2095-29 Rev. N
6I721-2095-30 Rev. K
6I721-2215-02 Rev. U
6I721-2205-06 Rev. J
6I721-2205-03 Rev. O
6I721-2205-05 Rev. P
6I721-2205-02 Rev. R

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (1 of 2)
RTT TRIP FUNCTION ITEM NO: 3.a
SYSTEM DESCRIPTION : High Pressure Coolant injection System
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 30.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
Level Transmitter	Senses Water Level-2.	B21-N091A Rosemount 1153
Slave Trip Unit	Trips at preset value for Level-2 setpoint.	B21-N692A Rosemount 510DU
MTU Output Relay	Receive signal from the STU and trips at preset value.	B21-K202A Agastat GP
Interfacing Relay	Energizes upon signal from the Output Relay.	E11A-K79A GE HFA
Initiating Relay	Actuates Reactor Low Water Level Logic for the following valves:-	E41A-K2 GE HFA
	Steam Supply to Turbine Valve E41-F001.	
	Steam Supply line Outbd Valve E41-F003.	
	Pump suction from CST E41-F004.	
	Pump Discharge E41-F006.	
	Test Bypass to CST E41-F008.	
	Redundant shut Off to CST E41-F011.	
Initiation Relay	Lube Oil Cooling water E41-F059.	E41A-K3 GE HFA

Reference Drawing Numbers:-

6I721-2095-29 Rev. N
6I721-2095-30 Rev. K
6I721-2221-05 Rev. T
6I721-2225-03 Rev. P
6I721-2221-07 Rev. T
6I721-2221-04 Rev. U
6I721-2221-06 Rev. Q
6I721-2205-02 Rev. R
6I721-2205-01 Rev. G

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 Fermi-2 (2 of 2)
RTT TRIP FUNCTION ITEM NO: 3.a
SYSTEM DESCRIPTION : High Pressure Coolant injection System
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 30.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE PIS & MODEL #
	Pump Discharge E41-F007.	
Initiation Relay	Starts vacuum Pump.	E41A-K7 GE HFA
	Starts Auxiliary Oil Pump at preset value.	

Reference Drawing Numbers:-

6I721-2095-29 Rev. N	6I721-2221-07 Rev. T	6I721-2205-01 Rev. G
6I721-2095-30 Rev. K	6I721-2221-04 Rev. U	
6I721-2221-05 Rev. T	6I721-2221-06 Rev. Q	
6I721-2225-03 Rev. P	6I721-2205-02 Rev. R	

APPENDIX C.2

RIVER BEND LEAD PLANT RTT INSTRUMENTATION LOOP COMPONENTS

This Appendix details the River Bend Lead Plant response time sensitive components, their corresponding functions in the respective loops, and their model and MPL (Master Parts List) numbers. The top heading of each instrumentation loop identifies the trip function, system description, table and item number and the response time requirement. The drawings used in the analyses, including their revision and sheet numbers and referenced plant procedures, are either listed at the bottom of each loop description or summarized in the tables at the front end of this appendix. The bases and assumptions for the River Bend RTT instrumentation loop component identification is listed in Section C.1.1, page C-1, of this appendix.

DRAWING REVISIONS USED IN REPORT

DRAWING	SHEET	REV
828E243AA	05	13
	16	14
	17	08
828E445AA	02	28
	03	27
	04	24
	08	27
	10	27
	11	27
	12	27
	13	27
	14	27
	15	29
	17	27
828E531AA	02	25
	02A	21
	03	26
	05	22
	09	26
	10	24
	18	22
828E534AA	03	18
	08	24
	09	25
	10	23

DRAWING REVISIONS USED IN REPORT

DRAWING	SHEET	REV
828E534AA	13	27
	14	24
	15	27
	16	24
	17	24
828E535AA	02	12
	06	20
	07	19
	10	19
828E536AA	03	20
	04	15
	05	15
	06	16
	07	20
828E539AA	02	27
	04	27
	08	28
	13	27
851E602AA	01A	13
	04	24
	05	19

RIVER BEND RTT PROCEDURE NUMBERS

STP-051-4801
STP-051-4802
STP-051-4803
STP-051-4804
STP-051-4805
STP-051-4806
STP-051-4807
STP-051-4808
STP-051-4809
STP-051-4810
STP-051-4811
STP-051-4812
STP-051-4813
STP-051-4814
STP-051-4815
STP-051-4816
STP-051-4851
STP-051-4852
STP-051-4853
STP-051-4854
STP-051-4855
STP-051-4856
STP-051-4857
STP-051-4858
STP-509-4801
STP-511-4801
STP-511-4802
STP-601-4801
STP-058-4802
STP-204-4802

STP-207-4801
STP-207-4802
STP-207-4803
STP-207-4804
STP-207-4805
STP-207-4806
STP-207-4807
STP-207-4808
STP-207-4809
STP-207-4810
STP-207-4811
STP-207-4812
STP-207-4813
STP-207-4814
STP-505-4801
STP-505-4802
STP-505-4803
STP-505-4804
STP-505-4805
STP-508-4801
STP-508-4802
STP-508-4803
STP-508-4804
STP-508-4805
STP-508-4806
STP-508-4807
STP-508-4808
STP-508-4809
STP-508-4810

RIVER BEND RTT LOOP CALIBRATION REPORT NUMBERS

1.ILRPS.013
1.ILRPS.014
1.ILRPS.015
1.ILRPS.016
1.ILRPS.009
1.ILRPS.010
1.ILRPS.011
1.ILRPS.012
1.ILISM.009
1.ILISM.012
1.ILISM.010
1.ILISM.011
1.ILCSL.025
1.ILRHS.089
1.ILCSL.026
1.ILRHS.090
1.ILCSL.027
1.ILRHS.091
1.ILCSL.028
1.ILRHS.092
1.ILCSH.036
1.ILCSH.034
1.ILCSH.032
1.ILCSH.033
1.ILCSH.038
1.ILCSH.037
1.ILCSH.039
1.ILCSH.040

1.ILMSS.012
1.ILMSS.015
1.ILMSS.013
1.ILMSS.050
1.ILMSS.016
1.ILMSS.019
1.ILMSS.017
1.ILMSS.018
1.ILMSS.020
1.ILMSS.023
1.ILMSS.021
1.ILMSS.022
1.ILMSS.024
1.ILMSS.027
1.ILMSS.025
1.ILMSS.026
1.ILMSS.028
1.ILMSS.031
1.ILMSS.029
1.ILMSS.030
1.ILLMS.061
1.ILLMS.057
1.ILLMS.059
1.ILLMS.062
1.ILLMS.058
1.ILLMS.060
1.ILICS.020
1.ILICS.021

1.ILICS.038
1.ILICS.039
1.ILRPS.017
1.ILRPS.020
1.ILRPS.018

RTT TRIP FUNCTION TABLE NO: 3.3.1-2 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.0
SYSTEM DESCRIPTION : Reactor Protection System Response Times
TRIP FUNCTION DESCRIPTION : Rx Vessel Steam Dome Pressure High
T/S RTT REQUIREMENT (Sec) : <= 0.35

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV Pressure signal to the master trip unit.	B21-N078A Rosemount 1152
Master Trip Unit	De-energizes Relay C71A-K5A on high RPV Pressure.	B21-N678A Rosemount 510DU/710DU
MTU Output Relay	De-energizes on High Pressure signal from the MTU.	C71A-K5A Agastat GP
Initiation Contactor	De-energizes Group 1 Pilot Scram valve Solenoid "A".	C71A-K14A GE CR205
Interfacing Relay	De-energizes on High Pressure.	C71A-K69 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group 3 Pilot Scram valve Solenoid "A".	C71A-K14G GE CR105
Interfacing Relay	De-energizes on High Pressure.	C71A-K70 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group 2 Pilot Scram valve Solenoid "A".	C71A-K14K GE CR205
Interfacing Relay	De-energizes on High Pressure.	C71A-K71 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group 4 Pilot Scram valve Solenoid "A".	C71A-K14S GE CR105

Reference Drawing Numbers:-

828E531AA, Sheets 2, 9, 10, 18.

RTT TRIP FUNCTION TABLE NO: 3.3.1-2 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.0
SYSTEM DESCRIPTION : Reactor Protection System Response Times
TRIP FUNCTION DESCRIPTION : Reactor Vessel Water Level - Low, Level-3
T/S RTT REQUIREMENT (Sec) : <= 1.05

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV Low water Level, Level-3 signal to the master trip unit.	B21-N080A Rosemount 1152
Master Trip Unit	De-energizes Relay C71A-K6A on low water level-3 signal.	B21-N680A Rosemount 510DU/710DU
MTU Output Relay	De-energizes on Low Water Level-3 signal from the MTU.	C71A-K6A Agastat GP
Initiation Contactor	De-energizes Group-1 Pilot Scram valve Solenoid "A".	C71A-K14A GE CR205
Interfacing Relay	De-energizes on Low Level Water.	C71A-K69 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-3 Pilot Scram valve Solenoid "A".	C71A-K14G GE CR105
Interfacing Relay	De-energizes on Low Level Water.	C71A-K70 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-2 Pilot Scram valve Solenoid "A".	C71A-K14K GE CR205
Interfacing Relay	De-energizes on Low Level Water.	C71A-K71 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-4 Pilot Scram valve Solenoid "A".	C71A-K14S GE CR105

Reference Drawing Numbers:-

828E531AA, Sheets 2, 9, 10, 18.

RTT TRIP FUNCTION TABLE NO: 3.3.1-2 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 5.0
SYSTEM DESCRIPTION : Reactor Protection System Response Times
TRIP FUNCTION DESCRIPTION : Reactor Vessel Water Level - High, Level-8
T/S RTT REQUIREMENT (Sec) : <= 1.05

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV high water level, level-8 signal to the master trip unit.	B21-N080A Rosemount 1152
Master Trip Unit	Sends Water Level signal to the STU B21-N683A.	B21-N680A Rosemount 510DU/710DU
Slave Trip Unit	De-energizes Relay C71A-K44A on high water level-8 signal.	B21-N683A Rosemount 510DU/710DU
STU Output Relay	De-energizes on high water level-8 signal from the MTU.	C71A-K44A Agastat GP
Initiation Contactor	De-energizes Group-1 Pilot Scram valve Solenoid "A".	C71A-K14A GE CR205
Interfacing Relay	De-energizes on High Water Level.	C71A-K69 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-3 Pilot Scram valve Solenoid "A".	C71A-K14G GE CR105
Interfacing Relay	De-energizes on High Water Level.	C71A-K70 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-2 Pilot Scram valve Solenoid "A".	C71A-K14K GE CR205
Interfacing Relay	De-energizes on High Water Level.	C71A-K71 Potter & Brumfield MDR
Initiation Contactor	De-energizes Group-4 Pilot Scram valve Solenoid "A".	C71A-K14S GE CR105

Reference Drawing Numbers:-

828E531AA, Sheets 2, 3, 9, 10, 18.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.a
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV level signal to MTU B21-N681A.	B21-N081A Rosemount 1152
Master Trip Unit	Transmits RPV level signal to STU B21-N682A.	B21-N681A Rosemount 510DU/710DU
Slave Trip Unit	Deenergizes relay B21H-K148A on L-2 to initiate isolation.	B21-N682A Rosemount 510DU/710DU
STU Output Relay	Deenergizes relays B21H-K27 *, K66A**, & K72A to actuate isolation.***	B21H-K148A Agastat GP
Initiation Relay	Closes reactor water sample valve B33-F020.	B21H-K72A Agastat CP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 12, 15, 17.

* Contact goes to RWCU Level-2 Isolation Logic, Table 3.2.2-3/4a.

** Contact goes to Secondary Containment Isolation Logic, Table 3.3.2-3/3a.

*** The signal from relay B21H-K148A goes through isolator B21H-AT38 before it reaches relays B21H-K27, K66A & K72A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.b
SYSTEM DESCRIPTION : Primary Containment Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends drywell pressure signal to MTU C71-N650A.	C71-N050A Rosemount 1154
Master Trip Unit	Deenergizes relays C71A-K45A & K4A * to initiate isolation.	C71-N650A Rosemount 510DU/710DU
MTU Output Relay	Deenergizes relay B21H-K23A to initiate RHR isolation.***	C71A-K45A Agastat GP
Initiation Relay and Interfacing Relay	Closes RHR sample line valves E12-F075A & B **; energizes relay B21H-K59A.	B21H-K23A Agastat GP
Initiation Relay and Interfacing Relay	Closes RHR discharge valve to radwaste, E12-F040 **; deenergizes relay E12A-K135A.	B21H-K59A Agastat GP
Initiation Relay	Closes shutdown cooling upper pool valve, E12-F037A	E12A-K135A Agastat GP

Reference Drawing Numbers:-

828E531AA, Sheets 2, 18
828E534AA, Sheets 3, 8, 13
828E445AA, Sheets 2, 11, 12, 15

* Contact goes to Secondary Containment Isolation Logic, Table 3.3.2-3/3b.
** Valves E12-F075A & B and E12-F040 are Secondary Containment Isolation valves.
*** The signal from relay C71A-K45A goes through isolator B21H-AT38 before it reaches relay B21H-K23A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 2.a
SYSTEM DESCRIPTION : Main Steam Line Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Water Level - Level-1
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level & sends signal to the MTU B21-N681A.	B21-N081A Rosemount 1152
Master Trip Unit	Deenergizes relay B21H-K1A on L-1 to initiate isolation.	B21-N681A Rosemount 510DU/710DU
Output Relay	Deenergizes relays B21H-K7A & K7K to actuate isolation logic.	B21H-K1A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K14A & K56A** to close valves.	B21H-K7A Agastat GP
Initiation Relay	Closes outboard MSIVs B21-F028A-D.*	B21H-K14A Agastat GP
Initiation Relay and Interfacing Relay	Closes Drain valve B21-F019 and deenergizes relays B21H-K8 & K9.	B21H-K56A Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067A & B.	B21H-K8 Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067C & D.	B21H-K9 Agastat GP
Interfacing Relay	Deenergizes relay B21H-K51B to close valves.	B21H-K7K Potter & Brumfield MDR
Initiation Relay	Closes inboard MSIVs B21-F022A-D.*	B21H-K51B Agastat GP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 8, 10, 11, 13, 14, 17

* MSIVs close on one-out-of-two-twice Logic.
** The signal from relay B21H-K7A goes through isolator B21H-AT38 before it reaches relay B21H-K56A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 2.b
SYSTEM DESCRIPTION : Main Steam Line "A" Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line Radiation - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MFL & MODEL #
Ion Chamber *	Sends MSL radiation signal to log radiation monitor D17-K610A.	D17-N003A GE, 237X731G1
Log Radiation Monitor	Deenergizes relay D17-K40 on High MSL rad to initiate isolation.	D17-K610A GE, 238X660G10
Output Relay	Deenergizes relay C71A-K7A to actuate isolation logic.	D17A-K40 GE Z2 Aux Trip Unit.
Interfacing Relay	Deenergizes relay B21H-K84A to close valves.	C71A-K7A Potter & Brumfield MDR
Initiation Relay	Deenergizes relays B21H-K72A***, K7A & K7K to close valves.	B21H-K84A Agastat GP
Initiation Relay	Closes reactor water sample valve B33-F020.	B21H-K72A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K14A & K56A to close valves.	B21H-K7A Agastat GP
Initiation Relay	Closes outboard MSIVs B21-F028A-D.**	B21H-K14A Agastat GP
Initiation Relay and Interfacing Relay	Closes Drain valve B21-F019 and deenergizes relays B21H-K8 & K9.	B21H-K56A Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067A & B.	B21H-K8 Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067C & D.	B21H-K9 Agastat GP
Interfacing Relay	Deenergizes relay B21H-K51B to close valves.	B21H-K7K Potter & Brumfield MDR
Initiation Relay	Closes inboard MSIVs B21-F022A-D.**	B21H-K51B Agastat GP

Reference Drawing Numbers:-
828E445AA, Sheets 2, 3, 8, 10, 11, 12, 13, 14
828E531AA, Sheets 2A, 5
828E243AA, Sheets 5, 16, 17

* Radiation Detectors are exempt from Response Time Testing.
** MSIVs Close on one-out-of-two-twice Logic.
*** The signal from relay B21H-K84A goes through isolator B21H-AT38 before it reaches relay B21H-K72A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 2.c
SYSTEM DESCRIPTION : Main Steam Line Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line Pressure - Low
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV pressure & sends signal to the MTU B21-N676A.	B21-N076A Rosemount 1152
Master Trip Unit	Deenergizes relay B21H-K4A on low pressure to initiate isolation.	B21-N676A Rosemount 510DU
Output Relay	Deenergizes relays B21H-K7A & K7K to actuate isolation logic.	B21H-K4A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K14A & K56A to close valves.	B21H-K7A Agastat GP
Initiation Relay	Closes outboard MSIVs B21-F028A-D.*	B21H-K14A Agastat GP
Initiation Relay and Interfacing Relay	Closes Drain valve B21-F019 and deenergizes relays B21H-K8 & K9.	B21H-K56A Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067A & B.	B21H-K8 Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067C & D.	B21H-K9 Agastat GP
Interfacing Relay	Deenergizes relay B21H-K51B to close valves.	B21H-K7K Potter & Brumfield MDR
Initiation Relay	Closes inboard MSIVs B21-F022A-D.*	B21H-K51B Agastat GP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 8, 10, 11, 13, 14, 17

* MSIVs Close on one-out-of-two-twice Logic.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 2.d
SYSTEM DESCRIPTION : Main Steam Line Isolation
TRIP FUNCTION DESCRIPTION : Main Steam Line Flow - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitters	Senses MSL flow & sends signal to the MTUs E31-N686A thru N689A.	E31-N086A thru N089A Rosemount 1152
Master Trip Units	Deenergize relays B21H-K120A thru K123A to initiate isolation.	E31-N686A thru N689A Rosemount 510DU/710DU
Trip Unit Output Relays	Deenergize relay B21H-K3A to actuate isolation logic.	B21H-K120A thru K123A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K7A & K7K to close valves.	B21H-K3A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K14A & K56A to close valves.	B21H-K7A Agastat GP
Initiation Relay	Closes outboard MSIVs B21-F028A-D.*	B21H-K14A Agastat GP
Initiation Relay and Interfacing Relay	Closes Drain valve B21-F019 and deenergizes relays B21H-K8 & K9.	B21H-K56A Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067A & B.	B21H-K8 Agastat GP
Initiation Relay	Closes outboard MSL drain valves B21-F067C & D.	B21H-K9 Agastat GP
Interfacing Relay	Deenergizes relay B21H-K51B to close valves.	B21H-K7K Potter & Brumfield MDR
Initiation Relay	Closes inboard MSIVs B21-F022A-D.*	B21H-K51B Agastat GP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 8, 10, 11, 13, 14, 17

* MSIVs Close on one-out-of-two-twice Logic.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.a
SYSTEM DESCRIPTION : Secondary Containment Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV level signal to MTU B21-N681A.	B21-N081A Rosemount 1152
Master Trip Unit	Transmits RPV level signal to STU B21-N682A.	B21-N681A Rosemount 510DU/710DU
Slave Trip Unit	Deenergizes relay B21H-K148A on L-2 to initiate isolation.	B21-N682A Rosemount 510DU/710DU
Output Relay	Deenergizes relays B21H-K27*, K66A*** & K72A** to actuate isolation.	B21H-K148A Agastat GP
Initiation Relay & Interfacing Relay	Closes drywell vent and purge valves, starts SGTS, deenergizes relay B21H-K87A. Starts control room Div. I air system.	B21H-K66A Agastat GP
Initiation Relay	Closes Radwaste isolation valves, shuts down & isolates containment vent system.	B21H-K87A Agastat GP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 10, 17

* Contacts go to the RWCU Level-2 Isolation Logic, Table 3.3.2-3/4a.
** Contacts go to the Primary Containment Isolation Logic, Table 3.3.2-3/1a.
*** The signal from relay B21H-K148A goes through isolator B21H-AT38 before it reaches relay B21H-K66A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 3.b
SYSTEM DESCRIPTION : Secondary Containment Isolation
TRIP FUNCTION DESCRIPTION : Drywell Pressure - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends drywell pressure signal to MTU C71-N650A.	C71-N050A Rosemount 1154
Master Trip Unit	Deenergizes relays C71A-K4A & K45A* to initiate isolation.	C71-N650A Rosemount 510DU/710DU
MTU Output Relay	Deenergizes relay B21H-K66A to actuate isolation logic.**	C71A-K4A Agastat GP
Initiation Relay and Interfacing Relay	Closes DW vent and purge valves, starts SGTS, deenergizes relay B21H-K87A.	B21H-K66A Agastat GP
Initiation Relay	Closes radwaste isolation valves, shuts down & isolates containment ventilation system.	B21H-K87A Agastat GP
MTU Output Relay	De-energizes relay B21H-K23A to initiate RHR isolation.***	C71A-K45A Agastat GP
Initiation Relay and Interfacing Relay	Closes RHR sample line valves E12-F075A & B; de-energizes relay B21H-K59A.	B21H-K23A Agastat GP
Initiation Relay	Closes RHR discharge valve to Radwaste, E12-F040.	B21H-K59A Agastat GP

Reference Drawing Numbers:-

828E531AA, Sheets 2, 18
828E445AA, Sheets 2, 10, 11, 12, 15

* Contacts go to the Primary Containment Isolation Logic, Table 3.3.2-3/1b.
** The signal from relay B21H-K4A goes through isolator B21H-AT38 before it reaches relay B21H-K66A.
*** The signal from relay B21H-K45A goes through isolator B21H-AT38 before it reaches relay B21H-K23A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 2)
RTT TRIP FUNCTION ITEM NO: 4.a
SYSTEM DESCRIPTION : Reactor Water Cleanup Isolation
TRIP FUNCTION DESCRIPTION : Delta Flow - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends signal of RWCU flow from RPV to E31-K602A via E31A-SRU1.	E31-N076A Rosemount 1152
Square Root Extractor	Transmits signal to Summer E31-K604A.	E31-K602A Bailey 750
Transmitter	Sends signal of RWCU flow from Clean-up F/D to E31-K605A via E31A-SRU1.	E31-N075A Rosemount 1152
Square Root Extractor	Transmits signal to Summer E31-K604A.	E31-K605A Bailey 750
Transmitter	Sends signal of RWCU flow from Regen. HX to E31-K603A via E31A-SRU1.	E31-N077A Rosemount 1152
Square Root Extractor	Transmits signal to Summer E31-K604A.	E31-K603A Bailey 750
Summer	Transmits signal to Electronic Switch E31-K609A.	E31-K604A Bailey 752
Electronic Switch	Energizes Timer E31-R615A on high differential flow.	E31-N609A Bailey 745
Time Delay Relay	After time delay energizes downstream Relay.	E31-R615A Eagle Signal HP5
Interfacing Relay	De-energize Relay in Isolation logic B21H-K172.	E31A-K7A Agastat GP
Interfacing Relay	De-energize downstream Relay B21H-K27.*	B21H-K172 Potter & Brumfield MDR
Interfacing Relay	De-energizes relays B21H-K145, K154, K159 and K160.	B21H-K27 Agastat GP

Reference Drawing Numbers:-

851E602AA, Sheets 1A, 4, 5
828E445AA, Sheets 2, 3, 11, 12, 15
* The signal from relay B21H-K172 goes through isolator B21H-AT38 before it reaches relay B21H-K27.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (2 of 2)
RTT TRIP FUNCTION ITEM NO: 4.a
SYSTEM DESCRIPTION : Reactor Water Cleanup Isolation
TRIP FUNCTION DESCRIPTION : Delta Flow - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Initiation Relay	Closes RWCU isolation valve G33-F034.	B21H-K145 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F004.	B21H-K154 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F054.	B21H-K159 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F039.	B21H-K160 Agastat GP

Reference Drawing numbers:-

851E602AA, Sheets 1A, 4, 5
828E445AA, Sheets 2, 3, 11, 12, 15

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.e
SYSTEM DESCRIPTION : RWCU System Isolation
TRIP FUNCTION DESCRIPTION : Rx Vessel Low Low Water Level - Level-2
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level & sends signal to the MTU B21-N681A.	B21-N081A Rosemount 1152
Master Trip Unit	Transmits RPV level signal to STU B21-N682A.	B21-N681A Rosemount 510DU/710DU
Slave Trip Unit	Deenergizes relay B21H-K148A on L-2 to initiate isolation.	B21-N682A Rosemount 510DU/710DU
STU Output Relay	Deenergizes relay B21H-K27 to actuate isolation.	B21H-K148A Agastat GP
Interfacing Relay	Deenergizes relays B21H-K145, K154, K159 & K160 to close valves.	B21H-K27 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F034.	B21H-K145 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F004.	B21H-K154 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F054.	B21H-K159 Agastat GP
Initiation Relay	Closes RWCU isolation valve G33-F039.	B21H-K160 Agastat GP

Reference Drawing Numbers:-

828E445AA, Sheets 2, 3, 15, 17

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 5.a
SYSTEM DESCRIPTION : RCIC Isolation
TRIP FUNCTION DESCRIPTION : RCIC Steam Line Flow - High
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RCIC turbine supply delta pressure signal to MTU E31-N683A.	E31-N083A Rosemount 1152
Master Trip Unit	Transmits delta pressure signal to STU E31-N690A & energizes Relay E51A E51A-K64 on Plus High Delta Pressure or on Negative High Delta Pressure.	E31-N683A Rosemount 510DU/710DU
Time Delay Relay	Energizes relays E51A-K15 & K24 after time delay to isolate RCIC.	E51A-K64 Agastat TR (TDPU)
Initiation Relay	Closes steam supply line isolation valve E51-F064.	E51A-K15 Agastat GP
Initiation Relay	Closes pump suction valve from suppression pool, E51-F031.	E51A-K24 Agastat GP

Reference Drawing Numbers:-

828E539AA, Sheets 2, 4, 8, 13

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 5.c
SYSTEM DESCRIPTION : RCIC Isolation
TRIP FUNCTION DESCRIPTION : RCIC Steam Supply Pressure - Low
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RCIC turbine supply pressure & sends signal to MTU E31-N685A.	E31-N085A Rosemount 1152
Master Trip Unit	Energizes relay E51A-K66 to initiate isolation.	E31-N685A Rosemount 510DU/710DU
Initiation Relay and Interfacing Relay	Closes vacuum breaker isolation valve E51-F077; energizes relays E51A-K15 & K24.	E51A-K66 Agastat TR
Initiation Relay	Closes steam supply line isolation valve E51-F064.	E51A-K15 Agastat GP
Initiation Relay	Closes pump suction valve from suppression pool, E51-F031.	E51A-K24 Agastat GP

Reference Drawing Numbers:-

828E539AA, Sheets 2, 4, 8, 13

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 6.c
SYSTEM DESCRIPTION : Residual Heat Removal System Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-3
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses reactor water level and sends signal to MTU B21-N680A.	B21-N080A Rosemount 1152
Master Trip Unit	De-energizes relays C71A-K6A and K46A on low water level-3.	B21-N680A Rosemount 510DU/710DU
Interfacing Relay	De-energizes relay B21H-K23A on low water level.*	C71A-K6A Agastat GP
Interfacing Relay	De-energizes relay B21H-K129A on low water level.**	C71A-K46A Agastat GP
Interfacing Relay and Initiation Relay	De-energizes Relay B21H-K59A & closes RHR sample line valves E12-F075A & B.	B21H-K23A Agastat GP
Interfacing Relay and Initiation Relay	Energizes Relay E12A-K135A & closes RHR discharge to RW Valve E12-F040.	B21H-K59A Agastat GP
Initiation Relay	Closes RHR shutdown cooling upper pool valve E12-F037A.	E12A-K135A Agastat GP
Interfacing Relay	De-energizes Relays B21H-K54 & K165; Energizes Relay E12A-K111A.	B21H-K129A Agastat GP
Initiation Relay	Closes RHR reactor head spray valve E12-F023.	B21H-K54 Agastat GP
Initiation Relay	Closes RHR suction cooling valve E12-F008.	B21H-K165 Agastat GP
Initiation Relay	Closes RHR shutdown cooling injection valve E12-F053A.	E12A-K111A Agastat GP

Reference Drawing numbers:-

828E445AA, Sheets 2, 11, 12, 15
828E534AA, Sheets 3, 8, 13
828E531AA, Sheets 2, 18

* The signal from relay C71A-K6A goes through isolator B21H-AT38 before it reaches relay B21H-K23A.

