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TECHNICAL SPECIFICATION IMPROVEMENT ANALYSIS FOR THE REACTOR PROTECTION SYSTEM FOR BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 & 2

(THIS REPORT HAS BEEN PREPARED FOR CAROLINA POWER & LIGHT (CP&L) THROUGH THE TECHNICAL SPECIFICATION IMPROVEMENT COMMITTEE OF THE BWR OWNERS' GROUP)

PREPARED BY: R. P. Raftery
R. P. Raftery, Principal Engineer

VERIFIED BY: C L Larson
C. L. Larson, Principal Engineer

APPROVED BY: S. V
S. Visweswaran, Project Manager
Brunswick Surveillance Interval
Extension Program

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1. INTRODUCTION

This report extends the generic study of modifying the technical specification requirements of the Reactor Protection System (RPS) on a plant specific basis for Brunswick Steam Electric Plant, Units 1 and 2 (BSEP). The generic study (