** The signal from relay C71A-K46A goes through isolator B21H-AT38 before it reaches relay B21H-K129A.

RTT TRIP FUNCTION TABLE NO: 3.3.2-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 6.d
SYSTEM DESCRIPTION : Residual Heat Removal System Isolation
TRIP FUNCTION DESCRIPTION : Reactor Vessel Low Water Level - Level-1
T/S RTT REQUIREMENT (Sec) : <= 10.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Sends RPV Level signal to the master trip unit B21-N691A.	B21-N091A Rosemount 1154
Master Trip Unit	Energizes Relay E21A-K91 on Level-1 to initiate Isolation.	B21-N691A Rosemount 510DU/710DU
Interfacing Relay	Energizes Relay E21A-K11 to close valves.	E21A-K91 Agastat GP
Interfacing Relay	Energizes Relays E12A-K109A, K110A, and K125A.	E21A-K11 Agastat GP
Initiation Relay	Closes RHR Test return valve E12-F024A.	E12A-K109A Agastat GP
Initiation Relay	Isolates BOP functions for LOCA initiation.	E12A-K110A GE HFA
Initiation Relay	Closes RHR Heat Exchanger Flow to Suppression Pool valve E21-F011A.	E12A-K125A Agastat GP

Reference Drawing numbers:-

828E535AA, Sheets 2, 6, 10.
828E534AA, Sheets 3, 8, 13.

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 1.0
SYSTEM DESCRIPTION : Low Pressure Core Spray System
TRIP FUNCTION DESCRIPTION : LPCS System Initiation
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level signal to MTU B21-N691A.	B21-N091A Rosemount 1154
Master Trip Unit	Energizes relays E21A-K91 and K3A to initiate system start.	B21-N691A Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E21A-K10 & K11 on RPV level-1.	E21A-K91 Agastat GP
Transmitter	Senses drywell pressure signal to MTU B21-N694A.	B21-N094A Rosemount 1154
Master Trip Unit	Energizes relays E21A-K94 and K1A to initiate system start.	B21-N694A Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E21A-K10 & K11 on high drywell pressure.	E21A-K94 Agastat GP
Initiation Relay and Interfacing Relay	Closes valve E21-F012; Energizes relays E21A-K151 & K14.	E21A-K10 Agastat GP
Interfacing Relay	Energizes relay E21A-K12 after 2 sec. time delay.	E21A-K151 Agastat TR14D
Initiation Relay	Starts LPCS pump E21-C001.	E21A-K12 GE HMA
Initiation Relay	Opens LPCS injection shutoff valve E21-F005.	E21A-K14 Agastat GP

Reference Drawing Numbers:-

828E535AA, Sheets 2, 6, 7, 10

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (1 of 3)
RTT TRIP FUNCTION ITEM NO: [illegible]
SYSTEM DESCRIPTION : Low Pressure Coolant Injection Mode of RHR System
TRIP FUNCTION DESCRIPTION : LPCI Mode of RHR System Initiation, Pumps A & B
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level signal to MTU B21-N691A.	B21-N091A Rosemount 1154
Master Trip Unit	Energizes relays E21A-K91 and B21C-K3A* to initiate system start.	B21-N691A Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E21A-K10** & K11 on RPV level-1.	E21A-K91 Agastat GP
Transmitter	Senses drywell pressure signal to MTU B21-N694A.	B21-N094A Rosemount 1154
Master Trip Unit	Energizes relays E21A-K94 and B21C-K1A* to initiate system start.	B21-N694A Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E21A-K10** & K11 on high drywell pressure.	E21A-K94 Agastat GP
Transmitter	Senses RPV level signal to MTU B21-N691B.	B21-N091B Rosemount 1154
Master Trip Unit	Energizes relay E12A-K7 to initiate system start.	B21-N691B Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E12A-K109B, K9B, and K126B on RPV level-1.	E12A-K7 Agastat GP
Transmitter	Senses drywell pressure signal to MTU B21-N694B.	B21-N094B Rosemount 1154
Master Trip Unit	Energizes relay E12A-K5 to initiate system start.	B21-N694B Rosemount 510DU/710DU

Reference Drawing Numbers:-

828E535AA, Sheets 2, 6, 10
828E534AA, Sheets 3, 8, 9, 10, 13, 14, 15, 16, 17, 24
851E602AA, Sheets 1A, 4

Notes:

* B21C-K3A & K1A, when energized, lead to ADS valves open if LPCS/LPCI pumps operate.
** E21A-K10, when energized, leads to start of LPCS (see Table 3.3.3-3, Item 1.0).

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (2 of 3)
RTT TRIP FUNCTION ITEM NO: 2.a
SYSTEM DESCRIPTION : Low Pressure Coolant Injection Mode of RHR System
TRIP FUNCTION DESCRIPTION : LPCI Mode of RHR System Initiation, Pumps A & B
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Trip Unit Output Relay	Energizes relays E12A-K109B, K9B, and K126B on high drywell pressure.	E12A-K5 Agastat GP
Interfacing Relay	Energizes relays E12A-K125A, K126A, K9A, K94A, & K109A.	E21A-K11 Agastat GP
Initiation Relay	Closes RHR HX flow valve to suppression pool, E12-F011A.	E12A-K125A Agastat GP
Initiation Relay and Interfacing Relay	Opens RHR injection valve E12-F027A.	E12A-K126A Agastat GP
Interfacing Relay	Energizes relays E12A-K93A, K70A, K23A & K95A.	E12A-K9A Agastat GP
Interfacing Relay	Deenergizes relay E12A-K95A after 10 min. time delay.	E12A-K93A Agastat TR14D
Initiation Relay	Opens valve E12-F048A for RHR HX shell side bypass; allows closure after 10 min.	E12A-K95A Agastat GP
Initiation Relay and Interfacing Relay	Starts RHR pump E12-C002A; energizes relay E12A-K18A after 7 sec. TD.	E12A-K70A Agastat TR14D
Initiation Relay	Starts RHR pump E12-C002A.	E12A-K18A GE HFA
Initiation Relay	Opens RHR injection valve E12-F042A.	E12A-K23A Agastat GP
Initiation Relay and Interfacing Relay	Closes RHR steam line isolation valve E12-F052A; deenergizes relay E12A-K96A.	E12A-K94A Agastat GP
Initiation Relay	Closes RHR valves E12-F051A & E12-F065A.	E12A-K96A Agastat GP

Reference Drawing Numbers:-

828E535AA, Sheets 2, 6, 10
828E534AA, Sheets 3, 8, 9, 10, 13, 14, 15, 16, 17, 24
851E602AA, Sheets 1A, 4

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (3 of 3)
RTT TRIP FUNCTION ITEM NO: 2.a
SYSTEM DESCRIPTION : Low Pressure Coolant Injection Mode of RHR System
TRIP FUNCTION DESCRIPTION : LPCI Mode of RHR System Initiation, Pumps A & B
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Initiation Relay	Closes RHR test return valve E12-F024B.	E12A-K109B Agastat GP
Interfacing Relay	Energizes relays E12A-K93B, K95B & K70B.	E12A-K9B Agastat GP
Timer Relay	Energizes relay E12A-K95B after 10 min. time delay.	E12A-K93B Agastat TR14D
Initiation Relay	Opens RHR HX shell bypass valve E12-F048B.	E12A-K95B Agastat GP
Timer Relay	Energizes relay E12A-K18B after 7 sec time delay. Starts RHR Pump E12-C002B.	E12A-K70B Agastat TR14D
Initiation Relay	Starts RHR pump E12-C002B.	E12A-K18B GE HFA
Interfacing Relay	Energizes relays E12A-K125B, K94B & K102.	E12A-K126B Agastat GP
Initiation Relay	Closes RHR HX valve E12-F011B, flow to suppression pool.	E12A-K125B Agastat GP
Initiation Relay and Interfacing Relay	Opens RHR "B" injection valve E12-F027B; energizes relay K23B; deenergizes relay E12A-K96B.	E12A-K94B Agastat GP
Initiation Relay	Closes Solenoid valve E12-F065B (condensate discharge to suppression pool or RCIC.)	E12A-K96B Agastat GP
Initiation Relay	Opens RHR injection valve E12-F042B.	E12A-K23B Agastat GP

Reference Drawing Numbers:-

828E535AA, Sheets 2, 6, 10
828E534AA, Sheets 3, 8, 9, 10, 13, 14, 15, 16, 17, 24
851E602AA, Sheets 1A, 4

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (1 of 2)
RTT TRIP FUNCTION ITEM NO: 2.b
SYSTEM DESCRIPTION : Low Pressure Coolant Injection Mode of RHR System
TRIP FUNCTION DESCRIPTION : LPCI Mode of RHR System Initiation, Pump C
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level signal to MTU B21-N691B.	B21-N091B Rosemount 1154
Master Trip Unit	Energizes relay E12A-K7 to initiate system start.	B21-N691B Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E12A-K109B*, K9B*, and K126B on RPV level-1.	E12A-K7 Agastat GP
Transmitter	Senses drywell pressure signal to MTU B21-N694B.	B21-N094B Rosemount 1154
Master Trip Unit	Energizes relay E12A-K5 to initiate system start.	B21-N694B Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relays E12A-K109B, K9B, and K126B on high drywell pressure.	E12A-K5 Agastat GP
Interfacing Relay	Energizes relays E12A-K125B, K94B & K102.	E12A-K126B Agastat GP
Initiation Relay and Interfacing Relay	Closes RHR HX valve E12-F011B, flow to suppression pool; energizes relay E12A-K23C.	E12A-K125B Agastat GP
Initiation Relay	Opens RHR injection valve E12-F042C.	E12A-K23C Agastat GP
Initiation Relay and Interfacing Relay	Opens RHR "B" injection valve E12-F027B; energizes relays E12A-K70C & K23B*; deenergizes relay E12A-K96B*.	E12A-K94B Agastat GP
Timer Relay	Energizes relay E12A-K18C after 2 sec time delay. Starts RHR pump E12-C002C.	E12A-K70C Agastat TR14D

Reference Drawing Numbers:-

828E534AA, Sheets 3, 9, 10, 15, 16, 17, 24

Notes:

* E21A-K109B, K9B, K23B & K96B lead to start of RHR pump B (see Table 3.3.3-3, Item 2.a).

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (2 of 2)
RTT TRIP FUNCTION ITEM NO: 2.b
SYSTEM DESCRIPTION : Low Pressure Coolant Injection Mode of RHR System
TRIP FUNCTION DESCRIPTION : LPCI Mode of RHR System Initiation, Pump C
T/S RTT REQU_REMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Initiation Relay	Starts RHR pump E12-C002C.	E12A-K18C GE HFA
Initiation Relay	Closes RHR "C" test return valve E12-F021.	E12A-K102 Agastat GP

Reference Drawing Numbers:-

828E534AA, Sheets 3, 9, 10, 15, 16, 17, 24

Notes:

* E21A-K109B, K9B, K23B & K96B lead to start of RHR pump B (see Table 3.3.3-3, Item 2.a).

RTT TRIP FUNCTION TABLE NO: 3.3.3-3 River Bend (1 of 1)
RTT TRIP FUNCTION ITEM NO: 4.0
SYSTEM DESCRIPTION : High Pressure Core Spray System
TRIP FUNCTION DESCRIPTION : HPCS System Initiation
T/S RTT REQUIREMENT (Sec) : <= 37.0

DESCRIPTION OF COMPONENT	FUNCTION	DEVICE MPL & MODEL #
Transmitter	Senses RPV level signal to MTU B21-N673C.	B21-N073C Rosemount 1154
Master Trip Unit	Energizes relay E22A-K73 to initiate system start.	B21-N673C Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relay E22A-K11 on RPV level 1.	E22A-K73 Agastat GP
Interfacing Relay	Energizes relays E22A-K3, K9 & K109.	E22A-K11 Agastat GP
Transmitter	Senses drywell pressure signal to MTU MTU B21-N667C.	B21-N067C Rosemount 1154
Master Trip Unit	Energizes relay E22A-K67 to initiate system start.	B21-N667C Rosemount 510DU/710DU
Trip Unit Output Relay	Energizes relay E22A-K29 on DW pressure.	E22A-K67 Agastat GP
Interfacing Relay	Energizes relays E22A-K3, K9 & K109.	E22A-K29 Agastat GP
Initiation Relay	Auto start of HPCS diesel generator.	E22A-K3 GE HFA
Initiation Relay	Opens HPCS valves E22-F001 & F004.	E22A-K9 Agastat GP
Initiation Relay	Closes HPCS test valves E22-F010, F011 & F023.	E22A-K109 Agastat GP

Reference Drawing Numbers:-

828E536AA, Sheets 3, 4, 5, 6, 7

APPENDIX D

RTT FAILURE EXPERIENCE REVIEW FROM INDUSTRY DATA BASES

APPENDIX D
RTT FAILURE EXPERIENCE REVIEW FROM INDUSTRY DATA BASES

This Appendix summarizes the results of a comprehensive BWR Owners' Group investigation with respect to the generic failure of response time sensitive components reported as of May 1991. The sources used to obtain this information are GE SILs, NPRDS database, NRC Bulletins and NRC Information Notices. The available information has been included in this Appendix which summarizes the generic RTT component failures. First, the response time sensitive components are identified followed by a brief description of the incident or generic failure event. Next the table evaluates whether the function was or was not lost. This is followed by the impact on response time (RT) and other redundant surveillance tests that would detect the same generic failure.

The remaining columns classify other or additional redundant surveillance tests that can also pick up the same generic failure mode. Each column in the Generic RTT Components Failure Mode Experience is described below:

(A) Part Name
This column identifies the response time sensitive component, its manufacturer and model number. The failed part is also listed, followed by the source of information such as GE SILs, NRC Bulletins etc.

(B) Generic Failure Mode(s)
This column contains a brief description or synopsis of the incident followed by the identification of the failed part, the root cause, the failure symptom and the resolution. Final resolution involves design change, material change, component disqualification for a specified function and even discontinuation of the component by the manufacturer.

(C) Functional Failure
Inability or interruption of ability of system, structure or component to perform its designed function within acceptance criteria.

(D) Impact on Response Time (RT)
When the response or performance characteristics of a response time sensitive component degrades to a point where it significantly exceeds its design tolerances without functional failure, this component is considered to have an impact on response time.

(E) Detectable by Types of Surveillance Tests

These columns identify redundant technical specification surveillance tests that would detect the generic failure mode. Channel Functional, Logic Functional and Channel Check refer to the Technical Specification tests defined in Appendix B.

NOTE: Calibration is channel calibration as defined in the Technical Specifications and Appendix B, but does not include the Channel Functional test. For relay calibrations, refer to initial installation testing and/or a one-time-only generic document requirement.

(F) Visual Inspection

This method carefully examines by sight but without the use of instrumentation. This can include disassembly when necessary, checks for tightness, cleaning, binding and freedom of movement, etc.

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
Generic Relay. Relay Contact Surface. (IEN 88-98)	Silver-nickel or silver-cadmium alloys will tarnish or oxidize when used in low current applications because of the absence of contact surface sparking from the typical relay contact "making and breaking" functions. The sparking in the contact surfaces tends to promote a self-cleaning mechanism that reduces the oxide buildup on the contacts.	Yes	No	Yes	No	Yes	No	Yes
Westinghouse ARD. Relay solenoid armature. (IEN 88-88 Suppl)	Increased drag was found on the relay solenoid armature. This was attributed to an increased resistance caused by dust on the relay contact. Increased drag was caused by granules from the coil potting compound (sand based material) lodging between the solenoids coil spool and the armature that moves inside the coil spool. Resulting in increased relay contact resistance and breakdown of coil potting compound due to aging.	No	Possible	Yes	No	Yes	No	Yes
GE HFA. Relay contact GAP and WIPE setting adjustment. (IEN 83-19 & Sil 44 + Suppl)	Improper adjustments of contact gap and wipe can effect the performance of the relay during seismic events. HFA relays are manufactured with contacts normally open, but can be changed to normally closed. If this setting is changed then the contact gap and wipe settings must be adjusted properly. (* Gap setting during installation)	Yes	None	No	Yes*	No	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Westinghouse BFD, NBFD. Armature over travel (IEB 79-25)	The new style BFD relays exhibited marginal or unsatisfactory contact making characteristics due to insufficient armature travel. The minimum acceptable overtravel established is 0.02 inch, which is defined as the distance the relay armature travels beyond the point at which normally open contacts make. Contact over travel of all eight pole & travel pole relays can be confirmed by measurement. (* Contact overtravel measurement)	Yes	Possible	Yes	Yes*	Yes	No	No
Cutler-Hammer Type M Relays with DC Coils. Coil burnout. (IEB 76-06)	Type-M Relays failed during testing. The cause of failure was loss of arc gap in the coil cleaning contact, where the normal mode of operation is to have the coil energized. This contact prevents winding burnout by interrupting the inrush current to the pickup coil. The loss of arc gap in the clearing contact was caused by an abnormal amount of heat induced shrinkage of molded magnet carriers.	Yes	None	Yes	No	Yes	No	No
Westinghouse BFD. Coil Insulation and solder joints. (IEB 76-05)	During testing relays were discovered with excessive operating times and open circuit failures. These were caused by over heating of the relay coils. This overheating may result in coil insulation breakdown or melting of the coil solder joints, either of which can lead to open circuit failure. This overheating can also result in the deformation of the nylon coil sleeve in which the plunger travelers, affecting the	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
	relay opening time. This coil has been replaced by a new coil insulation that is less susceptible to temperature degradation.							
GE Induction Disc Relays. (IAC, IAV, ICR or ISCV) Petroleum Jelly Lubricant. (IEC 80-01)	A higher than normal pick-up value was caused by petroleum jelly lubricant which under high temperature conditions can migrate to the backstop. Later, at room temperature the lubricant can act as an adhesive and cause pick-up values to be higher than setpoint values. Cleaning procedure is recommended.	No	None	Yes	Yes	Yes	No	No
Westinghouse BF(AC) BFD(DC). Pin misalignment. (IEC 76-02)	Relay malfunctions were caused by the pin that connects the plunger to the operating head rubbing against the contact block. This rubbing action resulted in friction that impeded the plunger movement when the relay coil was energized, there by preventing contact movement. Relays would operate properly when the pin was centered in the plunger. As a result the relay contacts remained in the de-energized position even though the coil was energized. Relay replacement was recommended.	Yes	None	Yes	No	Yes	No	No
Westinghouse BFD. Struck Armature. (IEB 79-25)	While conducting periodic response time test two relays were found to be stuck in the energized position with the coil de-energized. Investigation revealed that the armature was sticking to the armature	Yes	None	Yes	No	Yes	No	Yes

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	stop post. This condition is created when heat generated by normally energized coils causes a softening and resultant flow of epoxy adhesive. The epoxy adhesive is used to attach the magnetic antistick disc to the top of the armature stop post. When sufficient adhesive flows to the top of the armature stop, the armature becomes bonded to the stop post, resulting in the relay sticking in the energized position.							
Adams & Westlake Co. Mercury-Wetted matrix relays. (IEB 80-19)	Failures were "failed closed" type. The number of multiple failures detected suggest the presence of a common-mode failure mechanism. Due to the high random failure rate, and a possible common-mode failure mechanism, these relays have been replaced by dry-contact relays.	Yes	Yes	Yes	No	Yes	No	No
GE Type HFA Relays. Lexan Coil Spool material. (IEB 84-02)	Failures involved relays that were continuously energized in AC circuits and failed to open when de-energized. The cause was the deterioration of the coil wire insulation as a result of the effects of aging. Failure mechanism begins with wire insulation failure resulting in shorted turns, causing increased coil temperature and eventual coil failure. Coil temperatures can reach a level which can vaporize the insulating materials and can melt the coil spool. These materials may then deposit on cooler surfaces of the relay and cause armature damage and/or fail to make a	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	contact circuit. Recommended replacement by new "Century Series" HFA relay that uses a high-temperature-rated plastic material called "Tefzel".							
GE HFA Relays. Latch Engagement. (IE Not 88-14 NRC Bulletin 88-03)	Inadequate latch engagement, (when thr [illegible] is energized) was caused by the ar [illegible] latch operation that locks in the change in the state of the contacts and holds them in that state once the relay is de- energized until the relay is reset. With the armature in the latched position, each leg of the U-shaped latch should engage the top of the armature by the required minimum of 1/32 inch. With less than 1/32 inch latch engagement, it is possible that the relay could unlatch prematurely. There are two circumstances that can cause latch engagement to be less than 1/32 inch: (1) Insufficient clearance between the top of the relay armature and the top of the moving contact carrier and (2) Insufficient tension provided by the formed leaf spring that rotates the latch to its fully engaged position, which may permit the spring to relax before full engagement between the latch and the armature is achieved.	Yes	None	Yes	No	Yes	No	Yes

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
GE Type STD. Radio Frequency Interference. IEB 76-03.	A malfunction was caused by radio frequency interference from an activated transceiver. In the re-designed card the STD dropout point was reduced to 32 milliseconds. This significantly reduced the relay radio frequency sensitivity. (* Detectable after the trip has occurred)	No	None	No	No	No	No	Yes*
GE STD Transformer differential Relays. Zener diodes. (IEB 76-03)	The zener diode or the associated droping resistors on the STD sense Amplifier card have failed shorted. The cause was the two zener diodes whose cases were physically touching, resulting in a short circuit. The sense amplifier card has been redesigned using a new printed circuit card with components arranged to preclude any possibility of short circuits.	Yes	None	Yes	No	Yes	No	No
GE Relays HFA, HGA, HKA, HMA. Open Circuit Coil Failures. (IEB 84-02)	Open circuit coil failures of these relay windings, had been caused by corrosion. Halogens from a class of Nylon coil spools or bobbins plus humid conditions were attributed as the fundamental causes of the corrosion and resulting coil failures. Investigation revealed that heat stabilizing element of the nylon coil spool contained halogen ions which could be released over time. When combined with moisture the halogen ions form hydrochloric acid and copper salts which can cause the eventual open circuit failure of the coils. Vendor	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	recommended replacing the coils or relays with new relays that have LEXAN spool material.							
GE HFA. Coil Spools. (IE Not 81-01 & Sil 44 + Suppl)	Defective relay coil spools with either black or clear Lexan, a polycarbonate material is susceptible to surface cracking when exposed to hydrocarbons. These surface cracks can ultimately deteriorate to a point where the relay actuation would be blocked by this debris, and thereby inhibiting the safety function.	Yes	None	Yes	No	Yes	No	Yes
GE HFA (PVD 21B PVD 21D, HGA PVD 21B, PVD 21D, HGA). Stop tab location on the armature. (IE Not. 88-14)	The HFA relays were not resetting. The problem was the mechanical binding in the relays that prevented the normally closed contacts from making contact during de-energization. The cause was the incorrect location of a stop tab that is welded to the armature.	Yes	None	Yes	No	Yes	No	No
GTE Sylvania AC Relays. Relay Coil. (IE Info Notice No. 84-20.)	Normally energized relay coil was burning and smoke was observed coming from the Relay room. Upon de-energization of the relay coil the smoke stopped. The cause was determined to be coil end-of-life thermal aging and accelerated thermal aging of related relay components.	Yes	None	Yes	No	Yes	No	Yes

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Westinghouse Type SA-1 differential relays. Internal Capacitor Failure. (IEN No. 83-63)	Random trip output caused by relays containing S.T. SEMICON silicon-controlled rectifiers in SA-1 type relays. The two potentially significant problems are insufficient surge-withstand-capability (SWC) and internal tantalum capacitor failures due to corrosion that results in the leakage of the electrolyte. Vendor recommends a surge protection module be added to this relay model.	Yes	None	Yes	No	Yes	No	No
AGASTAT E-7000 Pneumatic timing diaphragm (IEN 82-04)	The pneumatic timing diaphragm leaks out a fluid substance as a function of time and temperature. This fluid substance tends to affect the diaphragm seal on the relays operating at high temperatures for extended periods, resulting in shorter time delays than those set on the relay dial. (Note: Time delay relays require response verification through calibration) (* assuming significant deviation from desired setting)	No	Yes	Yes*	Yes	Yes*	No	No
Westinghouse NBFD Relay coil insulating material (IEN No. 82-02)	At high ambient temperature conditions, relay coils could fail due to the inductive voltage spike generated by the de-energization of the relay coil. These failures are confined to normally energized relays. Mylar insulating material resolves the coil burnout by high voltage spikes.	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
GE HFA Coil Spool material (IEN No. 82-13)	Partial melting of the Nylon coil spool prevented the relay from moving to the de-energized position for several minutes after the coil was de-energized. On another occasion melted LEXAN material was found to be the cause. Melted insulation from the relay coil of an actuated relay had coated the relay contacts and thus prevented electrical contact. A piece of the spool flange had fallen into the gap between the open armature and pole face, preventing solid contact. With the contacts just touching must have created a fixed air gap in the magnetic circuit. The increase in the current caused by the air gap produced excessive temperature rise in the coil. This excessive temperature rise, through conduction and convection to the armature assembly and shading ring eventually caused remaining spool flange to soften, melt and move. As the piece of spool flange in the gap melted, the air gap closed permitting the normally open contacts to fully close. The closure of the gap caused a lower temperature and the melted LEXAN then hardened and created a bond between the armature and the pole face. Thus when the coil was de- energized the return spring force was not enough to break this bond. It was recommended that the LEXAN and Nylon coil spool be replaced with Century Series TEFZEL coil spools.	Yes	Yes	Yes	No	Yes	No	Yes

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
AGASTAT E-7000. Relay orientation. (IEN 85-49)	The time-relay measurements of horizontally bench calibrated but vertically installed relays were as much as 30% greater than that of the bench calibration. Bench calibration should be performed in the same orientation as the mounted device. (Note: Time delay relays require response verification through calibration) (* assuming significant deviation from desired setting)	No	Yes	Yes*	Yes	Yes*	No	No
Westinghouse NBFD. Coil Filler epoxy. (IEN 82-54)	Coil sticking problems were attributed to coil filler epoxy which flows during service into the plunger cavity, inhibiting the relay from moving to a de-energized position after the power is removed. This results in sluggish relay operation. (* Failure results over time) (** Some RT degradation possible before complete functional failure)	Yes*	Yes**	Yes	No	Yes	No	Yes
AGASTAT CR0095. Relay Sockets. (IE N 82-48)	Relay failed to energize due to the socket contact being disengaged from the socket and not making contact with the mating relay contact	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
GE HFA. Movable Contact Finger. (IEN 88-69 Supp. 1)	Difficulty in making wipe and gap settings due to binding of a movable contact finger in the phenolic support assembly. The root cause of the binding was determined to be movable contacts that were manufactured wider than the allowable tolerance. These wider contact arms do not float freely in the slot provided in the phenolic support. Consequently the binding of a movable contact arm could interfere with the relay contact wipe.	Yes	Possible	Yes	Yes	Yes	No	No
ASEA BB ITE-SIL Time-over current relays Silicon controlled rectifiers (SCRs). (IE 88-58)	The ITE-SIL relays encounter spurious relay actuations caused by faulty silicon-controlled rectifiers (SCRs). These SCR allow current to flow in the absence of the proper gating signal. These leakage currents were of sufficient magnitude to energize the trip coil of the associated circuit breaker. (* After trip has occurred)	No	None	Yes*	No	Yes*	No	No
AGASTAT (GP, EGP, [illegible]P) Nylon movable contact arm. (IEN 84-20)	The nylon movable contact arm was coming in contact with the barrier strip on the melamine phenol plastic relay base. Consequently this mechanical interference prevented one of the four sets of contacts from changing state in the relay. It was determined by GE and Amerace testing that these failures were end-of-service-life resulting from service aging of energized relays in combination with the mechanical configuration and tolerances. Vendor has	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	since made a design change to correct the mechanical configuration and tolerance problems.							
AGASTAT (GP) Relay contact arm and stationary base. (IEN 84-20)	Mechanical interference between the moving relay contact arm and the stationary base of the relay case. This was determined to be caused by the casing shrinkage as the melamine phenol plastic base cures after assembly. This phenomenon is also called post-mold plastic shrinkage that results in the reduction in clearances. Amerace Corporation introduced a design change by cutting a notch in the barrier strip to provide additional clearance. (* Stuck relay will be detected)	Yes	None	Yes*	No	Yes*	No	No
GE CR120A. Contact Arm retainer. (SIL No. 229)	A small relay fire occurred in a relay panel due to overheating and subsequent ignition. The contact arm retainer that was made of CELCAN M90 acetal copolymer which is flammable. The contact arm retainer material has been changed to VALOX 310-SEO, which is self extinguishing and flame resistant.	Yes	None	Yes	No	Yes	No	Yes
GE CR120A. Dirty Contacts. (Brunswick daily status report)	Dirty contacts were found on the transfer relay in feedwater level control contacts that were extremely resistive. Relay uses dry silver plated contacts. Relay contact with gold contacts would be better choice according to the customer.	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
GE CR120A. deposit buildup on contact surface (Fermi Report)	The apparent cause of the de-energization of the relay was loss of continuity to the relay due to deposit built up on the surface of the contacts. These deposits caused a momentary loss of continuity in the relay. The deposits were analyzed to consist of silver sulfide, silicon oil or light grease and chlorides.	Yes	None	Yes	No	Yes	No	No
GE HFA. Shorted Coil windings. (Sil. No 44 Supp 1,2)	Relay coil windings had shorted resulting in an increased current which eventually caused the relay coil to fail while exceeding the maximum current rating of downstream devices. Aging analysis revealed that the thermal aging of the nylon coil bobbins was the probable cause of failure. Embrittlement of the nylon bobbins was most severe at the location where the bobbin makes contact with the magnetic shading turn. Extreme embrittlement can lead to cracking of the nylon bobbin which allows the coil windings to move sufficiently to cause shorted turns. Nylon bobbin material was replaced by polycarbonate material.	Yes	None	Yes	No	Yes	No	No
GE HFA. Four No. 8 x 5/8 inch screws. (Sil No. 44 & Sup 1,2,3,4,5)	The four No. 8 x 5/8 inch screws which hold the aluminum adapter plate and magnetic core assembly to the back side of the relay case were not mechanically tight. Movement of the mechanical core can result in incorrect contact operation. Furthermore, partial contact between the magnetic core faces and the armature may occur causing	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	the relay coil to overheat due to an incomplete or partial path for the magnetic flux.							
HFA Relays. Armature stuck in energized position. (SIL No. 44)	Investigations to determine the cause of the stuck armature concluded that improperly cured (but hardened) varnish was the culprit. A long period of relay energization caused the varnish to soften and then reharden, resulting in the adhesion of the pole pieces.	Yes	None	Yes	No	Yes	No	Yes
HFA Relays. Defective Glass window. (SIL No. 44)	During inspections of relays, it was discovered that a defective glass window on one of the relay enclosures would not allow the armature to return to the fail-safe position if de-energized. One of the metal dips used to hold the glass window in place in the door frame was missing and substituted for by a piece of masking tape. Deterioration of the masking tape had permitted the glass window to sag from its normal position, jamming the relay armature in the energized mode.	Yes	None	Yes	No	Yes	No	Yes
HFA Relay Pickup voltage. (SIL No. 44)	The pickup voltages of some of the 125-volt DC HFA relays were found to be outside the recommended voltage range. Investigations revealed that the pickup voltage varies with temperature, which may have caused the out-of-range voltages. Also the relay pickup voltage below the lower limit of the	No	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
	recommended range indicates low spring tension which may allow normally closed contacts to chatter in a de-energized relay during a seismic event. These relays are qualified to prevent contact chatter during seismic events of up to 2.0 g ZPA (Zero period acceleration).							
Agastat Relay. Contact Resistance. NPRDS	A higher than normal resistance in the relay contact caused the relay to appear electrically open when it was mechanically closed. The mechanism for the failure is believed to be oxide build up which over time increases on the relay contact surfaces because of the low voltage, low current application and infrequent use.	Yes	None	Yes	No	Yes	No	No
Agastat GP. Slow response time. NPRDS	While performing response time testing on Reactor Protection System, low water level scram, the response time exceeded the technical specification requirement of 50 milliseconds. The cause was determined to be the 40 millisecond drop-out time of the Agastat Master trip relay. The root cause for the excessive drop out time was determined to be the relaxation of the contact opening spring. Relay was replaced. (Note: In RPS loops, only the sensor is exempt from response time testing.)	No	Yes	No	No	No	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Time delay Relay Setpoint drift NPRDS	While performing routine surveillance testing, the loss of normal auxiliary power interlock relay delay time was found to be out of specification. It was a minor deviation from Tech. Specs. Failure is attributed to age/set point drift. The relay was adjusted to an acceptable response time and returned to service. (Note: Time delay relays require response verification through calibration.) (* Assuming significant deviation from desired setting)	No	Yes	Yes*	Yes	Yes*	No	No
Time delay Relay Relay binding jolted loose NPRDS	Relay actuated slow at 17.84 seconds when the required Technical acceptance criteria is less than or equal to 5 seconds. Relay was repaired and reinstalled with a RTT of 3.01 seconds. (Note: Time delay relays require response verification through calibration.) (* assuming significant deviation from desired setting)	No	Yes	Yes*	Yes	Yes*	No	No
Time delay Relay Setpoint drift NPRDS	Auto-depressurization initiation time delay relay failed its 92 day response time test by more than one second. Relay was recalibrated. (Note: Time delay relays require response verification through calibration.) (* assuming significant deviation from desired setting)	No	Yes	Yes*	Yes	Yes*	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
GE HGA Relay Armature Binding. (SIL No. 77)	HGA armature binding was reported by operating BWRs. The binding can occur only with surface mounted HGA relays using front connecting terminals, and then only when their unsymmetrical cover is installed both upside down and in a cocked or displaced orientation. This problem cannot occur with flush mounted HGA relays. Correct relay orientation and installation will resolve this problem.	Yes	None	Yes	No	Yes	No	Yes
Potter-Brumfield KH & KHP. Loose Sockets. (SIL No. 172)	P-B type KH & KHP sockets were found loose. While removing a loosely mounted socket the complete socket assembly was detached causing the metal socket retainer ring to fall back on the socket terminals. This resulted in a short circuit.	Yes	None	Yes	No	Yes	No	No
Relays. Coil Overheating Problem. (SIL No. 189)	Trip relays rated at 24 volts DC in some ARM indicator trip units have failed with burned open coils. Actual coil operating voltages can reach 34-volts DC. Operating trip relays in an over-voltage condition results in excessive heating of the relay coil that may cause it to fail.	Yes	None	Yes	No	Yes	No	No
Relays GE HFA, HGA, HKA, HMA Electrolytic corrosion of coils.	Open coil circuits in GE relays - HFA, HGA, HKA & HMA could occur in direct current (DC) applications due to electrolytic corrosion. The three significant contributing factors to this failure mechanism are: 1. High humidity environment exceeding 60%.	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
(SIL No. 153)	2. Intermittent energizing as opposed to continuous relay operation. 3. D.C. Operation as opposed to A.C. operation. The mechanism of electrolytic corrosion results when moisture combines with halogens given up by the heat stabilizing compound used in the nylon bobbin of the relay coil. These halogens then migrate through the insulation causing corrosion of the copper wire. The chemical reaction usually occurs in the part of the coil windings in proximity to the bobbin. Relays used in circuits with high duty cycle are not prone to this failure since the heat generated by the continuously - energized coil tends to evaporate any excess moisture. Nylon coil bobbins that are the cause of this problem were replaced by Lexan coil bobbins.							
Relay Slow response time NPRDS	The 2 CSW Pump B 4160 breaker tripped late on instantaneous overcurrent after the loss of second air compressor, 2A & 2B chillers, turbine building exhaust radiation monitor and 2A-2 battery charger. There was no reason for delay. A response test was completed numerous times and the response time of the relay decreased with each test. On the final test the coil failed to energize and change the contact positions. Replaced relay coil 2-E-84-2553.	Yes	Possible	Yes	No	Yes	No	No

PART NAME	AUXILIARY CONTACT GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
Relay Mechanical linkage NPRDS	During surveillance test on the E-average power range monitors. On generating a 1/2 scram on the B-channel received a full scram. Scram Contactor contacts 5 and 6 did not open when relay was energized. Investigations revealed a mechanical linkage had fallen off that opens contacts. Replaced clip and linkage.	Yes	None	Yes	No	Yes	No	Yes
Relay CR305 (PRC 88-10)	Relay C71A-K14A failed and subsequent inspection revealed all scram contactors and actuator assemblies for contactor relay slightly loose. Tightened auxiliary contact assemblies.	Yes	None	Yes	No	Yes	No	No
REED Relays. Stuck relays. (SIL No. 184)	Stuck reed relays were discovered in the APRM averaging cards. One relay was stuck closed and the other was stuck open. An LPRM with a relay stuck open would not be averaged by the APRM circuit.	Yes	None	Yes	No	Yes	No	No
CR2820 Time Delay Relays. Defective timer. (SIL No. 230 Rev. 2)	GE CR2820 time delay relays used in the core spray, residual heat removal (RHR) and automatic depressurization systems have a tendency to increase after long periods in a de-energized condition. The CR2820 timer has an accuracy specification of ± 10% for repetitive use. However it may vary considerably more than 10% on the first pickup after more than a month in the de-energized state. Recommended to use Agastat Relays	No	Yes	Yes	Yes	Yes*	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RI	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
	for such applications. The actual value of the time delay should be verified by testing. (Note: Time delay relays require response verification through calibration.) (* Assuming significant deviation from desired setting)							
GE Relays. Contact Resistance. (SIL No. 332)	Relay contact resistance is found to be greater than specified when dust, dirt or contaminants are present. These relay contacts should be lightly dusted with a soft brush while vacuuming to remove dislodged particles. Following vacuuming, contacts should be cleaned only with a burnishing tool.	No	Possible degradation	Yes	No	Yes	No	No
Agastat Relay Type CR0095 Relay Bases. (SIL No. 384)	Agastat relays are plugged into a base that has sixteen plug-in terminals. A potential problem identified is the relay base, which could lead to a high impedance or "open" connection between one or more of the sixteen relay terminals (male) and the corresponding terminal in the relay base (female). The problem is caused by inadequate retention of the female terminal in the base which allows the terminal to be pushed out of the base when the relay is plugged-in.	Yes	None	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) RELAYS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Potter & Brumfield MDR Relays (RICSIL No. 053)	Upon de-energizing, the relays failed to return to the appropriate position and their normally open contacts failed to open. A failure analysis concluded that corrosion occurred from chlorine released from rubber grommets and polyvinyl chloride sleeving. Gases release also occurred from varnish on the coil while continuously energized. Chlorine and outgasing accumulated in the area of the bottom end bell bearing and caused the motor shaft to bond to the bearing.	Yes	None	Yes	No	Yes	No	No
Westinghouse Types ARD, BFD & NBFD Epoxy Flow In Energized Relays NRC Info. Notice 91-45	There is a potential for these relays to malfunction due to the epoxy compound becoming semi-fluid when the coil is energized for extended periods. This malfunction may degrade safety by disabling or delaying a function. These relays failed to reset properly after de-energization because epoxy coil had softened and flowed into the area of the return spring causing sticking of the plunger assembly. Probable cause is attributed to a poor mixing in the manufacturing process.	Yes	Yes	Yes	No	Yes	No	No

PART NAME	GENERIC FAILURE MODE(S) TRIP UNITS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Trip Unit Rosemount 510DU. Transistor degradation (SIL No. 520)	Rosemount 510DU master and slave trip unit malfunctions and erroneous trip signals have been experienced. The reported malfunction involves the trip unit sending an erroneous trip output signal without any change in the input signal on the trip units trip status indicator. This malfunction is caused by long term degradation of the trip units output Darlington transistor (2N6296,Q8). The trip output voltage gradually increases from zero volts to the 12-18 volts range, even though no trip condition exists. The root cause is formation of a conductive, hydroscopic residue in the transistor. As the residue grows with time, resistive leakage across the transistor eventually becomes large enough to activate trip signal output. Failure rate caused by resistive leakage across the transistor is 0.48 failure per million hours of operation, which is below the design failure rate. 1. In normally deenergized application (low output) of transistor leakage becomes large enough to create an enormous trip signal, it usually is detectable by the annunciator or downstream logic. 2. In normally energized applications (high output) the trip output signal can remain high and no trip occurs even though an actual trip signal exists.	Yes	None	Yes	Yes	Yes (For ECCS) No (For RPS)	Yes (For ECCS) No (For RPS)	No

PART NAME	GENERIC FAILURE MODE(S) TRIP UNITS	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Trip Unit Rosemount 510DU. Switch Failures. (IE Cir. 80-16)	The Rosemount 510DU trip units have a common mode failure of two switches namely S1 in the trip status output, LED logic circuit and S2 in the trip output logic circuit. These malfunctions result in open circuits in the output logic upon the reception of an actual trip signal. The switch (S2) failure could result in failure to automatically activate a safety function.	Yes	None	Yes	Yes	Yes	Yes	No
Trip Unit Rosemount 510DU and 710DU. R11 Potentiometer. (SIL No. 468)	Inadvertent trips and unstable trip point settings have been reported. This condition was traced to the R11 Potentiometer failures. The R11 potentiometer is the trip point adjustment potentiometer located on the front of the 510 DU system. Failure is caused by an accumulation of contaminants and/or oxidation on the wiper arm of R11 causing unstable intermittent changes in potentiometer settings. High humidity and temperature conditions can lead to this problem, since R11 potentiometer is unsealed and oxidation accumulation on the wiper arm under normal operating conditions can occur - the R11 potentiometer has been sealed for the 710DU system.	Possible	None	Yes	Yes	Yes	Yes	No

PART NAME	GENERIC FAILURE MODE(S) SWITCHES	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS				VISUAL INSPECTION
				CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	
Barksdale BIT-GH3255 Bourdon tube pressure switch noise. (SIL No. 429)	Hydraulic control unit (HCU) accumulator pressure switches have actuated below the Technical Specification limits during surveillance testing due to setpoint drift. SIL recommends Recalibration of Switches.	No	Yes	No	Yes	No	Yes	Yes
Barksdale TC9622-3 Pressure Switch. (SIL 456 - Rev. 1)	The nitrile rubber O-ring in the switch is incompatible with polyphosphate ester hydraulic oil. Nitrile rubber tends to soften and swell when exposed to polyphosphate ester oil resulting in piston and switch malfunction.	Yes	Yes	Yes	Yes	Yes	No	No
Panalarm (Riley) Model 86-86A Temp-Matic switches 1) Contract chattering. 2) Spurious Trip.	(a) A spurious trip could occur with Riley Model 86 and 86A temperature switches if their voltage power supply drops as low as 108 volts when the setpoint is within 6°F of operating temperature. Model 86B eliminates this problem by relocating the grounding jumper points between power supply card and the main card. (* Detected after the trip)	(a) No	None	Yes*	No	Yes*	No	No
(SIL No. 443 Suppl.)	(b) The burnout protection feature may continue to chatter. This chattering caused the contacts to burn or weld together. Panalarm has eliminated the problem in Model 86B by modifying the burnout protection circuit.	(b) Yes	None	Yes	Yes	No	No	No

PART NAME	GENERIC FAILURE MODE(S) SWITCHES	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Static O-Ring Pressure Switches. 6TA-B4-NX-JJTTX6. (IEB 87-16)	The pressure switch set points had drifted outside tech. spec. tolerances. Investigations revealed that ammonia present in the steam lines had interacted with the Kapton diaphragm of the pressure switch, permeated it, and formed a bubble between the laminations of the Kapton diaphragm (fluorinated silicone membrane). It is believed that the formation of this bubble between the diaphragm layers caused the set point of the switch to shift. In ammonia environment following pressure switch are affected for model numbers beginning with 1, 4, 5, 6, 8, 9, 12 and 54. Replaced diaphragms made of stainless steel do not encounter this problem.	Yes	None	No	Yes	Yes	No	No
NAMCO EA180 Limit Switches Elevated Temperatures. (EI 79-28)	Yellow and brown "crystal-like" resin deposits on the internal components of NAMCO model EA180 stem mounted limit switch (SMLS) caused it to malfunction. The problem was traced to a batch of top cover gaskets of which some were over impregnated and insufficiently heat cured. This condition can leave an uncured residue of "Loctite" in the gasket, which vaporizes at sustained temperatures above 175°F. Problem has been resolved by a properly heat curing in the manufacturing process.	Yes	None	Yes	No	Yes	No	Yes

PART NAME	GENERIC FAILURE MODE(S) SWITCHES	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
ITT Barton Model Numbers 288, 288A and 289, 289A. Differential Pressure Indicating Switch. Set Point Drift. (SIL No. 10)	Process fluid causes a problem when the DP switch constantly trips with the same reading and water buildup between the DP switch and the reference will cause different readings on the test reference. Another problem occurs when the DP switch isolation valve leaks. This allows the process fluid to enter the test lines after being cleared. If possible the test lines should be applied directly to the instrument. The most common problem with set point drift unique to these DP switches has been with the spring washers and to hold the switch plate against the back of the DP switch case. Vendor has devised a new switch plate locking device that prevents the set point drift. Vendor recommendations regarding adjustments can correct the set point drift.	No	None	Yes	Yes	Yes	Yes	No

PART NAME	GENERIC FAILURE MODE(S) TRANSMITTER	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Rosemount Models 1151, 1152, 1153 and 1154. Transmitter Failures. (Info N 89-42, Bulletin 90-01, RICSIL No. 33)	Five Rosemount model 1153 HD5PC differential pressure transmitters were reported to have malfunctioned. Operators during power operation noted that the signals from the Rosemount 1153 transmitters were indicating reduced levels of process noise. Attempts to recalibrate the transmitters also failed. Destructive testing by Rosemount determined that the failures were caused by the loss of oil from the transmitters sealed sensing module. Silicon oil leaks out of the sensing module resulting in gradual deterioration and eventual detectable failure of the transmitter. Some of the symptoms that have been observed during operation and before failure include slow drift in either direction of about 1/4 percent or more per month, lack of response over the transmitter's full range, increase in the transmitter's time response, deviation from the normal signal fluctuations, decrease in the detectable noise level, deviation of signals from one channel compared with redundant channels, "one sided" signal noise and slow response to a transient or inability to follow a transient. (* drift analysis and/or other techniques)	Possible	Yes	No	Yes*	No	Yes*	No

PART NAME	GENERIC FAILURE MODE(S) NUMAC	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
NUMAC Low Voltage Power Supply Reliability. (SIL No. 499)	Analysis of failed NUMAC low voltage power supplies (LVPS) have identified one generic problem and one potentially generic problem, that can lead to early life failures of LVPs.							
	(a) The generic problem results from a power supply manufacturing problem that causes early degradation of a capacitor in the LVPS followed by an abnormally high drift rate in the -15 VDC voltage in the NUMAC chassis.	No	None	No	Yes	No	No	No
	(b) The potentially generic problem appears to be caused by high voltage transients on the 120 VAC line supplying power to the NUMAC chassis. The suspected transient results in a shorted input diode rectifier bridge in the LVPS. This causes an LVPS failure, but in some cases also causes the NUMAC line fuse to open, rendering the instrument unavailable and defeating the value of the redundant LVPS in the NUMAC units. Drifting -15 VDC voltage drift can be corrected by the LVPS internal capacitor. Shorted bridge caused by transient can be corrected by replacing the NUMAC line fuse with a 5 amp slow blow fuse.	Yes	None	Yes	Yes	Yes	Yes	Yes

PART NAME	GENERIC FAILURE MODE(S) LOG RAD MONITOR	FUNCTIONAL FAILURE (YES/NO)	IMPACT ON RT	DETECTABLE BY TYPES OF SURVEILLANCE TESTS: CHANNEL FUNCTIONAL	CALIBRATION	LOGIC SYSTEM FUNCTION	CHANNEL CHECK	VISUAL INSPECTION
Logarithmic Radiation Monitor, Instable Voltage/ Inoperative Trip Circuit. (SIL No. 245)	Instability was encountered in the Logarithmic Radiation Monitor high voltage/inoperative trip circuit. Jarring the instrument or its external cables caused spurious trips. The cause of the trip instability resulted from the Logarithmic Radiation Monitors (LRM) high voltage trip adjust potentiometer, R90, being set too close to the operating high voltage. The adjustment procedure used was to adjust R90 until the front panel HV/Inop. trip light just came on and then to back off R90 until the light just went out. This provided only a few volts margin between the untripped and tripped states, rendering the trip circuit subject to spurious operation from jarring the drawer or the cables to the gamma sensitive ION chamber. GE recommendations regarding changing the Calibration procedures for Logarithmic Radiation Monitor resolves the instability.	No	None	No	Yes	No	No	Yes
Logarithmic Radiation Monitor. Heater Element. (SIL No. 296)	Lowest decade calibration of the solid state Log Radiation Monitor (LRM) has been difficult to obtain in some units with their thermostatically controlled heaters in operation. This is due to reduced leakages resistance of log element U8 at elevated temperatures. Calibration with stabilization of LRM resolves this problems.	No	None	No	Yes	No	No	No

APPENDIX E

RESPONSE TIME TEST FAILURE EXPERIENCE FROM PLANT SURVEY

APPENDIX E
RESPONSE TIME TEST FAILURE EXPERIENCE FROM PLANT SURVEY

This Appendix summarizes for the participating BWRs, how response time test related failures were identified.

A summary of response time test failures from the participating plant survey is shown in Table E-1. As indicated in this table, the majority of the plants have not encountered response time test failures. There have also been numerous instances of failures detected by other tests which would probably have resulted in response time test failures if a response time test had been performed. The few cases of exceeding administrative limits and response time test failures reported by some plants are described below:

E.1 LASALLE PLANT

LaSalle plant incidents exceeding RTT limits are described in the following sections.

E.1.1 Technical Specification

A search of LaSalle Plant Deviation Report system yielded two instances of failed response time tests.

(1) APRM Hi neutron flux function in RPS trip logic was determined to exceed technical specification response time limit by 0.003 second during routine response time testing. It was determined that response time of 1C51-K1 relay was slightly longer than the response times of similar relays while response times of other relays in the trip channel were within expected limits. The K1 relay was replaced and test was successfully completed. It is doubtful that this degradation could have been detected by any other routine test. It is important to note here that the response time testing requirements for this trip function (APRM Hi neutron flux) has not been exempted. In addition, this study only exempts the sensor from response time testing for the three trip functions identified in Section 5.3.1 of the main report.

(2) The reactor low water level-3 function in RPS/isolation trip logic was determined to exceed technical specification RPS response time limit during routine response time testing. Failure was apparently

caused by binding of SOR switch shaft due to corrosion. The switch was replaced and test was successfully completed. Since other instances of shaft corrosion have been detected during routine calibrations due to a significant setpoint drift and lack of repeatability, response time failures of this type could also be detected via calibration anomalies. In fact, a review of the calibration data for the two calibrations preceding the failed response time test showed that, in both cases, the as-found setpoint had drifted beyond the calibration limits but had not reached the administrative action or reject limits. Hence, calibration tests can successfully identify response time failures due to binding of SOR switch shaft by corrosion.

E.1.2 Administrative Limits

The Administrative Limit violations are grouped together as follows:

(1) Perforated dp Sensor Diaphragms: This type of failure is found frequently in SOR switches. Perforation of the diaphragm allows fluid to leak from the high to low pressure side of the switch. The detection method is a visible change in water bottle levels and/or failure to hold test pressure during functional tests or calibrations. Consequently, functional and calibration tests will readily identify this response time failure caused by the perforated dp sensor diaphragms.

(2) Corrosion-Induced Mechanical Binding: This type of failure is also inherent to SOR switches. Due to corrosion on the switch shaft or shaft bearings, higher than normal pressure is required to move the shaft to the switch actuation point. Detection of this failure mode is covered in the response time test failure discussion above.

(3) Loss of Cell Fill Oil: This failure mode has been observed in Rosemount transmitters. Leakage of oil out of the sensing cell causes drift and degraded transient response. A number of these failures have been detected due to visibly slow response during calibration. This failure mode is discussed in more detail in Appendix F.

E.2 PERRY PLANT

The following failure was reported:

(1) A RTT failure occurred in the main steam line high flow line break detection circuit. The response measured time was 0.6 seconds, as opposed to the allowable 0.5 seconds. The RTT surveillance test was done just prior to calibration. The calibration procedure confirmed loss of oil with its extended loss of oil check. Had the calibration been done first, it would have detected the loss of oil prior to RTT.

E.3 SUSQUEHANNA PLANT

Susquehanna has had one RTT failure exceeding the technical specifications. While performing the HPCI System sensor/trip relay, E41A-K430 (steam line high differential pressure) failed to actuate within the required time of 5.0 seconds. This sensor relay includes a 3-second time delay. The actual response time was 17.838 seconds. The relay was removed and the contacts were burnished and bench tested. The relay was replaced and RTT was performed satisfactorily with a time of 3.010 seconds.

The performance of the 18-month logic system functional test would likely have detected this failure. Had a calibration been performed on this time delay relay, the excessive time would have been identified during the calibration. Time delay relays require calibration to assure setpoint accuracy.

Table E-1

SUMMARY OF RESPONSE TIME TEST FAILURES FROM PLANT SURVEY

	Brunswick	Clinton	Fermi-2	Grand Gulf	WNP 2	Hatch	Hope Creek	LaSalle	Limerick	Perry	River Bend	Susquehanna
<u>Exceeding RTT Requirements</u>												
Technical Specification Limits	None	None	None	None	None	None	None	Two	None	One	None	One
<u>Component Involved</u>												
1) Transmitter										(3)		
2) Switch								(1)				
3) Trip Unit												
4) Relay Logic								(2)				(4)

<u>NOTES</u>: (1) Switch shaft was corroded. RPS switch was replaced. (Calibration not performed prior to RTT)

(2) 1C51-K1 RPS relay response time was slightly longer. (This RPS trip function was not selected for RTT elimination)

(3) Transmitter loss of cell fill oil. (See detailed discussion in Appendix F)

(4) Time delay relay. (Calibration not performed prior to RTT)

APPENDIX F

EPRI PRESSURE TRANSMITTER/SWITCHES RESPONSE TIME ANALYSIS

APPENDIX F
EPRI PRESSURE TRANSMITTER/SWITCHES RESPONSE TIME ANALYSIS

EPRI analyses (Reference F-1 and F-6) of pressure transmitters and switches were utilized by the BWROG in establishing the bases for eliminating response time testing of pressure transmitters and switches. The EPRI analyses scope included the majority of pressure sensor instrumentation currently installed or expected to be installed in U.S. plants. The pressure sensors which are applicable to the BWR plants participating in this BWROG study are the Barton, Rosemount, and SOR transmitters/switches.

The BWROG reviewed and provided comments on the draft EPRI analysis (Reference F-1) report prior to issuance. Most of the comments were related to inquiries as to whether specific failure modes that could potentially affect response times had been addressed in the analysis. EPRI assured the BWROG that these identified failure modes had been considered in the analysis and that the associated response time failure effects would be detected by means other than RTTs.

The EPRI report (Reference F-1) summarized the slow loss of fill-oil failure mode which has been experienced at plants using Rosemount transmitters. Rosemount has developed guidelines (Reference F-2) that address relationships between oil loss, zero and span drift, and response time degradation to assist in detecting slow oil loss. In addition, Rosemount has provided acceptance accuracy criteria for oil loss diagnostics. An EPRI analysis (Reference F-1) has concluded that current response time tests are ineffective in detecting response time failures due to slow oil loss but that other methods are available to detect the resulting change in instrument performance. EPRI has continued to develop and interpret FMEA analyses as part of its Instrument Calibration Monitoring Program (ICMP; Reference F-6).

EPRI report analyses (References F-1 and F-6) have identified only two failure modes and two manufacturing/ handling defects with the potential to affect response time without concurrently affecting sensor output. These failure modes and defects only apply to sensors utilizing a fill fluid to transfer the process pressure to the sensing element. Rosemount transmitters are the only sensors of this type identified for plants participating in this BWROG study. The two failure modes are the slow loss of fill fluid leak during pressurized operations and variable damping potentiometer misadjustment during maintenance or calibration. The two manufacturing and handling defects are low sensor fill fluid from the manufacturing process and crimped capillaries from the manufacturing process, improper handling by the manufacturer, or damage during field installation/maintenance. Sensitivity of fill oil viscosity due to temperature and radiation effects is addressed inherently in the design of the pressure transmitters (Reference F-6). Where credible, failure modes involving mechanical interaction of piece-parts have been considered (References F-1 and F-6).

The following is a discussion of the EPRI identified response time-related failure modes and effects.

F.1 SLOW LOSS OF FILL FLUID

For transmitters designed to sense fill fluid pressure, a slow loss of fill fluid will result in a gradual degradation of the measurement process by reducing the ability of the working fluid to rapidly transmit pressure changes to the sensing diaphragm. With applied static line pressure, a pressure differential will exist between the sensing cell and cell holder, or across the sensing cell. This pressure differential will induce a slow migration of the fill fluid from the sensing cell through the leak path. The loss of fill fluid from the isolation diaphragm region reduces the volume between the affected isolation diaphragm and the sensing element. The decrease in volume is accommodated by movements of both the affected isolation diaphragm and the sensing element, the amount depending on the relative stiffness of the central sensing diaphragm. This movement of the sensing element and associated changes in the hydraulic resistance induces a static calibration drift in both the zero setting and span of the transmitter. During the latter stages of slow loss of fill fluid, response time will degrade due to the reduction in clearances for fill fluid motion from behind the isolation diaphragm to the sensing element location. The only confirmed response time degradation due to loss of fill fluid has involved Rosemount transmitters.

Current response time tests are ineffective in detecting the initial stages of slow fluid loss. Industry has developed techniques for detecting transmitter degradation due to slow oil loss between calibrations using drift trending analysis. When enough (Reference F-2) fluid is lost to cause a significant response time degradation, the sluggish response of the leaking sensor can be detected during the scheduled transmitter calibration. The elimination of response time tests will thus not affect the ability to detect response time degradation or response time failures beyond design requirements.

F.2 VARIABLE DAMPING POTENTIOMETER MISADJUSTMENT

Damping devices have been utilized in fast acting trip circuits to minimize the potential for inadvertent actuations (Table F-1). The potential application of sensors in BWR plants include fast acting circuits in the RPS level trips (Level 3 or 8 trips) and high reactor dome pressure. The use of a variable damping potentiometer in the transmitter design provides a means of applying the same type transmitter to several circuits that require additional electronic filtering capability. Variable damping potentiometer misadjustment can affect the response time. Potentiometer misadjustment can only occur during initial installation or major maintenance. Degradation of the wiper contact resistance in a potentiometer used to control electronic damping is a failure mode that can occur anytime. However, degradation of the trimmer resistor/potentiometer for Rosemount differential and pressure transmitters causes the response time to be faster (Reference F-3).

Measures must be taken to ensure the potentiometer is at the required setting at time of installation and after major maintenance. This approach should eliminate the need for RTT to detect a variable damping failure mode.

F.3 MANUFACTURING AND HANDLING DEFECTS

Potential manufacturing problems are (1) low sensor fill fluid and (2) crimped capillaries.

Low fill fluid is a different failure mode than loss of fill fluid since the sensor characteristics remain the same over time. Low fill fluid does not automatically create a response time concern and only applies to a very narrow range of low fill conditions. If the quantity of fill fluid is such that its motion is not restricted by clearances under the isolation diaphragm(s), there is no response time degradation. Conversely, if the fill is so low that the isolation diaphragm comes in contact with its internal supports, the transmitter should become extremely sluggish (many minutes) and fail calibration tests due to obvious lack of sensor response. The low fill condition between these extremes is a response time concern. Hydraulic response verification should be performed prior to installation of a new sensor to determine an initial sensor-specific response time value. Since November 1989, Rosemount has been performing hydraulic RTT to assure acceptable fill.

Crimped capillaries due to manufacturing defects or mishandling can also affect response time if the motion of the fill fluid is significantly restricted. Response time is the only sensor characteristic affected by this manufacturing and handling defect. Hydraulic response verification at installation and after maintenance of the transmitter ensures that the sensor is operating properly. No additional response time tests are required.

F.4 REFERENCES

F-1. EPRI Report, NP-7243, "Investigation of Response Time Testing Requirements", May 1991.

F-2. Rosemount Technical Bulletins 1-4.

F-3. Rosemount Report D9100019, Failure Modes and Effects Analyses - N0037 Damping Option Potentiometer.

F-4. Loss of Fill-Oil in Transmitters Manufactured by Rosemount, NRC Bulletin No. 90-01, March 9, 1990.

F-5. Loss of Fill-Oil in Transmitters Manufactured by Rosemount, NRC Bulletin No. 90-01, Supplement 1, December 22, 1992

F-6. EPRI Report, TR-103436, "Instrument Calibration Monitoring Program (ICMP)", Volume 1 - "ICMP: Basis for Methodology", Volume 2 - "ICMP: Failure Modes and Effects Analysis", In Publication

Table F-1

APPLICATION OF THE TYPES OF DAMPING FILTERS BY THE PARTICIPATING BWRs

Type of Damping by System	Brunswick	Clinton	Fermi-2	Grand Gulf	WNP 2	Hatch	Hope Creek	LaSalle	Limerick	Perry	River Bend	Susquehanna
<u>RPS</u>												
Fixed	X					X				X	X	
Variable	X	X	X				X		X	X		
Neither				X	X			X				X
<u>Isolation</u>												
Fixed	X		X			X				X	X	X
Variable	X	X	X	X			X		X			
Neither					X			X*				
<u>ECCS</u>												
Fixed	X					X				X		
Variable	X	X	X				X		X	X	X	
Neither				X	X			X				X

* MSL Hi Flow and MSL Low Pressure have instrument line hydraulic dampeners (mesh) installed.

APPENDIX G

PLANT-SPECIFIC RTT VERIFICATION REPORTS

APPENDIX G

PLANT-SPECIFIC RTT VERIFICATION REPORTS

This Appendix provides the plant-specific verifications for the individual participating plants. The lead plants, namely Fermi-2 and River Bend, serve as the basis for this comparison and verification. Any response time components that are not covered by the lead plant analyses are treated and dispositioned separately in this Appendix. The RPS and radiation components typically fall into this category. For unique components that were not covered by the lead plants, supplemental analysis was performed.

The plant-specific verification also shows if a response time component requirement for RTT can be eliminated. The last column denotes additional comments associated with the exemption.

The participating plants other than the lead plants were the source for their respective component identification and verification.

Notes for Appendix G plant-specific verification tables:

(1) These RTT components are primarily found in RPS loops.

(2) These RTT components are primarily found in Radiation loops.

(3) Covered by RTT failure mode analysis (RTTA) of the specified component (non-lead plant components).

(4) Covered by comprehensive lead plant analyses (Fermi-2 and River Bend).

(5) Components that do not have Technical Specification RTT requirements (such as solid-state RTT components with self-test features) are listed as Exempt.

(6) May require other techniques such as drift analysis.

(7) Time delay relays require response verification through calibration.

Table G-1

BRUNSWICK PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1151, 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU, 710DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
GE Trip Unit	Trip Unit	no	no	RTTA	yes	5.3.1.2
GE HFA, HMA, HGA	Relay	no	no	Lead Plant	yes	5.3.2
GE CR120A	Relay	no	no	Lead Plant	yes	5.3.2

Table G-2

CLINTON PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1152, 1153, 1154	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
GE 147D8505G004	Trip Unit	no	no	RTTA	yes	5.3.1.2
RPS-1 GE147D8463G1	Logic Card	no	no	no	Exempt	NA
RPS-2 GE147D8464G1	Logic Card	no	no	no	Exempt	NA
RPS-5 GE147D8467G1	Logic Card	yes	no	no	Exempt	NA
RPS-6 GE147D8829G1	Logic Card	yes	no	no	Exempt	NA
RPS-3 GE147D8124G1	Logic Card	yes	no	no	Exempt	NA
RPS-4 GE147D8122G1	Logic Card	yes	no	no	Exempt	NA
NS4-1 GE147D8470G1	Logic Card	no	no	no	Exempt	NA
NS4-2 GE147D8471G1	Logic Card	no	no	no	Exempt	NA
NS4-3 GE228B1814G3	Logic Card	no	no	no	Exempt	NA
RHR-4 GE147D8490G1	Logic Card	no	no	no	Exempt	NA
RHR-5 GE147D8491G1	Logic Card	no	no	no	Exempt	NA
RHR-6 GE147D8492G1	Logic Card	no	no	no	Exempt	NA
HPCS-1 GE147D8500G1	Logic Card	no	no	no	Exempt	NA
HPCS-2 GE147D8501G1	Logic Card	no	no	no	Exempt	NA

Table G-2 (Cont d.)

CLINTON PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Flow Card GE204B7209G3	Logic Card	no	no	no	Exempt	NA
LPCS-1 GE147D8484G1	Logic Card	no	no	no	Exempt	NA
LPCS-2 GE147D8485G1	Logic Card	no	no	no	Exempt	NA
Trip Reference GE204B7667	Logic Card	no	no	no	Exempt	NA
Quad & Th Trip GE204B7672	Logic Card	yes	no	no	Exempt	NA
Scram/Rod Blk GE204B7602G1	Logic Card	yes	no	no	Exempt	NA
2/4 Logic GE147D8503G1	Logic Card	no	no	no	Exempt	NA
AC Load Driver (ALCD) GE147D8455G2	Logic Card	yes	no	no	Exempt	NA
DC Load Driver (DCLD) GE147D8455G2	Logic Card	yes	no	no	Exempt	NA
Hi Vltg Lvl Input Signal Conditioner GE147D8461	Logic Card	no	no	no	Exempt	NA
Hi Current Optical Isolator GE133D9947G4	HCOI	yes	no	no	Exempt	NA
APRM Card	Flux Monitor	yes	no	no	Exempt	NA

Table G-3

FERMI-2 PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1151, 1153 1154	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU, 710DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Agastat GP	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA, HMA, HGA	Relay	no	no	Lead Plant	yes	5.3.2
GE CR120A	Relay	no	no	Lead Plant	yes	5.3.2
Agastat TR Timer	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR2820 (time delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR105 - RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
NUMAC (D11-K603A-D) (GE304X3700G005)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2
Gamma Ion Chamber (GE237X731G001)	RAD Device	no	yes	Lead Plant	Exempt	NA
Sensor/Converter (GE194X927G011)	RAD Device	no	yes	Lead Plant	Exempt	NA
Indicator & Trip Unit (GE129B2802G011)	RAD Device	no	yes	Lead Plant	yes	5.3.1.3
Trip Auxiliary Unit (GE238X697G9)	RAD Device	no	yes	Lead Plant	yes	5.3.5.1

Table G-3 (Cont'd.)

FERMI-2 PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Power Supply	RAD Device	no	yes	Lead Plant	yes	5.3.7.4
External HPCI Filter	Capacitor	no	no	Lead Plant	yes	5.3.7.1

Table G-4

GRAND GULF PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1152, 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat GP, EGPIC, EGPBC	Relay	no	no	Lead Plant	yes	5.3.2
GE CR105 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
Radiation Detector GE 194X927G011 GE 237X731G001	RAD Device	no	yes	Lead Plant	Exempt	NA
Indicator & Trip Unit (GE129B2802G041)	RAD Device	no	yes	Lead Plant	yes	5.3.1.3
NUMAC (GE304A3700G003)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2

Table G-5

WNP-2 PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Barton 288A	Switch	no	no	RTTA	yes	5.3.6.1
SOR Series	Switch	no	no	RTTA	yes	5.3.6.1
Barksdale Series	Switch	no	no	RTTA	yes	5.3.6.2.1
Bailey 745 Lk Det Flow	Switch	no	no	RTTA	yes	5.3.7.2
Agastat EGPI	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA, HMA	Relay	no	no	Lead Plant	yes	5.3.2
ASEA RXMH2	Relay	no	no	RTTA	yes	5.3.2
Agastat ETR14 Timer	Relay	no	no	Lead Plant	yes(7)	5.3.3
Eagle Signal 45s Tm Delay	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR305 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
Bailey 750 Sq Rt Exctr	Sq Rt Exctr	no	no	Lead Plant	yes	5.3.4.2
Bailey 752 Flow Summer	Flow Summer	no	no	Lead Plant	yes	5.3.4.1

Table G-6

HOPE CREEK PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Agastat GP	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA, HMA	Relay	no	no	Lead Plant	yes	5.3.2
GE CR120A	Relay	no	no	Lead Plant	yes	5.3.2
Potter & Brumfield	Relay	no	no	Lead Plant	yes	5.3.2
Agastat TR Timer	Relay	no	no	Lead Plant	yes(7)	5.3.3
Signal Microprocessor 1SPRY-4857A RM-80	Logic Card	yes	no	Lead Plant	no	NA
Optical Isolators GE204B6186AAG004 GE204B6188AAG002	Optical Isolator	no	no	Lead Plant	yes	5.3.7.5
NUMAC GE304A3700G011	RAD Device	no	yes	Lead Plant	yes	5.3.5.2

Table G-7

HATCH PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153, 1154	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Barton 763, 764	Transmitter	no	nc	RTTA	yes	5.3.6.1
Barksdale B2T	Switch	no	no	RTTA	yes	5.3.6.2.1
Barksdale TC9622-3	Switch	no	no	RTTA	yes	5.3.6.2.1
Magnetrol R752B30C0	Switch	no	no	RTTA	Exempt	NA
ATTS G104, G112, G110 G114, G106, G101, G105 G505, G201, G401, G501	Trip Unit	no	no	RTTA	yes	5.3.1.2
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Potter & Brumfield KH4690	Relay	no	yes	RTTA	yes	5.3.2
Agastat EGP	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA	Relay	no	no	Lead Plant	yes	5.3.2
GE CR2820 (Time Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR305 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
APRM 2C51K605	Flux Monitor	yes	no	Lead Plant	no	4.3

Table G-7 (Cont.)

HATCH PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
NUMAC (D11-K603) (GE304A3700G001)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2
Indicator & Trip Unit (GE129B2802G041)	RAD Device	no	yes	Lead Plant	yes	5.3.1.3
RWCU Alarm Unit GE560	Alarm Unit	no	no	RTTA	yes	5.3.7.3

Table G-8

LaSalle PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153, 1154	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 710DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
SOR-9N6 TT Oil Press	Switch	no	no	RTTA	yes	5.3.6
SOR-102-AS MSL Flow	Switch	no	no	RTTA	yes	5.3.6
SOR-103-AS RCIC Flow	Switch	no	no	RTTA	yes	5.3.6
Bailey 745 RWCU D-Flow	Switch	no	no	RTTA	yes	5.3.7.2
GE HFA, HMA	Relay	no	no	Lead Plant	yes	5.3.2
Agastat GPI, EGPB, GPIR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat ETR Timer	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR105 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
APRM	Flux Monitor	yes	no	Lead Plant	no	4.3
NUMAC (D11-K603A-D) (GE304X3700)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2
Indicator & Trip Unit (GE129B2802G011)	RAD Device	no	yes	Lead Plant	yes	5.3.1.3

Table G-9

LIMERICK PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1151, 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Barksdale TC9622-3	Switch	no	no	RTTA	yes	5.3.6.2.1
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat EGP	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA, HMA, HGA	Relay	no	no	Lead Plant	yes	5.3.2
GE SAT6004	Relay	yes	no	RTTA	yes	5.3.2
Agastat TDPU (Time Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
Eagle Signal HP5(Tm Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR105, CR305 RPS Scram Contactors	Relay	yes	no	Lead Plant	no	4.3
APRM Card	Flux Monitor	yes	no	RTTA	no	4.3
Bailey Summer-752	Summer	no	no	Lead Plant	yes	5.3.4.1
Bailey Square Root-750	SQR RT device	no	no	Lead Plant	yes	5.3.4.2
Bailey 745 Diff Flow	Timer	no	no	Lead Plant	yes	5.3.7.2
NUMAC (D11-K603A-D)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2

Table G-10

PERRY PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU, 710DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Barksdale TC9622-3	Switch	no	no	RTTA	yes	5.3.6.2.1
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat EGPB, EGPI	Relay	no	no	Lead Plant	yes	5.3.2
GE CR205 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
APRM GEK-75605	Flux Monitor	yes	no	Lead Plant	no	4.3
Indicator & Trip Unit (GE129B2802G041)	RAD Device	no	yes	Lead Plant	yes	5.3.1.3
Log Rad Monitor (GE238X660G013)	RAD Device	no	yes	RTTA	no	5.3.5.3

Table G-11

RIVER BEND PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1152, 1153, 1154	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Rosemount 510DU, 710DU	Trip Unit	no	no	Lead Plant	yes	5.3.1.1
Agastat GP	Relay	no	no	Lead Plant	yes	5.3.2
GE HFA	Relay	no	no	Lead Plant	yes	5.3.2
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat TR Timer	Relay	no	no	Lead Plant	yes(7)	5.3.3
Agastat TDPU (Time Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
Eagle Signal HP5 (Tm Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR105, CR205 - RPS Scram Contactors	Relay	yes	no	Lead Plant	no	4.3
Bailey 750 Sq Rt Exctr	Sq Rt EXCTR	no	no	Lead Plant	yes	5.3.4.2
Bailey 752 Summer	Summer	no	no	Lead Plant	yes	5.3.4.1
Bailey 745 D-Flow	Timer	no	no	Lead Plant	yes	5.3.7.2
NUMAC Log RAD Monitor (D17-N610A)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2
Gamma Ion Chamber (D17-N003A)	RAD Device	no	yes	Lead Plant	Exempt	NA

Table G-12

SUSQUEHANA PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
Rosemount 1153	Transmitter	no	no	Lead Plant	yes(6)	5.3.6 Appendix F
Bailey 745	Trip Unit	no	no	RTTA	yes	5.3.1.1
Barton 288A	Switch	no	no	RTTA	yes	5.3.6.1
Barton 760	Transmitter	no	no	RTTA	yes	5.3.6.2.2
Barksdale TC9622-3	Switch	no	no	RTTA	yes	5.3.6.2.1
Barksdale B1T	Switch	no	no	RTTA	yes	5.3.6.2.1
SOR Series	Switch	no	no	RTTA	yes	5.3.6
GE HFA, HMA, HGA	Relay	no	no	Lead Plant	yes	5.3.2
Potter & Brumfield MDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat EGPI, EGPDR	Relay	no	no	Lead Plant	yes	5.3.2
Agastat TR Timer	Relay	no	no	Lead Plant	no	5.3.3
Agastat 7000 (Time Delay)	Relay	no	no	Lead Plant	yes(7)	5.3.3
GE CR205 RPS Scram Contr	Relay	yes	no	Lead Plant	no	4.3
Bailey Summer-G33-K604	Summer	no	no	Lead Plant	yes	5.3.4.1

Table G-12 (Contd.)

SUSQUEHANA PLANT SPECIFIC VERIFICATION AND RTT COMPONENT REPORT

NAME OF RTT COMPONENT	TYPE OF COMPONENT	UNIQUE RPS COMPONENT(1)	UNIQUE RADIATION COMPONENT(2)	COVERED BY LEAD PLANT(4) OR RTTA(3)	REQUIREMENT FOR RTT ELIMINATED(5)	REFERENCE SECTION
APRM Card	Flux Monitor	yes	no	Lead Plant	no	4.3
Radiation Monitor R1SHH (GE238X660G007)	RAD Device	no	yes	RTTA	no	5.3.5.3
Indicator & Trip Unit (GE129B2802G011)	RAD Device	no	yes	Lead Plant	yes	5.3.5.2

APPENDIX H

PLANT-SPECIFIC TECHNICAL SPECIFICATION MARKUP TABLES

APPENDIX H

PLANT-SPECIFIC TECHNICAL SPECIFICATION MARKUP TABLES

The technical specifications for each of the plants participating in this BWR Owners' Group activity have been reviewed and marked up to indicate changes needed to implement the conclusions of this report. This appendix contains samples of the plant-specific technical specification markups deleting the response time testing (RTT) requirements justified by this report. Table H-1 of this appendix is an explanation of the symbols used in the markups. When plants submit proposed technical specification changes to the NRC (see Appendix I), the explanations in Table H-1 should be added as footnotes on the appropriate technical specification pages.

The technical specification markups contained in this appendix reflect one option available to licensees and may be modified by licensees as appropriate for their specific license change request. A licensee that in the future installs instruments that are addressed by this report, may apply the conclusions of this report to that equipment by making the appropriate technical specification changes. Another option available to licensees is to make the appropriate technical specification changes (i.e., eliminate response time testing requirements) prior to the equipment modification if a change in equipment is scheduled. In this case, the effective date (i.e., the date the equipment modification will be made) of the technical specification change should be specified in the technical specifications, or the technical specifications should state that the response time testing requirements apply only to specified equipment and not to the equipment addressed by this report.

Table H-1

RTT TECHNICAL SPECIFICATION MARKUP NOTES

#	Sensor is eliminated from response time testing for the RPS circuits. Response time testing and conformance to the administrative limits for the remaining channel including trip unit and relay logic are required.
##	Sensor is eliminated from response time testing for the MSIV actuation logic circuits. Response time testing and conformance to the administrative limits for the remaining channel including trip unit and relay logic are required.
###	Response time testing is eliminated for the radiation loops based on the qualified Log Rad Monitors.
&&	ECCS actuation instrumentation is eliminated from response time testing.

NOTE: Time delay relays in the RTT loops require response verification through calibration.

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors	
a. Neutron Flux - High[a]	NA
b. Inoperative	NA
2. Average Power Range Monitor[a]	
a. Neutron Flux - High, 15%	≤ 0.09
b. Flow-Biased Neutron Flux - High	NA
c. Neutron Flux - High, 120%	≤ 0.09
d. Inoperative	NA
e. Downscale	NA
f. LPRM	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Water Level - Low, Level 1	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High	NA
7. Drywell Pressure - High	NA
8. Scram Discharge Volume Water Level - High	NA
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure, Control Oil Pressure - Low	≤ 0.08
11. Reactor Mode Switch in Shutdown Position	NA
12. Manual Scram	NA

(a) Neutron detectors are exempt from response time testing. Response time shall be measured from detector output or from the input of the first electronic component in the channel.

BRUNSWICK - UNIT 2

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)[e]
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level -	
1. Low, Level 1	NA
2. Low, Level 2	≤1.0[d] ##
3. Low, Level 3	≤1.0[d] ##
b. Drywell Pressure - High	NA
c. Main Steam Line	
1. Radiation - High[b]	≤1.0[d]
2. Pressure - Low	NA
3. Flow - High	≤0.5[d] ##
4. Flow - High	≤0.5[d] ##
d. Main Steam Line Tunnel Temperature - High	≤13
e. Condenser Vacuum - Low	≤13
f. Turbine Building Area Temperature - High	NA
g. Main Stack Radiation - High[b]	≤ 1.0[d]
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Building Exhaust Radiation - High[b]	NA ###
b. Drywell Pressure - High	NA
c. Reactor Vessel Water Level - Low, Level 2	≤1.0[d] ##
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	NA
b. Area Temperature - High	≤13
c. Area Ventilation Temperature Δ T - High	≤13
d. SLCS Initiation	NA
e. Reactor Vessel Water Level - Low, Level 2	≤1.0[d] ##

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)(e)
4. CORE STANDBY COOLING SYSTEMS ISOLATION	
a. High Pressure Coolant Injection System Isolation	
1. HPCI Steam Line Flow - High	~~[illegible]~~(a)(c) NA
2. HPCI Steam Line High Flow Time Delay Relay	NA
3. HPCI Steam Supply Pressure - Low	~~[illegible]~~ NA
4. HPCI Steam Line Tunnel Temperature - High	~~[illegible]~~ NA
5. Bus Power Monitor	NA
6. HPCI Turbine Exhaust Diaphragm Pressure - High	NA
7. HPCI Steam Line Ambient Temperature - High	NA
8. HPCI Steam Line Area	NA
9. Emergency Area Cooler Temperature - High	NA
b. Reactor Core Isolation Cooling System Isolation	
1. RCIC Steam Line Flow - High	~~[illegible]~~(a)(c) NA
2. RCIC Steam Line High Flow - Time Delay Relay	NA
3. RCIC Steam Supply Pressure - Low	NA
4. RCIC Steam Line Tunnel Temp - High	NA
5. Bus Power Monitor	NA
6. RCIC Turbine Exhaust Diaphram Pressure - High	NA
7. RCIC Steam Line Ambient Temperature - High	NA
8. RCIC Steam Line Area Δ Temp - High	NA
9. Emergency Area Cooler Temperature - High	NA
10. RCIC Equipment Room Δ Temp - High	NA

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. CORE SPRAY SYSTEM	≤ 27 &&
2. LPCI MODE of RHR SYSTEM	≤ 40 &&
3. HIGH PRESSURE COOLANT INJECTION SYSTEM	≤ 30 &&
4. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
5. LOSS OF POWER	NA

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power - High	≤ 0.09**
c. Neutron Flux - High	≤ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.33 #
4. Reactor Vessel Water Level - Low, Level 3	≤ 1.03 #
5. Reactor Vessel Water Level - High, Level 8	≤ 1.03 #
6. Main Steam Line Isolation Valve - Closure	≤ 0.04
7. Main Steam Line Radiation - High	NA
8. Drywell Pressure - High	NA
9. Scram Discharge Volume Water Level - High	
a. Level Transmitter	NA
b. Float Switches	NA
10. Turbine Stop Valve - Closure	≤ 0.04
11. Turbine Control Valve Fast Closure, Valve Trip System Oil Pressure - Low	≤ 0.05# → X
12. Reactor Mode Switch Shutdown Position	NA
13. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Not including a simulated thermal power time constant of 6 ± 0.6 seconds.

X → #Measured from start of turbine control valve fast closure.

TABLE 3.3.2-3

CRVICS INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)
1. PRIMARY AND SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low Low, Level 2	NA
b. Reactor Vessel Water Level - Low Low, Level 2 (ECCS Div. I and II)	NA
c. Reactor Vessel Water Level - Low Low, Level 2 (ECCS Div. III)	NA
d. Drywell Pressure - High	NA
e. Drywell Pressure - High (ECCS Div. I and II)	NA
f. Drywell Pressure - High (ECCS Div. III)	NA
g. Containment Building Fuel Transfer Pool Ventilation Plenum Radiation - High	NA
h. Containment Building Exhaust Radiation - High	NA
i. Containment Building Continuous Containment Purge (CCP) Exhaust Radiation - High	NA
j. Reactor Vessel Water Level-Low Low Low, Level 1	NA
k. Containment Pressure - High	NA
l. Main Steam Line Radiation - High	NA
m. Fuel Building Exhaust Radiation - High	NA
n. Manual Initiation	NA
2. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level - Low Low Low, Level 1	$\leq$ 1.0* #
b. Main Steam Line Radiation - High	NA
c. Main Steam Line Pressure - Low	$\leq$ 1.0* #
d. Main Steam Line Flow - High	$\leq$ 0.5* #
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Temp. - High	NA
g. Main Steam Line Tunnel Δ Temp. - High	NA
h. Main Steam Line Turbine Bldg. Temp. - High	NA
i. Manual Initiation	NA
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	NA
b. Δ Flow Timer	NA
c. Equipment Area Temp. - High	NA
d. Equipment Area Δ Temp. - High	NA
e. Reactor Vessel Water Level - Low Low, Level 2	NA
f. Main Steam Line Tunnel Ambient Temp. - High	NA

TABLE 3.3.2-3 (Continued)

CRVICS INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)
3. REACTOR WATER CLEANUP SYSTEM ISOLATION (Continued)	
g. Main Steam Line Tunnel Δ Temp. - High	NA
h. SLCS Initiation	NA
i. Manual Initiation	NA
4. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	NA
b. RCIC Steam Line Flow High - Timer	NA
c. RCIC Steam Supply Pressure - Low	NA
d. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
e. RCIC Equipment Room Ambient Temp. - High	NA
f. RCIC Equipment Room Δ Temp. - High	NA
g. Main Steam Line Tunnel Ambient Temp. - High	NA
h. Main Steam Line Tunnel Δ Temp. - High	NA
i. Main Steam Line Tunnel Temp. Timer	NA
j. Drywell Pressure - High	NA
k. Manual Initiation	NA
l. RHR/RCIC Steam Line Flow - High	NA
m. RHR Heat Exchanger Rooms A, B Ambient Temp. - High	NA
n. RHR Heat Exchanger Rooms A, B Δ Temp. - High	NA
5. RHR SYSTEM ISOLATION	
a. RHR Heat Exchanger Rooms A, B Ambient Temp. - High	NA
b. RHR Heat Exchanger Rooms A, B Δ Temp. - High	NA
c. Reactor Vessel Water Level - Low, Level 3	NA
d. Reactor Vessel Water Level - Low Low Low, Level 1	NA
e. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
f. Drywell Pressure - High	NA
g. Manual Initiation	NA

*CRVICS instrumentation response time for MSIVs only. No diesel generator delays assumed.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. LOW PRESSURE CORE SPRAY SYSTEM	≤ 37 && ,
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	
a. Loops A, B and C	≤ 37 && ,
3. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
4. HIGH PRESSURE CORE SPRAY SYSTEM	≤ 27 && ,
5. LOSS OF POWER	NA

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power - High	6 ± 1**
c. Fixed Neutron Flux - High	≤ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Low Water Level - Level 3	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High	NA
7. Drywell Pressure - High	NA
8. Scram Discharge Volume Water Level - High	
a. Float Switch	NA
b. Level Transmitter	NA
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure	≤ 0.08***
11. Reactor Mode Switch Shutdown Position	NA
12. Manual Scram	NA
13. Deleted	

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Including simulated thermal power time constant.

***Measured from deenergization of K-37 relay which inputs the turbine control valve closure signal to the RPS.

TABLE 3.3.2-3

ISOLATION ACTUATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Low Water Level	
1) Level 3	NA
2) Level 2	NA
3) Level 1	## NA
b. Drywell Pressure - High	NA
c. Main Steam Line	
1) Radiation - High(b)	NA ###
2) Pressure - Low	NA
3) Flow - High	NA
d. Main Steam Line Tunnel Temperature - High	NA
e. Condenser Pressure - High	NA
f. Turbine Bldg. Area Temperature - High	NA
g. Deleted	
h. Manual Initiation	NA
2. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	NA
b. Heat Exchanger/Pump/High Energy Piping Area Temperature - High	NA
c. Heat Exchanger/Pump/Phase Separator Area Ventilation Temperature ΔT - High	NA
d. SLCS Initiation	NA
e. Reactor Vessel Low Water Level - Level 2	NA
f. Deleted	
g. Manual Initiation	NA
3. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	NA
b. RCIC Steam Supply Pressure - Low	NA
c. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d. RCIC Equipment Room Temperature - High	NA
e. Manual Initiation	NA

TABLE 3.3.2-3 (Continued)

ISOLATION ACTUATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)@ →X
4. HIGH PRESSURE COOLANT INJECTION SYSTEM ISOLATION	
a. HPCI Steam Flow - High	~~≤13(a)~~ NA
b. HPCI Steam Supply Pressure - Low	~~≤13(a)~~ NA
c. HPCI Turbine Exhaust Diaphragm Pressure - High	NA
d. HPCI Equipment Room Temperature - High	NA
e. Manual Initiation	NA
5. RHR SYSTEM SHUTDOWN COOLING MODE ISOLATION	
a. Reactor Vessel Low Water Level - Level 3	NA
b. Reactor Vessel (Shutdown Cooling Cut-in Permissive Interlock) Pressure - High	NA
c. Manual Initiation	NA
6. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Low Water Level - Level 2	~~≤13(a)~~ NA
b. Drywell Pressure - High	~~≤13(a)~~ NA
c. Fuel Pool Ventilation Exhaust Radiation - High(b)	~~≤13(b)~~ NA
d. Manual Initiation	NA

delete

~~(a) The isolation system instrumentation response time shall be measured and recorded as a part of the ISOLATION SYSTEM RESPONSE TIME. Isolation system instrumentation response time specified includes diesel generator starting and sequence loading delays.~~ — e

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed for MSIVs.

~~**Isolation system instrumentation response time for associated valves except MSIVs.~~ — e

change to X → @Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Table 3.6.3-1 and 3.6.5.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

TABLE 3.3.3-3
EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

TRIP FUNCTION		RESPONSE TIME (Seconds)
1.	CORE SPRAY SYSTEM	
a.	Reactor Vessel Low Water Level - Level 1	≤ 30 & &
b.	Drywell Pressure - High	≤ 30 & &
c.	Reactor Steam Dome Pressure - Low	NA*
d.	Manual Initiation	NA
2.	LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	
a.	Reactor Vessel Low Water Level - Level 1	≤ 55 & &
b.	Drywell Pressure - High	≤ 55 & &
c.	Reactor Steam Dome Pressure - Low	NA*
d.	Reactor Vessel Low Water Level - Level 2	NA
e.	Reactor Steam Dome Pressure - Low	NA
f.	Riser Differential Pressure - High	NA
g.	Recirculation Pump Differential Pressure - High	NA
h.	Manual Initiation	NA
3.	HIGH PRESSURE COOLANT INJECTION SYSTEM	
a.	Reactor Vessel Low Water Level - Level 2	≤ 30 & &
b.	Drywell Pressure - High	NA
c.	Condensate Storage Tank Level - Low	NA
d.	Reactor Vessel Water Level - High, Level 8	NA
e.	Suppression Pool Water Level - High	NA
f.	Manual Initiation	NA
4.	AUTOMATIC DEPRESSURIZATION SYSTEM	
a.	Reactor Vessel Low Water Level - Level 1	NA
b.	Drywell Pressure - High	NA
c.	ADS Timer	NA
d.	Core Spray Pump Discharge Pressure - High	NA
e.	RHR LPCI Mode Pump Discharge Pressure - High	NA
f.	Reactor Vessel Low Water Level - Level 3	NA
g.	Manual Initiation	NA
h.	Drywell Pressure - High Bypass Timer	NA
i.	Manual Inhibit	NA
5.	LOSS OF POWER	
a.	4.16 kV Emergency Bus Undervoltage (Loss of Voltage)	NA
b.	4.16 kV Emergency Bus Undervoltage (Degraded Voltage)	NA

*These are permissive signals only. They do not activate ECCS initiation.

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power - High	≤ 0.09**
c. Neutron Flux - High	≤ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.35 #
4. Reactor Vessel Water Level - Low, Level 3	≤ 1.05 #
5. Reactor Vessel Water Level - High, Level 8	≤ 1.05 #
6. Main Steam Line Isolation Valve - Closure	≤ 0.06
7. Main Steam Line Radiation - High	NA
8. Drywell Pressure - High	NA
9. Scram Discharge Volume Water Level - High	NA
10. Turbine Stop Valve - Closure	≤ 0.10
11. Turbine Control Valve Fast Closure, Valve Trip System Oil Pressure - Low	≤ 0.10# → X
12. Reactor Mode Switch Shutdown Position	NA
13. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Not including simulated thermal power time constant.

X → #Measured from start of turbine control valve fast closure.

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low Low, Level 2	~~≤ 10(a)~~ NA
b. Reactor Vessel Water Level - Low Low, Level 2 (ECCS - Division 3)	~~≤ 10(a)~~ NA
c. Reactor Vessel Water Level-Low Low Low, Level 1 (ECCS - Division 1 and Division 2)	~~≤ 10(a)~~ NA
d. Drywell Pressure - High	~~≤ 10(a)~~ NA
e. Drywell Pressure-High (ECCS - Division 1 and Division 2)	~~≤ 10(a)~~ NA
f. Drywell Pressure-High (ECCS - Division 3)	~~≤ 10(a)~~ NA
g. Containment and Drywell Ventilation Exhaust Radiation - High High(b)	~~≤ 10(a)~~ NA ###
h. Manual Initiation	NA
2. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level - Low Low Low, Level 1	## ≤ 1.0*/~~≤ 10(a)**~~ NA
b. Main Steam Line Radiation - High(b)	## ≤ 1.0*/~~≤ 10(a)**~~ NA
c. Main Steam Line Pressure - Low	## ≤ 1.0*/~~≤ 10(a)**~~ NA
d. Main Steam Line Flow - High	## ≤ 0.5*/~~≤ 10(a)**~~ NA
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Temperature - High	NA
g. Main Steam Line Tunnel Δ Temp. - High	NA
h. Manual Initiation	NA
3. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low Low, Level 2	~~≤ 10(a)~~ NA
b. Drywell Pressure - High	~~≤ 10(a)~~ NA
c. Fuel Handling Area Ventilation Exhaust Radiation - High High(b)	≤ 3.0***/~~≤ 10(a)~~ NA ###
d. Fuel Handling Area Pool Sweep Exhaust Radiation - High High(b)	≤ 3.0***/~~≤ 10(a)~~ NA ###
e. Manual Initiation	NA
4. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	NA
b. Δ Flow Timer	NA
c. Equipment Area Temperature - High	NA
d. Equipment Area Δ Temp. - High	NA
e. Reactor Vessel Water Level - Low Low, Level 2	~~≤ 20(a)~~ NA
f. Main Steam Line Tunnel Ambient Temperature - High	NA
g. Main Steam Line Tunnel Δ Temp. - High	NA
h. SLCS Initiation	NA
i. Manual Initiation	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	≤ 10(a)### → XXX NA
b. RCIC Steam Supply Pressure - Low	≤ 10(a) NA
c. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d. RCIC Equipment Room Ambient Temperature - High	NA
e. RCIC Equipment Room Δ Temp. - High	NA
f. Main Steam Line Tunnel Ambient Temp. - High	NA
g. Main Steam Line Tunnel Δ Temp. - High	NA
h. Main Steam Line Tunnel Temperature Timer	NA
i. RHR Equipment Room Ambient Temperature - High	NA
j. RHR Equipment Room Δ Temp. - High	NA
k. RHR/RCIC Steam Line Flow - High	NA
l. Manual Initiation	NA
m. Drywell Pressure - High (ECCS Division 1 and Division 2)	≤ 10(a) NA
6. RHR SYSTEM ISOLATION	
a. RHR Equipment Room Ambient Temperature - High	NA
b. RHR Equipment Room Δ Temp. - High	NA
c. Reactor Vessel Water Level - Low, Level 3	≤ 10(a) NA
d. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
e. Drywell Pressure - High	NA
f. Manual Initiation	NA

delete

(a) The isolation system instrumentation response time shall be measured and recorded as a part of the ISOLATION SYSTEM RESPONSE TIME. Isolation system instrumentation response time specified includes the delay for diesel generator starting assumed in the accident analysis.

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed.

**Isolation system instrumentation response time for associated valves except MSIVs.

***Isolation system instrumentation response time for air operated dampers. No diesel generator delays assumed.

chng to X

#Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Tables 3.6.4-1 and 3.6.6.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

###Includes time delay of 3 to 7 seconds.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES (SECONDS)

1. LOW PRESSURE CORE SPRAY SYSTEM	NA
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM PUMPS A, B AND C	NA
3. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
4. HIGH PRESSURE CORE SPRAY SYSTEM	$\leq$ 27 &&
5. LOSS OF POWER	NA

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	N.A.
b. Inoperative	N.A.
2. Average Power Range Monitor*:	
a. Neutron Flux - Upscale, Setdown	N.A.
b. Flow Biased Simulated Thermal Power - Upscale	6±1**
c. Fixed Neutron Flux - Upscale	< 0.09
d. Inoperative	N.A.
3. Reactor Vessel Steam Dome Pressure - High	< 0.55 #
4. Reactor Vessel Water Level - Low, Level 3	< 1.05 #
5. Main Steam Line Isolation Valve - Closure	< 0.06
6. Main Steam Line Radiation - High	N.A.
7. Primary Containment Pressure - High	N.A.
8. Scram Discharge Volume Water Level - High	
a. Level Transmitter	N.A.
b. Float Switch	N.A.
9. Turbine Throttle Valve - Closure	≤ 0.06
10. Turbine Governor Valve Fast Closure, Trip Oil Pressure - Low	< 0.08# → X
11. Reactor Mode Switch Shutdown Position	N.A.
12. Manual Scram	N.A.

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Including simulated thermal power time constant.

#Measured from start of turbine control valve fast closure.

↳ X
Use

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → XY
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1) Low, Level 3	N.A.
2) Low Low, Level 2	## ≤ 1.0*/~~≤ 13(a)~~ NA
b. Drywell Pressure - High	~~≤ 13(a)~~ NA
c. Main Steam Line	
1) Radiation - High(b)	## ≤ 1.0*/~~≤ 13(a)~~ NA
2) Pressure - Low	## ≤ 1.0*/~~≤ 13(a)~~ NA
3) Flow - High	## ≤ 0.5*/~~≤ 13(a)~~ NA
d. Main Steam Line Tunnel Temperature - High	N.A.
e. Main Steam Line Tunnel Δ Temperature - High	N.A.
f. Condenser Vacuum - Low	N.A.
g. Manual Initiation	N.A.
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Building Vent Exhaust Plenum Radiation - High(b)	~~≤ 13(a)~~ NA
b. Drywell Pressure - High	~~≤ 13(a)~~ NA
c. Reactor Vessel Water Level - Low Low, Level 2	~~≤ 13(a)~~ NA
d. Manual Initiation	N.A.
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	~~≤ 13(a)##~~ NA
b. Heat Exchanger Area Temperature - High	N.A.
c. Heat Exchanger Area Ventilation Δ Temp. - High	N.A.
d. Pump Area Temperature - High	N.A.
e. Pump Area Ventilation Δ Temp. - High	N.A.
f. SLCS Initiation	N.A.
g. Reactor Vessel Water Level - Low Low, Level 2	~~≤ 13(a)~~ NA
h. RWCU/RCIC Line Routing Area Temperature - High	N.A.
i. RWCU Line Routing Area Temperature - High	N.A.
j. Manual Initiation	N.A.

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
4. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	~~≤ 13(a)~~ NA
b. RHR/RCIC Steam Line Flow - High	~~≤ 13(a)~~ NA
c. RCIC Steam Supply Pressure - Low	~~≤ 13(a)~~ NA
d. RCIC Turbine Exhaust Diaphragm Pressure - High	N.A.
e. RCIC Equipment Room Temperature - High	N.A.
f. RCIC Equipment Room Δ Temperature - High	N.A.
g. RWCU/RCIC Steam Line Routing Area Temperature - High	N.A.
h. Drywell Pressure - High	N.A.
i. Manual Initiation	N.A.
5. RHR SYSTEM SHUTDOWN COOLING MODE ISOLATION	
a. Reactor Vessel Water Level - Low, Level 3	~~≤ 13(a)~~ NA
b. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	N.A.
c. Equipment Area Temperature - High	N.A.
d. Equipment Area Ventilation Δ Temp. - High	N.A.
e. Shutdown Cooling Return Flow Rate - High	N.A.
f. RHR Heat Exchanger Area Temperature - High	N.A
g. Manual Initiation	N.A.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. LOW PRESSURE CORE SPRAY SYSTEM	≤ 43 &&
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	
a. Pumps A and B	≤ 43 &&
b. Pump C	≤ 43 &&
3. AUTOMATIC DEPRESSURIZATION SYSTEM	N.A.
4. HIGH PRESSURE CORE SPRAY SYSTEM	≤ 27 &&
5. LOSS OF POWER	N.A.

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High*	NA
b. Inoperative	NA
2. Average Power Range Monitor*	
a. Neutron Flux - Upscale, 15%	NA
b. Flow Referenced Simulated Thermal Power - Upscale	≤ 0.09**
c. Fixed Neutron Flux - Upscale, 118%	≤ 0.09
d. Inoperative	NA
d. Inoperative	NA
e. Downscale	NA
f. LPRM	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Water Level - Low	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High	NA
7. Drywell Pressure - High	NA
8. Scram Discharge Volume Water Level - High	NA
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure, Trip Oil Pressure - Low	≤ 0.08# → x
11. Reactor Mode Switch in Shutdown Position	NA
12. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from detector output or input of first electronic component in channel.

**Not including simulated thermal power time constant.

#Measured from start of turbine control valve closure.

x (change to x)

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1. Low (Level 3)	~~≤13~~ NA
* 2. Low Low (Level 2)	~~≤13~~ NA
3. Low Low Low (Level 1), except MSIVs	~~≤13~~ NA
b. Drywell Pressure - High	~~≤13~~ NA
c. Main Steam Line	
1. Radiation - High***	≤1.0** ##
2. Pressure - Low	~~≤13~~ NA
3. Flow - High	≤1.0** ##
4. Reactor Vessel Water Level - Low Low Low (Level 1)	≤1.0** ##
d. Main Steam Line Tunnel Temperature - High	~~≤13~~ NA
e. Condenser Vacuum - Low	NA
f. Turbine Building Area Temperature - High	NA
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Building Exhaust Radiation - High***	~~≤13~~ NA ###
b. Drywell Pressure - High	~~≤13~~ NA
c. Reactor Vessel Water Level - Low Low (Level 2)	~~≤13~~ NA
d. Refueling Floor Exhaust Radiation - High***	~~≤13~~ NA

delete

*The isolation actuation instrumentation response time shall be measured and recorded as a part of the ISOLATION SYSTEM RESPONSE TIME. Response time specified is diesel generator start delay time assumed in accident analysis.

**Isolation actuation instrumentation response time.

***Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

use X → #Times to be added to valve movement times shown in Tables 3.6.3-1, 3.6.5.2-1 and 3.9.5.2-1 to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

XXX → ##With time delay of 45 seconds.

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	~~≤13##~~ NA
b. Area Temperature - High	~~≤12~~ NA
c. Area Ventilation Temperature ΔT - High	~~≤12~~ NA
d. SLCS Initiation	NA
e. Reactor Vessel Water Level-Low Low (Level 2)	~~≤13~~ NA
4. HIGH PRESSURE COOLANT INJECTION SYSTEM ISOLATION	
a. HPCI Steam Line Flow-High	3 ≤ Isolation Time ≤ 13*
b. HPCI Steam Supply Pressure - Low	~~≤13~~
c. HPCI Turbine Exhaust Diaphragm Pressure - High	NA
d. HPCI Pipe Penetration Room Temperature - High	NA
e. Suppression Pool Area Ambient Temp. - High	NA
f. Suppression Pool Area ΔT - High	NA
g. Suppression Pool Area Temp. Timer Relays	NA
h. Emergency Area Cooler Temperature - High	NA
i. Drywell Pressure - High	~~≤2~~ NA
j. Logic Power Monitor	NA
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	3 ≤ Isolation Time ≤ 13*
b. RCIC Steam Supply Pressure - Low	NA
c. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d. Emergency Area Cooler Temperature - High	NA
e. Suppression Pool Area Ambient Temp. - High	NA
f. Suppression Pool Area ΔT - High	NA
g. Suppression Pool Area Temperature Timer Relays	NA
h. Drywell Pressure - High	~~≤13~~ NA
i. Logic Power Monitor	NA
6. SHUTDOWN COOLING SYSTEM ISOLATION	
a. Reactor Vessel Water Level - Low (Level 3)	NA
b. Reactor Steam Dome Pressure - High	NA

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. CORE SPRAY SYSTEM	≤ 34 &&
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	≤ 64 &&
3. HIGH PRESSURE COOLANT INJECTION SYSTEM	≤ 30 &&
4. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
5. ARM LOW LOW SET SYSTEM	≤ 1

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - Upscale, Setdown	NA
b. Flow Biased Simulated Thermal Power - Upscale	≤ 0.09**
c. Fixed Neutron Flux - Upscale	≤ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Water Level - Low, Level 3	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High, High	NA
7. Drywell Pressure - High	NA
8. Scram Discharge Volume Water Level - High	NA
a. Float Switch	NA
b. Level Transmitter/Trip Unit	NA
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure, Trip Oil Pressure - Low	≤ 0.08# → X
11. Reactor Mode Switch Shutdown Position	NA
12. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Not including simulated thermal power time constant, 6 ± 0.6 seconds.

X → #Measured from start of turbine control valve fast closure.

use

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1) Low Low, Level 2	NA
2) Low Low Low, Level 1	NA
b. Drywell Pressure - High	NA
c. Reactor Building Exhaust Radiation - High	NA
d. Manual Initiation	NA
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level-Low Low, Level 2	NA
b. Drywell Pressure - High	NA
c. Refueling Floor Exhaust Radiation - High(b)	≤ 4.0 ###
d. Reactor Building Exhaust Radiation - High(b)	≤ 4.0 ###
e. Manual Initiation	NA
3. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level - Low Low Low, Level 1	## ≤ 1.0*/≤ 10(a)** NA
b. Main Steam Line Radiation - High, High(a)(b)	## ≤ 1.0*/≤ 10(a)** NA
c. Main Steam Line Pressure - Low	## ≤ 1.0*/≤ 10(a)** NA
d. Main Steam Line Flow-High	## ≤ 0.5*/≤ 10(a)** NA
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Temperature - High	NA
g. Manual Initiation	NA
4. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. RWCU Δ Flow - High	NA
b. RWCU Δ Flow - High, Timer	NA
c. RWCU Area Temperature - High	NA
d. RWCU Area Ventilation Δ Temperature - High	NA
e. SLCS Initiation	NA
f. Reactor Vessel Water Level - Low Low, Level 2	NA
g. Manual Initiation	NA
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Δ Pressure (Flow) - High	NA
b. RCIC Steam Line Δ Pressure (Flow) - High, Timer	NA
c. RCIC Steam Supply Pressure - Low	NA
d. RCIC Turbine Exhaust Diaphragm Pressure - High	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# use → X
REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
e. RCIC Pump Room Temperature - High	NA
f. RCIC Pump Room Ventilation Ducts Δ Temperature - High	NA
g. RCIC Pipe Routing Area Temperature - High	NA
h. RCIC Torus Compartment Temperature - High	NA
i. Drywell Pressure - High	NA
j. Manual Initiation	NA
6. HIGH PRESSURE COOLANT INJECTION SYSTEM ISOLATION	
a. HPCI Steam Line Δ Pressure (Flow) - High	NA
b. HPCI Steam Line Δ Pressure (Flow) - High, Timer	NA
c. HPCI Steam Supply Pressure - Low	NA
d. HPCI Turbine Exhaust Diaphragm Pressure - High	NA
e. HPCI Pump Room Temperature - High	NA
f. HPCI Pump Room Ventilation Ducts Δ Temperature - High	NA
g. HPCI Pip. Routing Area Temperature - High	NA
h. HPCI Torus Compartment Temperature - High	NA
i. Drywell Pressure - High	NA
j. Manual Initiation	NA
7. RHR SYSTEM SHUTDOWN COOLING MODE ISOLATION	
a. Reactor Vessel Water Level - Low, Level 3	NA
b. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
c. Manual Initiation	NA

delete

(a) Isolation system instrumentation response time specified includes diesel generator starting and sequence loading delays. e

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed for MSIVs.

**Isolation system instrumentation response time for associated valves except MSIVs. e

X → use #Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Table 3.6 3-1 and 3.6.5.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. CORE SPRAY SYSTEM	≤ 27 &&
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	≤ 40 &&
3. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
4. HIGH PRESSURE COOLANT INJECTION SYSTEM	≤ 35 &&
5. LOSS OF POWER	NA

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High*	NA
b. Inoperative	NA
2. Average Power Range Monitor*	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power-Upscale	$\leq$ 0.09**
c. Fixed Neutron Flux - High	$\leq$ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	$\leq$ 0.55 #
4. Reactor Vessel Water Level - Low, Level 3	$\leq$ 1.05 #
5. Main Steam Line Isolation Valve - Closure	$\leq$ 0.06
6. Main Steam Line Radiation - High	NA
7. Primary Containment Pressure - High	NA
8. Scram Discharge Volume Water Level - High	NA
9. Turbine Stop Valve - Closure	$\leq$ 0.06
10. Turbine Control Valve Fast Closure, Trip Oil Pressure - Low	$\leq$ 0.08# → X
11. Reactor Mode Switch Shutdown Position	NA
12. Manual Scram	NA
13. Control Rod Drive	
a. Charging Water Header Pressure - Low	NA
b. Delay Timer	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Not including simulated thermal power time constant.

X → #Measured from start of turbine control valve fast closure.

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
A. AUTOMATIC INITIATION	
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1) Low, Level 3	NA
2) Low Low, Level 2	≤ ~~13(a)~~ NA
3) Low Low Low, Level 1	## ≤ 1.0*/≤ ~~13(a)**~~ NA
b. Drywell Pressure - High	≤ ~~13(a)~~ NA
c. Main Steam Line	
1) Radiation - High(b)	## ≤ 1.0*/≤ ~~13(a)**~~ NA
2) Pressure - Low	## ≤ 2.0*/≤ ~~13(a)**~~ NA
3) Flow - High	## ≤ 0.5*/≤ ~~13(a)**~~ NA
d. Main Steam Line Tunnel Temperature - High	NA
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Δ Temperature - High	NA
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Building Vent Exhaust Plenum Radiation - High(b)	≤ ~~13(a)~~ NA ###
b. Drywell Pressure - High	≤ ~~13(a)~~ NA
c. Reactor Vessel Water Level - Low, Level 2	≤ ~~13(a)~~ NA
d. Fuel Pool Vent Exhaust Radiation - High(b)	≤ ~~13(a)~~ NA ###
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	≤ ~~13(a)##~~ NA &
b. Heat Exchanger Area Temperature - High	NA
c. Heat Exchanger Area Ventilation ΔT-High	NA
d. SLCS Initiation	NA
e. Reactor Vessel Water Level - Low Low, Level 2	≤ ~~13(a)~~ NA
4. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	≤ ~~13(a)###~~ NA &
b. RCIC Steam Supply Pressure - Low	≤ ~~13(a)~~ NA &
c. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d. RCIC Equipment Room Temperature - High	NA
e. RCIC Steam Line Tunnel Temperature - High	NA
f. RCIC Steam Line Tunnel Δ Temperature - High	NA
g. Drywell Pressure - High	NA
h. RCIC Equipment Room Δ Temperature - High	NA
5. RHR SYSTEM STEAM CONDENSING MODE ISOLATION	
a. RHR Equipment Area Δ Temperature - High	NA
b. RHR Area Cooler Temperature - High	NA
c. RHR Heat Exchanger Steam Supply Flow High	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
6. RHR SYSTEM SHUTDOWN COOLING MODE ISOLATION	
a. Reactor Vessel Water Level - Low, Level 3	≤10(a) NA
b. Reactor Vessel (RHR Cut-In Permissive) Pressure - High	N.A.
c. RHR Pump Suction Flow - High	N.A.
d. RHR Area Cooler Temperature High	N.A.
e. RHR Equipment Area ΔT High	N.A.
8. MANUAL INITIATION	N.A.

1. Inboard Valves
2. Outboard Valves
3. Inboard Valves
4. Outboard Valves
5. Inboard Valves
6. Outboard Valves
7. Outboard Valve

delete

(a) The isolation system instrumentation response time shall be measured and recorded as a part of the ISOLATION SYSTEM RESPONSE TIME. Isolation system instrumentation response time specified includes the delay for diesel generator starting assumed in the accident analysis.

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

* Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed.

** Isolation system instrumentation response time for associated valves except MSIVs.

use

X → # Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Table 3.6.3-1 and 3.6.5.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

XX → ## Without 45±1 second time delay.

XXX → ### Without ≤ 5 second time delay.

N.A. Not Applicable.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. LOW PRESSURE CORE SPRAY SYSTEM	≤ 40*
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM (Pumps A, B, and C)	≤ 40*
3. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
4. HIGH PRESSURE CORE SPRAY SYSTEM	≤ 27
5. LOSS OF POWER	NA

*Injection valves shall be fully OPEN within 20 seconds after receipt of the reactor vessel pressure and ECCS Injection Line Pressure Interlock signal concurrently with power source availability and receipt of an accident initiation signal.

Lo Rx Lvl 2 & Hi DW Pressure

Lo Rx Lvl 1 & Hi DW Pressure

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	N.A.
b. Inoperative	N.A.
2. Average Power Range Monitor*:	
a. Neutron Flux - Upscale, Setdown	N.A.
b. Neutron Flux - Upscale	
1) Flow Biased	≤0.09
2) High Flow Clamped	≤0.09
c. Inoperative	N.A.
d. Downscale	N.A.
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Water Level - Low, Level 3	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High	N.A.
7. Drywell Pressure - High	N.A.
8. Scram Discharge Volume Water Level - High	
a. Level Transmitter	N.A.
b. Float Switch	N.A.
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure, Trip Oil Pressure - Low	≤ 0.08**
11. Reactor Mode Switch Shutdown Position	N.A.
12. Manual Scram	N.A.

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.
**Measured from start of turbine control valve fast closure.

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
1. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level	
1) Low, Low - Level 2	≤25(a) sec NA
2) Low, Low, Low - Level 1	≤ 1.0*
b. Main Steam Line Radiation - High(b)	## ≤ 1.0*/≤25(a) sec NA
c. Main Steam Line Pressure - Low	## ≤ 1.0*/≤25(a) sec NA
d. Main Steam Line Flow - High	## ≤ 0.5*/≤25(a) sec NA
e. Condenser Vacuum - Low	N.A.
f. Main Steam Line Tunnel Temperature - High	N.A.
g. Turbine Enclosure - Main Steam Line Tunnel Temperature - High	N.A.
h. Manual Initiation	N.A.
2. RHR SYSTEM SHUTDOWN COOLING MODE ISOLATION	
a. Reactor Vessel Water Level Low - Level 3	≤25(a) NA
b. Reactor Vessel (RHR Cut-In Permissive) Pressure - High	N.A.
c. Manual Initiation	N.A.
3. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. RWCS Δ Flow - High	≤25** → XY NA
b. RWCS Area Temperature - High	N.A.
c. RWCS Area Ventilation Δ Temperature - High	N.A.
d. SLCS Initiation	N.A.
e. Reactor Vessel Water Level - Low, Low - Level 2	≤25(a) NA
f. Manual Initiation	N.A.

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
4. HIGH PRESSURE COOLANT INJECTION SYSTEM ISOLATION	
a. HPCI Steam Line Δ Pressure - High	NA
b. HPCI Steam Supply Pressure - Low	NA
c. HPCI Turbine Exhaust Diaphragm Pressure - High	N.A.
d. HPCI Equipment Room Temperature - High	N.A.
e. HPCI Equipment Room Δ Temperature - High	N.A.
f. HPCI Pipe Routing Area Temperature - High	N.A.
g. Manual Initiation	N.A.
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. Reactor Steam Line Δ Pressure - High	NA
b. RCIC Steam Supply Pressure - Low	NA
c. RCIC Turbine Exhaust Diaphragm Pressure - High	N.A.
d. RCIC Equipment Room Temperature - High	N.A.
e. RCIC Equipment Room Δ Temperature - High	N.A.
f. RCIC Pipe Routing Area Temperature - High	N.A.
g. Manual Initiation	N.A.

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RE[illegible]E (Seconds)# →X
6. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1) Low, Low - Level 2	~~≤ 35(a)~~ NA
2) Low, Low, Low - Level 1	~~≤ 35(a)~~ NA
b. Drywell Pressure - High	~~≤ 35(a)~~ NA
c. North Stack Effluent Radiation - High	N.A.
d. Deleted	
e. Reactor Enclosure Ventilation Exhaust Duct - Radiation - High	N.A.
f. Outside Atmosphere To Reactor Enclosure Δ Pressure - Low	N.A.
g. Deleted	
h. Drywell Pressure - High/ Reactor Pressure - Low	N.A.
i. Primary Containment Instrument Gas to Drywell Δ Pressure-Low	N.A.
j. Manual Initiation	N.A.
7. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level Low, Low - Level 2	N.A.
b. Drywell Pressure - High	N.A.
c. Refueling Area Ventilation Exhaust Duct Radiation - High	N.A.
d. Reactor Enclosure Ventilation Exhaust Duct Radiation - High	N.A.
e. Outside Atmosphere to Reactor Enclosure Δ Pressure - Low	N.A.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. CORE SPRAY SYSTEM	≤ 27 &&
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	≤ 40 &&
3. AUTOMATIC DEPRESSURIZATION SYSTEM	N.A.
4. HIGH PRESSURE COOLANT INJECTION SYSTEM	≤ 30 &&
5. LOSS OF POWER	N.A.

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power - High	$\leq$ 0.09**
c. Neutron Flux - High	$\leq$ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	$\leq$ 0.35 #
4. Reactor Vessel Water Level - Low, Level 3	$\leq$ 1.05 #
5. Reactor Vessel Water Level - High, Level 8	$\leq$ 1.05 #
6. Main Steam Line Isolation Valve - Closure	$\leq$ 0.06
7. Main Steam Line Radiation - High	NA
8. Drywell Pressure - High	NA
9. Scram Discharge Volume Water Level - High	NA
10. Turbine Stop Valve - Closure	$\leq$ 0.06
11. Turbine Control Valve Fast Closure, Valve Trip System Oil Pressure - Low	$\leq$ 0.07# → x
12. Reactor Mode Switch Shutdown Position	NA
13. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

**Not including simulated thermal power time constant, 6 ± 0.6 seconds.

#Measured from start of turbine control valve fast closure.

x → use

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# →X
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low, Level 2	NA
b. Drywell Pressure - High	NA
c. Containment and Drywell Purge Exhaust Plenum Radiation - High(b)	≤ 20(a) NA ###
d. Reactor Vessel Water Level - Low, Level 1	NA
e. Manual Initiation	NA
2. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level - Low, Level 1	## ≤ 1.0*/≤ 20(a)** NA
b. Main Steam Line Radiation - High(b)	## ≤ 1.0*/≤ 10(a)** NA
c. Main Steam Line Pressure - Low	## ≤ 1.0*/≤ 10(a)** NA
d. Main Steam Line Flow - High	## ≤ 0.5*/≤ 10(a)** NA
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Temperature - High	NA
g. Main Steam Line Tunnel Δ Temperature - High	NA
h. Turbine Building Main Steam Line Temperature - High	NA
i. Manual Initiation	NA
3. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low, Level 2	NA
b. Drywell Pressure - High	NA
c. Manual Initiation	NA
4. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	NA
b. Δ Flow Timer	NA
c. Equipment Area Temperature - High	NA
d. Equipment Area Δ Temperature - High	NA
e. Reactor Vessel Water Level - Low, Level 2	NA
f. Main Steam Line Tunnel Ambient Temperature - High	NA
g. Main Steam Line Tunnel Δ Temperature - High	NA
h. SLCS Initiation	NA
i. Manual Initiation	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION		RESPONSE TIME (Seconds)# →X
5.	REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a.	RCIC Steam Line Flow - High	NA
b.	RCIC Steam Supply Pressure - Low	NA
c.	RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d.	RCIC Equipment Room Ambient Temperature - High	NA
e.	RCIC Equipment Room Δ Temperature - High	NA
f.	Main Steam Line Tunnel Ambient Temperature - High	NA
g.	Main Steam Line Tunnel Δ Temperature - High	NA
h.	Main Steam Line Tunnel Temperature Timer	NA
i.	RHR Equipment Room Ambient Temperature - High	NA
j.	RHR Equipment Room Δ Temperature - High	NA
k.	RCIC Steam Line Flow High Timer	NA
l.	Drywell Pressure - High	NA
m.	Manual Initiation	NA
6.	RHR SYSTEM ISOLATION	
a.	RHR Equipment Area Ambient Temperature - High	NA
b.	RHR Equipment Area Δ Temperature - High	NA
c.	RHR/RCIC Steam Line Flow - High	NA
d.	Reactor Vessel Water Level - Low, Level 3	NA
e.	Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
f.	Drywell Pressure - High	NA
g.	Manual Initiation	NA

delete

(a) Isolation system instrumentation response time specified includes the diesel generator starting and sequence loading delays.

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed.

**Isolation system instrumentation response time for associated valves except MSIVs.

#Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Table 3.6.4-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
A. DIVISION 1 TRIP SYSTEM	
1. RHR-A (LPCI MODE) AND LPCS SYSTEM	
a. Reactor Vessel Water Level - Low, Level 1	≤ 37 &&
b. Drywell Pressure - High	≤ 37 &&
c. LPCS Pump Discharge Flow - Low (Bypass)	NA
d. Reactor Vessel Pressure - Low (LPCS Injection Valve Permissive)	NA
e. Reactor Vessel Pressure - Low (LPCI Injection Valve Permissive)	NA
f. LPCI Pump A Start Time Delay Relay	NA
g. LPCI Pump A Discharge Flow - Low (Bypass)	NA
h. Manual Initiation	NA
2. AUTOMATIC DEPRESSURIZATION SYSTEM TRIP SYSTEM "A"	
a. Reactor Vessel Water Level - Low, Level 1	NA
b. Manual Inhibit	NA
c. ADS Timer	NA
d. Reactor Vessel Water Level - Low, Level 3 (Permissive)	NA
e. LPCS Pump Discharge Pressure - High (Permissive)	NA
f. LPCI Pump A Discharge Pressure - High (Permissive)	NA
g. Manual Initiation	NA
B. DIVISION 2 TRIP SYSTEM	
1. RHR B AND C (LPCI MODE)	
a. Reactor Vessel Water Level - Low, Level 1	≤ 37 &&
b. Drywell Pressure - High	≤ 37 &&
c. Reactor Vessel Pressure - Low (LPCI Injection Valve Permissive)	NA
d. LPCI Pump B Start Time Delay Relay	NA
e. LPCI Pump Discharge Flow - Low (Bypass)	NA
f. Manual Initiation	NA

TABLE 3.3.3-3 (Continued)

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

TRIP FUNCTION	RESPONSE TIME (Seconds)
2. AUTOMATIC DEPRESSURIZATION SYSTEM TRIP SYSTEM "B"	
a. Reactor Vessel Water Level - Low, Level 1	NA
b. Manual Inhibit	NA
c. ADS Timer	NA
d. Reactor Vessel Water Level - Low, Level 3 (Permissive)	NA
e. LPCI Pump B and C Discharge Pressure - High (Permissive)	NA
f. Manual Initiation	NA
C. DIVISION 3 TRIP SYSTEM	
1. HPCS SYSTEM	
a. Reactor Vessel Water Level - Low, Level 2	≤ 27 &&
b. Drywell Pressure - High	≤ 27 &&
c. Reactor Vessel Water Level - High, Level 8	NA
d. Condensate Storage Tank Level - Low	NA
e. Suppression Pool Water Level - High	NA
f. HPCS Pump Discharge Pressure - High	NA
g. HPCS System Flow Rate - Low	NA
h. Manual Initiation	NA
D. LOSS OF POWER	
1. 4.16 kv Emergency Bus Undervoltage# → X (Loss of Voltage)	NA
2. 4.16 kv Emergency Bus Undervoltage# → X (Degraded Voltage)	NA

X → #The Loss of Voltage and Degraded Voltage functions are common to Division 1, Division 2, and Division 3.

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JUL 11 1990
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TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - High, Setdown	NA
b. Flow Biased Simulated Thermal Power - High	≤0.09**
c. Neutron Flux - High	≤0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤0.35 #
4. Reactor Vessel Water Level - Low, Level 3	≤1.05 #
5. Reactor Vessel Water Level - High, Level 8	≤1.05 #
6. Main Steam Line Isolation Valve - Closure	≤0.09
7. Main Steam Line Radiation - High	NA
8. Drywell Pressure - High	NA
9. Scram Discharge Volume Water Level - High	
a. Level Transmitter	NA
b. Float Switches	NA
10. Turbine Stop Valve - Closure	≤0.06
11. Turbine Control Valve Fast Closure, Valve Trip System Oil Pressure - Low	<0.07# → X
12. Reactor Mode Switch Shutdown Position	NA
13. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.
**Not including simulated thermal power time constant specified in the COLR.
#Measured from start of turbine control valve fast closure.

X ↗ we

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low Low Level 2	≤ 20(a) NA
b. Drywell Pressure - High	≤ 20(a) NA
c. Containment Purge Isolation Radiation - High(b)	NA
2. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level - Low Low Low Level 1	## ≤ 1.0 */≤ 20(a) → NA
b. Main Steam Line Radiation - High(b)	## ≤ 1.0 */≤ 20(a) → NA
c. Main Steam Line Pressure - Low	## ≤ 1.0 */≤ 20(a) → NA
d. Main Steam Line Flow - High	## ≤ 0.5 */≤ 20(a) → NA
e. Condenser Vacuum - Low	NA
f. Main Steam Line Tunnel Temperature - High	NA
g. Main Steam Line Tunnel Δ Temperature - High	NA
h. Main Steam Line Area Temperature - High (Turbine Bldg)	NA
3. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level - Low Low Level 2	≤ 20(a) NA
b. Drywell Pressure - High	≤ 10(a) NA
c. Fuel Building Ventilation Exhaust Radiation - High(b)	NA
d. Reactor Building Annulus Ventilation Exhaust Radiation - High(b)	NA
4. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. Δ Flow - High	≤ 20(a)## → XX NA
b. Δ Flow Timer	NA
c. Equipment Area Temperature - High	NA
d. Equipment Area Δ Temperature - High	NA
e. Reactor Vessel Water Level - Low Low Level 2	≤ 20(a) NA
f. Main Steam Line Tunnel Ambient Temperature - High	NA
g. Main Steam Line Tunnel Δ Temperature - High	NA
h. SLCS Initiation	NA
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Flow - High	≤ 20(a)### → XXX NA
b. RCIC Steam Line Flow-High Timer	NA
c. RCIC Steam Supply Pressure - Low	≤ 20(a) NA
d. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
e. RCIC Equipment Room Ambient Temperature - High	NA
f. RCIC Equipment Room Δ Temperature - High	NA
g. Main Steam Line Tunnel Ambient Temperature - High	NA
h. Main Steam Line Tunnel Δ Temperature - High	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
i. Main Steam Line Tunnel Temperature Timer	NA
j. RHR Equipment Room Ambient Temperature - High	NA
k. RHR Equipment Room Δ Temperature - High	NA
l. RHR/RCIC Steam Line Flow - High	NA
m. Drywell Pressure - High	NA
n. Manual Initiation	NA
6. RHR SYSTEM ISOLATION	
a. RHR Equipment Area Ambient Temperature - High	NA
b. RHR Equipment Area Δ Temperature - High	NA
c. Reactor Vessel Water Level - Low Level 3	~~≤ 20(a)~~ NA
d. Reactor Vessel Water Level - Low Low Low Level 1	~~≤ 20(a)~~ NA
e. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
f. Drywell Pressure - High	NA
7. MANUAL INITIATION	NA

delete

(a) Isolation system instrumentation response time specified includes the diesel generator starting and sequence loading delays.

...iation detectors are exempt from response time testing. Response time ...all be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed.

**Isolation system instrumentation response time for associated valves except MSIVs.

Change to X → #Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Tables 3.6.4-1 and 3.6.5.3-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

XX → ##Time delay of 45-47 seconds.

XXX → ###Time delay of 3-13 seconds.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

ECCS	RESPONSE TIME (Seconds)
1. LOW PRESSURE CORE SPRAY SYSTEM	≤ 37
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	
a. Pumps A and B	≤ 37
b. Pump C	≤ 37
3. AUTOMATIC DEPRESSURIZATION SYSTEM	NA
4. HIGH PRESSURE CORE SPRAY SYSTEM	≤ 27
5. LOSS OF POWER	NA

TABLE 3.3.1-2

REACTOR PROTECTION SYSTEM RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME (Seconds)
1. Intermediate Range Monitors:	
a. Neutron Flux - High	NA
b. Inoperative	NA
2. Average Power Range Monitor*:	
a. Neutron Flux - Upscale, Setdown	NA
b. Flow Biased Simulated Thermal Power - Upscale	≤ 0.09**
c. Fixed Neutron Flux - Upscale	≤ 0.09
d. Inoperative	NA
3. Reactor Vessel Steam Dome Pressure - High	≤ 0.55 #
4. Reactor Vessel Water Level - Low, Level 3	≤ 1.05 #
5. Main Steam Line Isolation Valve - Closure	≤ 0.06
6. Main Steam Line Radiation - High	NA
7. Drywell Pressure - High	NA
8. Scram Discharge Volume Water Level - High	
a. Level Transmitter	NA
b. Float Switch	NA
9. Turbine Stop Valve - Closure	≤ 0.06
10. Turbine Control Valve Fast Closure, Trip Oil Pressure - Low	< 0.08# → X
11. Reactor Mode Switch Shutdown Position	NA
12. Manual Scram	NA

*Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.
**Not including simulated thermal power time constant.
#Measured from actuation of fast-acting solenoid.

X change to

TABLE 3.3.2-3

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)# → X
1. PRIMARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level	
1) Low, Level 3	~~≤10(a)~~ NA
2) Low Low, Level 2	## ~~≤1.0*/≤10(a)**~~ NA
3) Low Low Low, Level 1	~~≤10(a)~~ NA
b. Drywell Pressure - High	~~≤10(a)~~ NA
c. Manual Initiation	NA
d. SGTS Exhaust Radiation - High(b)	~~≤10(a)~~ NA ###
e. Main Steam Line Radiation - High(b)	~~≤10(a)~~ NA ###
2. SECONDARY CONTAINMENT ISOLATION	
a. Reactor Vessel Water Level-Low Low, Level 2	~~≤10(a)~~ NA
b. Drywell Pressure - High	~~≤10(a)~~ NA
c. Refuel Floor High Exhaust Duct Radiation - High(b)	~~≤10(a)~~ NA ###
d. Railroad Access Shaft Exhaust Duct Radiation - High(b)	~~≤10(a)~~ NA ###
e. Refuel Floor Wall Exhaust Duct Radiation -High(b)	~~≤10(a)~~ NA ###
f. Manual Initiation	NA
3. MAIN STEAM LINE ISOLATION	
a. Reactor Vessel Water Level- Low Low Low, Level 1	~~≤10(a)~~ NA
b. Main Steam Line Radiation - High(b)	## ~~≤1.0*/≤10(a)**~~ NA
c. Main Steam Line Pressure - Low	## ~~≤1.0*/≤10(a)**~~ NA
d. Main Steam Line Flow-High	## ~~≤0.5*/≤10(a)**~~ NA
e. Condenser Vacuum - Low	NA
f. Reactor Building Main Steam Line Tunnel Temperature - High	NA
g. Reactor Building Main Steam Line Tunnel Δ Temperature - High	NA
h. Manual Initiation	NA
i. Turbine Building Main Steam Line Tunnel Temperature - High	NA
4. REACTOR WATER CLEANUP SYSTEM ISOLATION	
a. RWCU Δ Flow - High	~~≤10(a)##~~ NA → XX
b. RWCU Area Temperature - High	NA
c. RWCU Area Ventilation Temperature ΔT - High	NA
d. SLCS Initiation	NA
e. Reactor Vessel Water Level - Low Low, Level 2	~~≤10(a)~~ NA
f. RWCU Flow - High	NA
g. Manual Initiation	NA
5. REACTOR CORE ISOLATION COOLING SYSTEM ISOLATION	
a. RCIC Steam Line Δ Pressure - High	~~≤10(a)###~~ NA → XXX
b. RCIC Steam Supply Pressure - Low	~~≤10(a)~~ NA
c. RCIC Turbine Exhaust Diaphragm Pressure - High	NA
d. RCIC Equipment Room Temperature - High	NA

TABLE 3.3.2-3 (Continued)

ISOLATION SYSTEM INSTRUMENTATION RESPONSE TIME

TRIP FUNCTION	RESPONSE TIME (Seconds)#
e. RCIC Equipment Room Δ Temperature - High	NA
f. RCIC Pipe Routing Area Temperature - High	NA
g. RCIC Pipe Routing Area Δ Temperature - High	NA
h. RCIC Emergency Area Cooler Temperature - High	NA
i. Manual Initiation	NA
j. Drywell Pressure - High	NA
6. HIGH PRESSURE COOLANT INJECTION SYSTEM ISOLATION	
a. HPCI Steam Flow - High	NA
b. HPCI Steam Supply Pressure - Low	NA
c. HPCI Turbine Exhaust Diaphragm Pressure - High	NA
d. HPCI Equipment Room Temperature - High	NA
e. HPCI Equipment Room Δ Temperature - High	NA
f. HPCI Emergency Area Cooler Temperature - High	NA
g. HPCI Pipe Routing Area Temperature - High	NA
h. HPCI Pipe Routing Area Δ Temperature - High	NA
i. Manual Initiation	NA
j. Drywell Pressure - High	NA
7. RHR SYSTEM SHUTDOWN COOLING/HEAD SPRAY MODE ISOLATION	
a. Reactor Vessel Water Level - Low, Level 3	NA
b. Reactor Vessel (RHR Cut-in Permissive) Pressure - High	NA
c. RHR Equipment Area Δ Temperature - High	NA
d. RHR Equipment Area Temperature - High	NA
e. RHR Flow - High	NA
f. Manual Initiation	NA
g. Drywell Pressure - High	NA

(a) The isolation system instrumentation response time shall be measured and recorded as a part of the ISOLATION SYSTEM RESPONSE TIME. Isolation system instrumentation response time specified includes the delay for diesel generator starting assumed in the accident analysis.

(b) Radiation detectors are exempt from response time testing. Response time shall be measured from detector output or the input of the first electronic component in the channel.

*Isolation system instrumentation response time for MSIVs only. No diesel generator delays assumed for MSIV Valves.

**Isolation system instrumentation response time for associated valves except MSIVs.

#Isolation system instrumentation response time specified for the Trip Function actuating each valve group shall be added to isolation time shown in Table 3.6.3-1 and 3.6.5.2-1 for valves in each valve group to obtain ISOLATION SYSTEM RESPONSE TIME for each valve.

##With time delay of 45 seconds.

###With time delay of 3 seconds.

####With time delay of 3 seconds.

TABLE 3.3.3-3

EMERGENCY CORE COOLING SYSTEM RESPONSE TIMES

TRIP FUNCTION	RESPONSE TIME (Seconds)
1. CORE SPRAY SYSTEM	
a. Reactor Vessel Water Level-Low Low Low, Level 1	$\leq$27
b. Drywell Pressure-High	$\leq$27
c. Reactor Vessel Steam Dome Pressure-Low	$\leq$27
d. Manual Initation	NA
2. LOW PRESSURE COOLANT INJECTION MODE OF RHR SYSTEM	
a. Reactor Vessel Water Level-Low Low Low, Level 1	$\leq$40
b. Drywell Pressure-High	$\leq$40
c. Reactor Vessel Steam Dome Pressure-Low	
1) System Initiation	$\leq$40
2) Recirculation Discharge Valve Closure	$\leq$40
d. Manual Initiation	NA
3. HIGH PRESSURE COOLANT INJECTION SYSTEM	
a. Reactor Vessel Water Level - Low Low, Level 2	$\leq$30
b. Drywell Pressure - High	$\leq$30
c. Condensate Storage Tank Level-Low	NA
d. Reactor Vessel Water Level-High, Level 8	NA
e. Suppression Pool Water Level-High	NA
f. Manual Initiation	NA
4. AUTOMATIC DEPRESSURIZATION SYSTEM	
a. Reactor Vessel Water Level-Low Low Low, Level 1	NA
b. Drywell Pressure-High	NA
c. ADS Timer	NA
d. Core Spray Pump Discharge Pressure-High	NA
e. RHR LPCI Mode Pump Discharge Pressure-High	NA
f. Reactor Vessel Water Level-Low, Level 3	NA
g. ADS Drywell Pressure Bypass Timer	NA
h. Manual Inhibit	NA
i. Manual Initiation	NA
5. LOSS OF POWER	
a. 4.16 kV ESS Bus Undervoltage (Loss of Voltage <20%)	NA
b. 4.16 kV ESS Bus Undervoltage (Degraded Voltage <65%)	NA
c. 4.16 kV ESS Bus Undervoltage (Degraded Voltage <84%)	NA

APPENDIX I

EXAMPLE LICENSE CHANGE REQUEST

Appendix I

Example License Change Request

This appendix provides the sample format and contents of a request for Technical Specification changes associated with the elimination of response time testing for selected instrument loops. Included in this appendix is a sample cover letter with three enclosures. Enclosure 1 is a discussion of the basis for the proposed changes, and Enclosure 2 is an evaluation of the proposed changes per 10CFR50.92 which demonstrates there are no significant hazards considerations. Enclosure 3 contains Technical Specification changes and page change instructions. Plant-specific information is indicated by brackets ([]).

Plant-specific information should be incorporated as required. This includes mark-ups of revised Technical Specifications, typed Technical Specification pages incorporating the changes, and instructions for including the changed pages into Technical Specifications (see Enclosure 3). Enclosures 1, 2, and 3 should be submitted to the NRC on the utility's letterhead.

SAMPLE COVER LETTER

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

[Plant Name]
NRC Docket No. [ ]
Operating License [ ]

SUBJECT: REQUEST TO REVISE TECHNICAL SPECIFICATIONS: RESPONSE TIME TESTING

Reference: NEDO-32291, "System Analyses for the Elimination of Selected Response Time Testing Requirements", January 1994.

In accordance with the provisions of 10CFR50.90, [Utility Name] hereby proposes changes to the [Plant Name] Technical Specifications, Appendix A to Operating License [ ].

The proposed changes involve elimination from Technical Specifications of selected response time testing requirements. Specifically, the response time testing requirements to be eliminated include sensors and specified loop instrumentation for the 1) Reactor Protection System, 2) Isolation System, and 3) Emergency Core Cooling System.

In support of the proposed changes to the Technical Specifications, enclosed are:

- Basis for Change Request
- 10CFR50.92 Evaluation
- Technical Specification Changes and Page Change Instructions

The proposed Technical Specification changes are supported by an analysis performed by the BWR Owners' Group (see reference), demonstrating that other periodic tests required by Technical Specifications, such as channel calibrations, channel checks, channel functional tests, and logic system functional tests ensure that instrument response times are within acceptable limits. The applicability of the reference analysis to [Plant Name] has been verified.

Because this licensing change improves plant safety and reduces plant operation and maintenance costs, the proposed change qualifies as a Cost Beneficial Licensing Action (CBLA) and should be reviewed by the NRC on a priority basis. Based on a conservative reduction of 1500 man-hours per outage and the potential reduction in outage length, cost savings are estimated to range from $50,000 to $100,000 per unit per year.

SAMPLE COVER LETTER (continued)

The results of the 10CFR50.92 evaluation demonstrate that there are no significant hazards considerations.

[[Name] states that he is [Vice President] of [Utility Name] and is authorized to execute this oath on behalf of [Utility Name], and that to the best of his knowledge and belief, the facts set forth in this letter are true.

Very truly yours,

[Name]
[Title]

Sworn to and subscribed before me this [ ] day of [Month, Year].

[Signature of Notary Public]]

Enclosures

cc: [ ]

ENCLOSURE 1

[PLANT NAME]
NRC DOCKET [ ]
OPERATING LICENSE [ ]

REQUEST TO REVISE TECHNICAL SPECIFICATIONS:
RESPONSE TIME TESTING

BASIS FOR CHANGE REQUEST

Background:

This proposed change is to eliminate from Technical Specifications selected response time testing requirements. Specifically, the response time testing requirements to be eliminated include sensors and specified loop instrumentation for the 1) Reactor Protection System, 2) Isolation System, and 3) Emergency Core Cooling System. An analysis has been performed demonstrating that other periodic tests required by Technical Specifications, such as channel calibrations, channel checks, channel functional tests, and logic system functional tests provide adequate assurance that instrument response times are within acceptance limits. The BWROG evaluation confirms that response time tests are of no safety significance and cause unnecessary personnel exposure, reduce availability of safety systems during shutdown and are a significant burden to utility resource.

Basis:

Regulatory Guide 1.118 (Revision 2) states:

> "Response time testing of all safety related equipment, per se, is not required if, in lieu of response time testing, the response time of the safety equipment is verified by functional testing, calibration checks or other tests, or both. This is acceptable if it can be demonstrated that changes in response time beyond acceptable limits are accompanied by changes in performance characteristics which are detectable during routine tests."

An analysis has been performed by the BWR Owners' Group (BWROG) which provides the basis for eliminating selected response time testing requirements (see Reference 1). The analysis was performed for two representative BWRs, and its applicability to [plant name] has been verified.

The analysis includes the identification of potential failure modes of components in the affected instrumentation loops which could potentially impact the instrument loop response time. In addition, plant operating experiences were reviewed to identify response time failures and how they were detected. The failure modes identified were then evaluated to determine if the effect on response time would be detected by other testing requirements contained in Technical Specifications.

The results of the analy... ...monstrate that other Technical Specification testing requirements (channel calibration, channel check, channel functional test, and logic system functional test) ensure that instrument response times are within acceptable limits.

These other tests are normally sufficient to identify failure modes or degradations in instrument response time and assure operation of the analyzed instrument loops within acceptance limits. Furthermore, there are no known failure modes that can be detected by response time testing that cannot also be detected by other Technical Specification tests.

Participating utilities will update test procedures (if required) to assure that the instrument technicians recognize response time delays in instrumentation. A BWROG survey has concluded that instrument response time delays of 5 seconds can be reasonably detected by instrument technicians. A safety evaluation has confirmed that delays of individual specific trip functions of a few seconds have very low safety significance. This realistic bases evaluation showed that a good deal of margin exists in the licensing analysis. Within a trip function, redundancy exists in individual instrument channels (e.g., 1 out of 2 twice) and diversity exists in most safety trip functions (e.g., neutron flux, water level, drywell pressure). Also, for most of these instruments the response times are insignificant compared to the safety system actuation times.

The Reference 1 evaluations demonstrate that response time testing can be eliminated for the following:

1) All Emergency Core Cooling System instrument loops;
2) All Isolation System actuation instrument loops except for main steam line isolation valves (MSIVs);
3) Sensors for selected Reactor Protection System actuation; and
4) Sensors for MSIV closure actuation.

Significant Hazards consideration:

The significant hazards consideration assessment is presented in Enclosure 2 and concludes that the proposed amendment does not involve a significant hazards consideration.

Reference:

1. NEDO-32291, "System Analyses for the Elimination of Selected Response Time Testing Requirements", January 1994.

2. EPRI Report, NP-7243, "Investigation of Response Time Testing Requirements", May 1991.

ENCLOSURE 2

[PLANT NAME]
NRC DOCKET [ ]
OPERATING LICENSE [ ]

REQUEST TO REVISE TECHNICAL SPECIFICATIONS:
RESPONSE TIME TESTING

10CFR50.92 EVALUATION

Basis for Significant Hazards Determination:

The proposed Technical Specification changes described in Enclosure 1 do not involve a significant hazards consideration for the following reasons:

1. The changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

   The purpose of the proposed Technical Specification change is to eliminate response time testing requirements for selected instrumentation in the Reactor Protection System, Isolation System, and Emergency Core Cooling System. However, because of the continued application of other existing Technical Specification requirements such as channel calibrations, channel checks, channel functional tests, and logic system functional tests, the response time of these systems will be maintained within the acceptance limits assumed in plant safety analyses and required for successful mitigation of an initiating event. The proposed Technical Specification changes do not affect the capability of the associated systems to perform their intended function within their required response time.

   The BWR Owners' Group has completed an evaluation (Reference 1) which demonstrates that response time testing is redundant to the other Technical Specification requirements listed in the preceding paragraph. These other tests are sufficient to identify failure modes or degradations in instrument response time and ensure operation of the associated systems within acceptance limits. There are no known failure modes that can be detected by response time testing that cannot also be detected by the other Technical Specification tests.

2. The changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

   As discussed above, the proposed Technical Specification changes do not affect the capability of the associated systems to perform their intended function within the acceptance limits assumed in plant safety analyses and required for successful mitigation of an initiating event.

3. The changes do not involve a significant reduction in the margin of safety.

The current Technical Specification response times are based on the maximum allowable values assumed in the plant safety analyses. These analyses conservatively establish the margin of safety. As described above, the proposed Technical Specification changes do not affect the capability of the associated systems to perform their intended function within the allowed response time used as the basis for the plant safety analyses. Plant and system response to an initiating event will remain in compliance within the assumptions of the safety analyses, and therefore the margin of safety is not affected.

Although not explicitly evaluated, the proposed Technical Specification changes will provide an improvement to plant safety and operation by:

a) Reducing the time safety systems are unavailable

b) Reducing safety system actuations

c) Reducing shutdown risk

d) Limiting radiation exposure to plant personnel

e) Eliminating the diversion of key personnel to conduct unnecessary testing

Reference:

1. NEDO-32291, "System Analyses for the Elimination of Selected Response Time Testing Requirements", January 1994.

ENCLOSURE 3

[PLANT NAME]
NRC DOCKET [ ]
OPERATING LICENSE [ ]

REQUEST TO REVISE TECHNICAL SPECIFICATIONS:
RESPONSE TIME TESTING

TECHNICAL SPECIFICATION CHANGES
AND
PAGE CHANGE INSTRUCTIONS

Attached are mark-ups of the existing Technical Specifications, indicating the proposed changes, and a typed version of the Technical Specifications incorporating the proposed changes. Provided below are instructions for incorporating these pages into the Technical Specifications.

Remove Page	Insert Page
[3/4 3-6]	[3/4 3-6]
[3/4 3-24]	[3/4 3-24]
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[Attach Technical Specification mark-ups and retyped pages.]

APPENDIX J
EVALUATION OF DELAY IN TRIP FUNCTIONS SELECTED FOR RESPONSE TIME TEST ELIMINATION

APPENDIX J

EVALUATION OF DELAY IN TRIP FUNCTIONS SELECTED FOR RESPONSE TIME TEST ELIMINATION

This Appendix provides an assessment of a delayed (sluggish) instrumentation response on the order of 5 seconds for the trip functions selected for RTT elimination. The 5 second delay in response time represents a factor of fifteen (15) increase in the specified response time of the fastest trip function selected for elimination. This realistic bases evaluation shows that a significant margin exists in the licensing analysis. Within a trip function, redundancy exists in individual instrument channels (e.g., 1 out of 2 twice) and diversity exists in most safety trip functions (e.g., neutron flux, water level, drywell pressure). The resulting analyses demonstrate that a 5 second instrumentation delay in the trip function will not have any significant impact on plant safety. This assessment provides added assurance that there is sufficient time within existing safety margins for an I&C technician to reasonably detect a failure or degradation in instrumentation response time.

The 5 second delay was chosen based on a survey of I&C technicians from participating BWR and selected PWR plants. Technicians were asked the following: "When performing calibration and/or loop functional tests, what is your estimate of the maximum time it would take you to identify sluggish component performance ? .... Your estimate represents the time elapsed to detect a degradation in instrument response time no matter what individual component is sticking, sluggish, or failed." A summary of the results from this survey is provided in Figure J-1. This Figure shows the number of technicians responding to the survey as a function of the time to detect sluggish component performance. Fifty percent (median value) of the technicians estimated the time to detect sluggish response as 3 seconds and 85 percent of the technicians' estimates were within 5 seconds.

Interviews were conducted with some I&C personnel whose response was greater than 10 seconds to determine what problem might exist. Each one of these individuals stated that a level transmitter with a capillary seal sensor takes from two to three times as long to determine if a component is sticking, sluggish, or failed depending on the length of the capillary tubes. These individuals used capillary seal sensors as the basis for their answer even though this type of sensor is not used in a time response application.

1) SYSTEM: REACTOR PROTECTION SYSTEM
TRIP FUNCTION: REACTOR WATER LEVEL 3

PURPOSE OF TRIP:

A low level trip indicates that the water level in the reactor vessel has dropped, and a continued decrease in level would cause steam to bypass the seal skirts of the separators or dryers. Generally, this is indicative of a problem with the level control system or reactor feedwater system. Under these circumstances, reactor scram is initiated at this low level by a Reactor Protection System (RPS) trip to substantially reduce steam production. If the Residual Heat Removal (RHR) system is operating in the shutdown cooling mode, the isolation valves on the RHR system suction piping are also closed to prevent further loss of vessel water inventory via that path. This low level trip also serves as a permissive signal for initiation of the Automatic Depressurization System (ADS) to avoid inadvertent activation of the low pressure Emergency Core Cooling Systems (ECCS) on a spurious high drywell pressure signal. This low level signal only provides confirmation that the reactor vessel water level is low; ADS is not actually activated until the Reactor Water Level 1 signal is received and other logic also indicates the need for depressurization.

EFFECT OF TRIP DELAY:

Current response time Technical Specification requirements for this trip range from 1.03 to 1.05 seconds. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. The design basis event for the Level 3 scram is the Loss of Feedwater Event (LOFW). The Level 3 scram may occur during other events but it would be a backup function after other scram signals have occurred. For example, in the postulated LOCA, the primary scram signal is the high drywell pressure signal. The LOFW is a non-limiting event for the determination of the core thermal limits. Therefore, a 5 second delay in the scram actuation would not affect plant thermal limits or fuel integrity. The core cooling function for the LOFW will still be provided by High Pressure Coolant Injection/High Pressure Core Spray (HPCI/HPCS) and Reactor Core Isolation Cooling (RCIC) systems which will initiate on Level 2 which is much lower than Level 3. A 5 second delay in scram would neither affect the capability of these systems to initiate nor to provide core cooling function.

2) SYSTEM: REACTOR PROTECTION SYSTEM
TRIP FUNCTION: REACTOR WATER LEVEL 8

PURPOSE OF TRIP:

A high level trip signal indicates that the water level in the reactor vessel has increased. Protective actions are initiated to prevent further vessel overfill. The trip signal is selected low enough to protect the turbine against gross carryover of moisture and to provide adequate core thermal margins during abnormal events. This signal initiates the closure of main turbine stop valves and trips the reactor feedwater pumps. For BWR/6 plants, a reactor scram is initiated by a RPS trip. For BWR/2 to 5 plants, the reactor scram is initiated by the turbine stop valves fast closure on high water level. The purpose of this RPS trip is to minimize the effect on core thermal margins from the resulting turbine trip caused by the high water level signal.

EFFECT OF TRIP DELAY:

Current response time Technical Specification requirements for this trip range from 1.03 to 1.05 seconds. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. The design basis event for the Level 8 scram is the Feedwater Controller Failure (FWCF). Plant specific transient analysis can be performed to confirm that the core thermal limits would still be valid for the delayed trip on Level 8 scram. The reactor water level is estimated to increase by less than 2 inches (40000 gpm [feedwater pump capacity] * 0.1 (10% flow increase) /60 min/sec* 5 sec/200 gal/inch [volume of reactor vessel] < 2 inches). This increase in reactor water level would not result in cold water intrusion in the main steam lines (MSLs) as the Level 8 is still several feet below the MSL elevation.

3) SYSTEM: REACTOR PROTECTION SYSTEM
TRIP FUNCTION: REACTOR HIGH STEAM DOME PRESSURE

PURPOSE OF TRIP:

The reactor vessel pressure must be maintained within the limits prescribed by the ASME Boiler & Pressure Vessel Code, Section III. If pressure increases to a preset value, a trip signal to the Reactor Protection System (RPS) will initiate reactor scram in order to shutdown nuclear heat generation. Reactor scram is initiated by high pressure if other signals have failed to scram the reactor to limit the effect of increased pressure on reactor power ard provide assurance that reactor vessel integrity will be maintained within emergency limits.

This scram also serves to shutdown the plant for non-design basis events that may involve slightly higher steam flow than the turbine and/or bypass valves can handle. If no other trip occurs first, the high pressure scram will shutdown the unit before initiation of relief valve flow to the suppression pool. An example of this sequence is a Turbine/Generator (T/G) trip at a power level above the bypass capacity, but below the power interlock which activates the T/G trip scram (typically at 5% above the bypass capacity). If the bypass response is normal, the flux scram may be avoided, but the pressure will gradually increase to the pressure scram setpoint.

EFFECT OF TRIP DELAY:

Current response time Technical Specification requirements for this trip range from 0.33 to 0.55 seconds. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. The reactor high steam dome pressure is primarily a backup scram signal. The primary scram signals for various pressurization events are the position switches (or other appropriate logic at some plants) for the turbine stop valves or Main Steam Isolation Valves (MSIVs), the pressure switches for the turbine control valves, or in some cases, the high neutron flux scram signal. Under the current Anticipated Transient Without Scram (ATWS) rules, plants can meet the ASME Section III Code Limits without taking credit for the high pressure scram. For the non-design basis events, the reactor pressure response is also much slower due to the lower power level. Consequently, the delay would not affect the integrity of the reactor vessel. A 5 second delay in the pressure scram does not affect the core thermal limits for the non-design basis events.

The only exception for the use of the high pressure scram signal is for plants with the APRM-RBM Technical Specifications (ARTS) implementation. The Minimum Critical Power Ratio (MCPR)(P) and power-dependent Maximum Average Planar Linear Heat Generation Rate (MAPLHGR)(P) were determined by taking credit for the high pressure scram for events which occur at reactor power below the bypass of the turbine trip or generator trip scrams (typically between 30% to 45% of rated power). Plant specific evaluations can be performed for these plants to determine the impact on these power-dependent limits. However, given the large operating margin normally available at these low power ranges, a 5 second delay in this scram signal would not affect fuel integrity.

4) SYSTEM: ISOLATION ACTUATION (MSIV CLOSURE)
TRIP FUNCTION: REACTOR WATER LEVEL 1 OR 2

PURPOSE OF TRIP:

Abnormally low reactor water level is used to generate initiation signals for several functions, one of which is closure of the MSIVs. The signal is at either Level 1 or 2, depending on the plant configuration. Fuel cladding integrity must be assured by the initiation of the ECCS systems. To limit the possibility of off-site release, the MSIVs will be closed at the low water level signals.

EFFECT OF TRIP DELAY:

The current response time Technical Specification requirement for this trip is 1.0 second. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. Closure of the MSIVs at low reactor water level would occur during events which involves loss of reactor inventory, such as LOFW or LOCA events. However, immediate valve closure is not required for core or plant safety. The reactor would have been scrammed at either Level 2 or 1. The MSIV closure does not affect core cooling. The only purpose of the MSIV closure at low reactor water level during this type of event is to limit the potential increase in the off-site dose. However, at these reactor water levels, there is no fuel damage and the radioactivity is limited to the inventory in the steam lines. No fuel damage would occur even if there is a 5 second delay in the MSIV closure under these conditions. Therefore, the 5 second delay in the MSIV closure on low reactor water level does not affect plant safety.

5) SYSTEM: ISOLATION ACTUATION (MSIV CLOSURE)
TRIP FUNCTION: MSL RADIATION HIGH

PURPOSE OF TRIP:

MSIV Closure on MSL radiation high signal is provided to prevent the large release of radioactivity to the environment. The protection is provided primarily for events which may result in fuel failures, such as the control rod drop accident (CRDA) or loss of coolant accidents.

EFFECT OF TRIP DELAY:

The current response time Technical Specification requirement for this trip is 1.0 second. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. MSIV closure on high radiation level is required when fuel failure has occurred. For CRDA, fuel failure is limited due to the restriction placed on the rod worth. The increase in radioactivity will not occur in the first several minutes of the event and will be contained inside the steam lines. For LOCA events, the MSIVs would have been closed on other signals prior to the high radiation signal. Therefore, a 5 second delay in the MSIV closure on MSL high radiation signal does not affect plant safety.

6) SYSTEM: ISOLATION ACTUATION (MSIV CLOSURE)
TRIP FUNCTION: MAIN STEAM LINE LOW PRESSURE

PURPOSE OF TRIP:

MSIV closure on low steam line pressure is provided to protect the reactor system during normal power generation (RUN Mode) against transients that could cause uncontrolled depressurization. Protection is provided primarily for a pressure regulator malfunction which results in turbine control and/or bypass valves opening. The MSL low pressure trip setpoint is specified to limit the duration and severity of the depressurization so that vessel thermal stresses (resulting from vessel cooldown rate) remain below the appropriate safety limit and inventory loss is limited to prevent uncovering the core. The setpoint is chosen to be low enough that unnecessary isolations are avoided.

EFFECT OF TRIP DELAY:

Current response time Technical Specification requirements for this trip range from 1.0 to 2.0 seconds. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. The MSL low pressure trip signal is used primarily to protect the reactor system in case of a pressure regulator malfunction event. This event is not a limiting event for the core thermal limits. The primary concern is the reactor inventory loss and the thermal cyclic effect on the reactor vessel. During this event, the rapid depressurization causes an increase in water level which results in the high water level trip. This in turn initiates a turbine trip and reactor scram. After reactor scram, reactor water level can be maintained by HPCI/HPCS or Reactor Core Isolation Cooling (RCIC) systems which are initiated at Level 2. The trip setpoint for many BWRs is approximately 850 psig. Analysis demonstrates that the setpoint can be lowered to 750 psig without affecting vessel integrity. The reactor vessel is designed to accommodate more rapid depressurization than this event. Therefore, a 5 second delay would not affect vessel integrity or plant safety.

7) SYSTEM: ISOLATION ACTUATION (MSIV CLOSURE)
TRIP FUNCTION: MAIN STEAM LINE FLOW HIGH

PURPOSE OF TRIP:

MSIV closure on high steam line flow is provided to protect the reactor system against transients or accidents that could cause unexpected increase in steam flow. Protection is provided primarily for a break in the steam line outside the primary containment. Flow restrictors are provided to limit the maximum steam flow to 140% of rated steam flow. The MSL high flow trip setpoint is specified to limit the duration and severity of the high steam flow condition so that any off-site release will remain below the appropriate limit and inventory loss is limited to prevent uncovering the core. The setpoint is chosen to be high enough that unnecessary isolations are avoided.

EFFECT OF TRIP DELAY:

Current response time Technical Specification requirements for this trip range from 0.5 to 1.0 seconds. If this trip initiation time is increased to 5 seconds, there would be no significant impact on plant safety. The MSL high flow is designed primarily to protect against a MSL break outside containment. The high steam flow from the postulated double ended break would result in releasing a large amount of steam and water outside the primary containment. However, fuel failure would not result from this event as the break would be isolated long before the reactor water level has any significant drop. The analysis of this event for older plants assumes a 10 second valve closure time, although the Technical Specification requirements for the MSIVs are 3 to 5 seconds. Even with the conservative valve closure time, the off-site release for this event is only a small fraction of the allowable 10CFR100 limits. A 5 second delay in the MSIV closure on high steam flow would still meet the requirements of 10CFR100. Therefore, the 5 second trip delay for this function does not affect plant safety.

8) SYSTEM: ISOLATION ACTUATION

TRIP FUNCTION:
- RCIC System
- HPCI System (BWR3/4)
- HPCS System (BWR 5/6)
- RWCU System
- RHR Shutdown Cooling/Head Spray
- Primary Containment
- Secondary Containment

PURPOSE OF TRIP:

Depending on this system, this instrumentation is either for high flow or high area temperature. The instrumentation is provided on various systems to protect the reactor system against accidents that could cause unexpected loss of reactor coolant caused primarily by a break or a leak in the process lines outside the primary containment. For the primary and secondary containment, the protection is to prevent release of radioactivity materials to the surrounding environment.

EFFECT OF TRIP DELAY

The Isolation Actuation Instrumentation is provided to limit the release of reactor inventory following a break in the system process lines. Each system listed above is connected to the nuclear boiler and penetrates the primary containment. These lines are equipped with an ac and dc powered isolation valve. The design basis evaluation for the reactor inventory release for these lines are based on the assumption that the dc valve has failed and that the plant has lost off-site power. In this case, the ac powered isolation valve cannot close until the on-site emergency diesel generator provides the power for the valve. The delay for the emergency diesel generator is typically between 10 to 13 seconds which is longer than the 5 second delay for the instrumentation. The emergency diesel generator is initiated upon loss of off-site power and is independent of the isolation actuation instrumentation. Therefore, this 5 second delay on isolation actuation does not have any effect on the plant safety.

9) SYSTEM: EMERGENCY CORE COOLING SYSTEM ACTUATION

TRIP FUNCTION:
- HPCI/HPCS
- LPCS
- LPCI

PURPOSE OF TRIP:

The ECC system is provided to assure adequate core cooling following loss of normal reactor cooling capability. The HPCI/HPCS provides core cooling at high reactor pressure conditions. In case of a LOCA or when the reactor pressure is sufficiently low, the low pressure ECC systems (LPCI or LPCS) initiate to provide core cooling. In the event of a small leak in the primary coolant system where HPCS cannot provide adequate core cooling, the ADS would initiate to depressurize the reactor vessel to allow the low pressure ECC system to provide the necessary core cooling. The typical response time for the ECCS is as shown below:

- o HPCI/HPCS (27 to 35 seconds)
- o LPCS (27 to 43 seconds)
- o LPCI (37 to 64 seconds)

EFFECT OF TRIP DELAY:

The ECC systems are required to mitigate LOCAs. The application of the GE SAFER/GETSR code for BWRs has demonstrated that there is significant safety margin for LOCA events. The realistic peak cladding temperature for the design basis LOCA is 1000°F which is significantly below the 2200°F Peak Cladding Temperature (PCT) limit. The delay in the HPCI/HPCS response time does not have any significant impact on the design basis LOCA because the system is not used as the primary cooling source due to the rapid reactor depressurization. For isolation and small breaks, a 5 second delay in system response has minimal impact since the release of the reactor inventory from the break is significantly reduced. For the design basis LOCA, analysis (Ref. 1) has demonstrated that a 11 second increase in the response time for the core spray system would increase the PCT by approximately 84°F. A 15 second increase in the LPCI response time would increase the PCT by 131°F. The combined effect of a 10 second delay for LPCS and 9 second for LPCI is an increase in the PCT by 137°F, still considerably below the PCT limits. Therefore, a 5 second delay in the ECCS system response time does not affect plant safety.

Ref. 1: "Basis for Relaxing ECCS Performance Requirements for BWR/4s", EPRI, NSAC-131, September 1988.

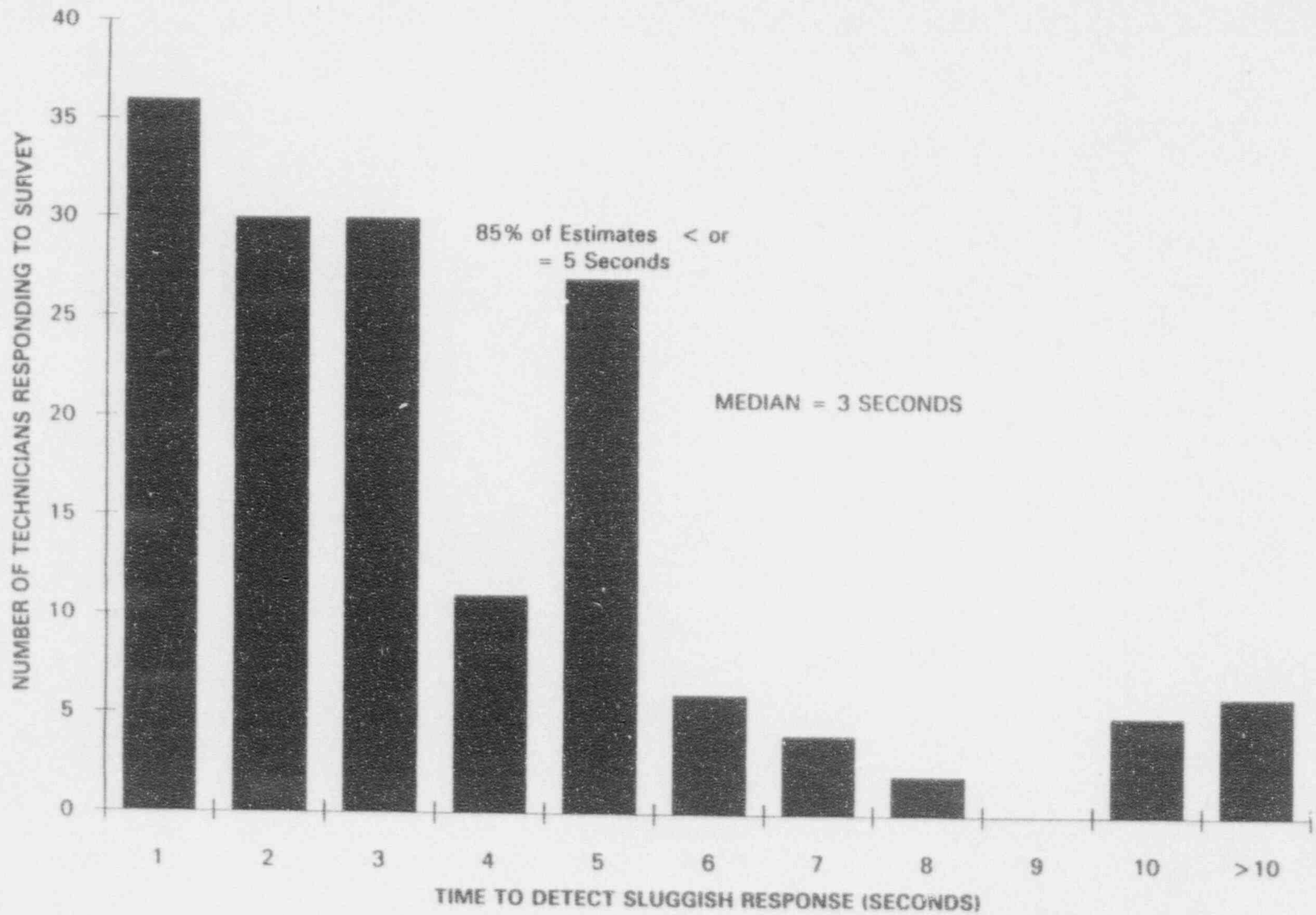

Figure J-1

BWROG SURVEY OF INSTRUMENT TECHNICIANS - TIME TO DETECT INSTRUMENT SLUGGISH RESPONSE

APPENDIX K
RTT COMPONENT FAILURE MODES ANALYSES

APPENDIX K
RTT COMPONENT FAILURE MODE ANALYSES

This Appendix summarizes the results of the failure modes analyses for the generic components that could potentially affect the instrumentation loop response time. These analyses are based on detailed engineering evaluations including vendor contacts, operating experience, and design experience to investigate the potential failure modes of the specific loop instrumentation.

K.1 TRIP UNIT

K.1.1 Rosemount Trip Unit

The 510DU/710DU trip/calibration system is a seismically-qualified, multichannel signal conditioning unit with a built-in calibration capability. It is designed to provide accurate, easily-calibrated trip output signals for process variables (pressure, temperature, level etc.) which are received from 4 to 20 mA transmitters. The trip output signals drive external relays or loads of up to one amp. The master trip unit produces a trip output signal when transmitter input current passes through a preset trip point. A gross failure signal is generated when the transmitter current is outside preset high or low limits. One analog output is used to drive up to seven slave trip units, thereby establishing as many as eight trip points for a single transmitter input.

Master trip units have a trip point adjustment potentiometer on the front panel, as well as an analog meter displaying transmitter input current, two light-emitting diodes (LEDs) indicating trip and gross failure outputs, a gross failure reset button and a test jack to monitor the transmitter input.

Each slave trip unit is driven by a master trip unit with analog output, and adds one additional trip point and gross failure circuit to the transmitter loop. The slave trip unit receives a buffered 1-5 Vdc signal proportional to transmitter current and, like the master trip unit, produces a trip output signal when the transmitter current passes through a preset trip point, and a gross failure signal when transmitter current is outside preset high or low limits.

Rosemount Models 510DU/710DU are very fast devices with respect to response time. The nominal response time for this master trip unit is of the order of 2 milliseconds. The master trip unit is designed such that it either trips or does not trip. When the circuitry associated with the master trip unit fails, it does not provide the normal observable trip function indication. Furthermore, there were no failure modes identified that lead to a degraded condition that significantly affects the response time of the trip function.

The only component within the master trip unit that can potentially lead to response time degradation is a capacitor that is used for noise suppression. Two failure modes are associated with this capacitor: (1) shorted out or leakage and (2) open. If the capacitor shorts out to the maximum value of 100%, the master trip unit response time will become faster by approximately 100 microseconds, and this will result in erratic operation. However, from a practical standpoint, the impact on the master trip unit response time is negligible. Similarly, if the capacitor is open, the master trip unit response time will increase by a negligible amount while causing erratic operation. The typical failure frequency of these failures is very small (approximately 1.0 x E-7 per hour).

Therefore, no failure modes were identified within the master trip unit that could potentially increase its response time above the millisecond range.

K.1.2 GE Master Trip Unit (184C5988 Series)

The GE master trip unit, which is similar to Rosemount, provides the signal processing necessary to monitor analog inputs and provide contact closure/open as trip outputs. Trip points, hysteresis, and gross failure limits are adjustable. There are no failure modes within the master trip unit circuitry which would delay the normal response time without also affecting calibration or causing misoperation. If calibration checks are normal, the trip unit response time will be within specifications.

K.1.3 Indicator and Trip Unit (129B2802 Series)

The indicator and trip unit is an electronic amplifier and trip circuit module consisting of discrete transistors, resistors, capacitors, diodes, etc. The dominant failure mode affecting response time is the degradation of resistors and electrolytic capacitors in the input and feedback circuits. However, the time constants are in the range of 10 to 27 milliseconds. These are insignificant compared to overall system response time requirements.

The predominate failure mode which could affect response time is an increase of resistance in the feedback circuit. If the resistance increases, the circuit response may become significantly slower before it fails to operate. An engineering evaluation of the feedback circuits shows that the indicator and trip unit could potentially sustain operation with a response time increase of an estimated 200 to 300 milliseconds. Failure modes (resistance increase) which can extend the time further, can be detectable by loss of DC performance and misoperation during other surveillance tests.

The predominate failure mode of the capacitor is a reduction of capacitance and lower resistance. This failure mode will make the indicator trip unit respond faster to input signals. Considering that the worst case failure mode results in a 200 to 300 milliseconds degradation in response time, the component response time will still remain in the millisecond range, and, therefore, response time testing is not required.

K.2 Relays

Relay failure modes normally result in a failure of the relay to operate or a gross degradation in relay performance. Either of these conditions is readily detectable through functional testing, inspection, or observations of abnormalities during routine operation. In addition, due to the relative frequency of performance of functional versus response time tests, it is likely that such failures would be detected via functional tests much sooner than response time tests. The failure experience review evaluation (Appendix D) confirms these conclusions and shows that the majority of failures are due to aging and wearout (Reference 8.0 in main report). Furthermore, many of these failure modes have been eliminated through design enhancements and substitution of superior materials. See Appendix D for a more detailed discussion of typical failure modes encountered by relays.

K.3 Time Delay Relays

An engineering evaluation and the failure experience review (Appendix D) has confirmed that time delay relays affect response time and are subject to setpoint drift. These failure modes include pickup or dropout delays well in excess of the time delay setting. In addition, failure modes involving operator misadjustment and misoperation (e.g., early or inadvertent actuations) frequently occur. For these reasons, time delay relays require calibration for response verification and to assure setpoint accuracy.

K.4 Flow Devices (Bailey/GEMAC Modules)

The following modules were analyzed for delay failure modes by review of their schematic diagrams. These units operate essentially instantaneously, and "instant" operation can be easily confirmed during normal calibration surveillances.

K.4.1 752 Summer

The input and feedback resistors and capacitors on the output amplifier are the only identified response time dependent components. If these resistors and capacitors change value, the delay time will be affected, but so will the calibration. If the unit calibrates properly, it can be concluded that the resistors are functioning properly. Failure of feedback capacitors will change calibration and speed up the circuitry, not slow it down. Therefore, it can be concluded that response time degradation can readily be detected by other surveillance tests.

K.4.2 750 Square Root Extractor

Changes in the resistors in the output amplifier T network and feedback resistors may cause response delays, but they would also cause calibration accuracy changes. If the unit calibrates properly, the response time will remain within requirements. Therefore, any response time degradation beyond acceptable limits can be detected by the other technical specification surveillance tests.

K.5 Radiation Devices

K.5.1 Trip Auxiliary Unit (238X697 Series)

The trip auxiliary unit consists of relays which either will operate or fail to operate. There is no identified failure mode which would alter the relay nominal pickup or dropout delays. If a relay fails to operate, it will be detected by logic system functional tests as a functional failure.

K.5.2 GE NUMAC Log Rad Monitor (304A3700 Series)

The NUMAC Log Rad Monitor is a microprocessor-based instrument running with an internal clock using a piezo-electric crystal. Crystal failure would result in an increase in frequency. This causes either a faster response or total shutdown with trip initiation.

The failure modes listed in the MIL Spec for the crystals used in NUMAC seal indicate that a frequency shift of 0.01% may occur, when the package hermetic seal is broken, which is rare. The frequency shift of 0.01% translates into one microsecond response time difference. The mean time between failure (MTBF) is on the order of 200 years. Thus, it is concluded that the potential for instrument slowdown due to crystal failure is in the microsecond range and does not significantly affect response time.

K.5.3 Log Radiation Monitor 38X660 Series)

The 238X660 series Logarithmic Radiation Monitor is a complex analog circuit design utilizing discrete components including electrometer tubes. It is used to monitor main steam line radiation over a six-decade range to provide a scram trip, if radiation exceeds a trip point. This analog instrument has a number of potential component failure modes. Some will affect response time and others will disable the instrument. For example, the feedback capacitor in the logarithmic diode circuit can change value and adversely affect response time. The malfunction can be discovered during routine surveillance such as calibration procedures. Analysis of potential failure modes which could change response time is difficult to justify without extensive testing. Therefore, the elimination of response time testing for the Log Rad Monitor cannot be justified.

K.6 Transmitters/Switches

Transmitters and switches can be eliminated from response time testing based on analyses performed by EPRI (Reference 1) and additional BWROG analyses for sensors not included in the EPRI analysis. The RPS water level, reactor pressure sensors, and sensors that support selected ECCS and isolation actuation functions are included in these supplemental analyses. The specific sensors are listed in Table 7-1 in main report.

The following is a discussion of the EPRI results and additional BWROG analyses of sensors not included in the EPRI study.

K.6.1 Transmitters/Switches Included in EPRI Analyses

The EPRI analysis scope included the majority of pressure sensor instrumentation currently installed or expected to be installed in U.S. plants. The pressure sensors which are applicable to the BWR plants participating in this BWROG study are the Barton, Rosemount, and SOR transmitters/switches. Sensor failure modes associated with all Barton transmitters, models 763 and 764, switches model 288/289, and SOR switches were not found to affect sensor response time without significantly affecting calibration. The BWROG reviewed and provided comments on the draft EPRI analysis report prior to issuance. All comments were addressed in the final report.

Only two failure modes and two manufacturing/handling defects were identified in Reference 1 as affecting response time without concurrently affecting sensor output. These failure modes and defects apply only to sensors utilizing a fill fluid to transfer the process pressure to the sensing element. Rosemount supplies the only sensors of this type identified for plants participating in this BWROG study. The two failure modes are the slow loss of fill fluid during pressurized operations and variable damping potentiometer misadjustment during maintenance. The two manufacturing and handling defects are low sensor fill fluid from the manufacturing process and crimped capillaries from the manufacturing process, improper handling by the manufacturer, or damage during field installation/maintenance.

A discussion of these failure modes and effects are included in Appendix F. The effect of these failure modes and effects on RTT elimination can be summarized as follows:

(1) <u>**Slow loss of fill fluid**</u> - A slow loss of fill fluid causes a gradual degradation of the measurement process by reducing the ability of the working fluid to rapidly transmit pressure changes to the sensing diaphragm. Current response time tests are ineffective in detecting the initial stages of slow fluid loss. For sensors that are susceptible to the slow loss of fill-oil, Drift Analysis is the preferred method to detect the change in instrument performance. Other diagnostic techniques such as sluggish response and process noise analysis may be used to supplement Drift Analysis. When enough fluid (Reference 10-13) is lost to cause a significant response time degradation, the sluggish response of the leaking sensor will be detected during transmitter calibration.

(2) **Variable damping potentiometer misadjustment** - Damping devices have been utilized in fast acting trip circuits to minimize the potential for inadvertent actuations. The use of a variable damping potentiometer in the transmitter design provides a means of applying the same type of transmitter to several circuits that require additional electronic filtering capability. Variable damping potentiometer misadjustment can affect the response time in circuits having capacitors and resistors that control electronic response time. Measures must be taken to ensure that the potentiometer is at the required setting at time of installation and after major maintenance.

Therefore, no additional response time tests are required. A more detailed discussion on damping filters is also found in Appendix F.

(3) **Manufacturing and handling defects** - Low sensor fill fluid during manufacturing and crimped fill capillaries due to manufacturing or mishandling during installation/maintenance were identified in Reference 1 as affecting transmitter response time. Response time is the only sensor characteristic affected by these manufacturing and handling defects. Since November 1989, vendor testing has been implemented to ensure acceptable fill and capillarics. In addition, when low fill fluid or crimped capillaries affect response time, the degradation can be identified by pre-installation calibration.

K.6.2 Transmitters/Switches Not Included in EPRI Analysis

The following two switch models are not part of the EPRI report (Reference 1 of main report) but were supplemented by BWROG.

K.6.2.1 Barksdale Pressure Switches

The only potential failure mode for model TC9622-3 (piston with O-ring) occurs if the switch is misapplied in process or range. The O-ring seal can swell due to pressure above its rating, and this swelling causes the plunger pin to react sluggishly. This will increase the instrument response time. Since safety-related switches are carefully specified and verified, this failure mode is considered extremely unlikely. The only electrical failure mode occurs in the microswitch. This will not produce a delay, but will cause failure to operate, which can be readily detected during surveillance testing.

The Barksdale B1T and B2T series are Bourdon tube instruments and do not have components that can cause response time related failures. Therefore, response time testing is not required.

K.6.2.2 Barton 760 Transmitters

Barton 760 is a differential pressure transmitter which contains a mechanical bellows and electronic circuit similar to Model 764. As concluded in Reference 1 of main report, response time testing is not required for the Barton 764 Model. This conclusion also applies to Model 760.

K.7 Loop Devices

K.7.1 Rosemount/GE Trip Unit Noise Suppression Filter Capacitor

The WBR 2000-50 capacitor, used as a process noise filter in an analog transmitter loop, is manufactured by Cornell Dubilier-Sangamo Components. It is a 2000 ufd aluminum electrolytic capacitor with a 50V rating. Failure modes of the capacitor are (1) open, (2) short, (3) increased leakage, and (4) change in capacitance. When installed in parallel with the trip unit input, short circuit and increased leakage current failures can affect analog loop accuracy. Loop calibration procedures (end to end) performed on a periodic basis can demonstrate loop operability within the required performance requirements as long as the capacitor is in the circuit during the procedure. Open circuit failures are in the conservative direction and are not a concern with respect to response time. Capacitance change failures can include (a) decreased capacitance, which is in the conservative direction with respect to response time, and (b) an increase of capacitance. The vendor states that capacitance may increase by 10% with time. These parts are already specified with a -10%/+75% tolerance. The time delay added by the capacitor should have sufficient margin to the maximum allowable to account for this possible increase. With surveillance tests demonstrating loop operability, there are no failures with the capacitor which will adversely affect system response time.

K.7.2 745 Alarm Unit

These alarm units are used only in trip functions such as reactor water cleanup isolation. A review of the schematic diagram revealed that only the input 4.99K resistor and 10 microfarad capacitor contribute to a delay time on the order of 50 milliseconds. If the input resistor failed to a higher resistance, the delay would increase linearly until the unit failed to operate. The limits are unknown without testing. A ten-fold increase in resistance would increase the delay to approximately 0.5 seconds. Noting the apparent and almost instantaneous operation of a normal unit during calibration checks may be an alternate means to ascertaining that no failure mode affecting response time has occurred. Therefore, it can be concluded that insignificant response time degradation in the millisecond range is possible and any greater degradation can readily be detected by other surveillance tests.

K.7.3 560 Alarm Unit

A review of the schematic showed no potential response time related failure modes except for the power supply filter capacitors. If the filter capacitors fail, the circuit would experience excess AC ripple and may operate erratically. Measurement of the DC voltage verifies normal operation. Failure of other capacitors would lead to misoperation, not response time delays. Therefore, it can be concluded that response time is not affected.

K.7.4 Power Supply

The 24V power supplies furnish operating voltages to the indicator and trip unit and the sensor converter. It is possible for the power supply to incur failures which would change the output voltage. There is no direct correlation between power supply voltage and response time of the indicator and trip unit and the sensor converter. Failures that result in changes of the output voltage would affect the overall operability and calibration accuracy but will not affect response time.

K.7.5 Optical Isolators

Field Contact Input	204B6186AAG2
High Level Output	204B6186AAG4

These isolator pairs operate with a propagation delay not to exceed 20 milliseconds. By review of the circuit and components, it is concluded that there are no response time related failure modes which would extend this time without causing a failure to operate. Therefore, response time testing is not required on these units.

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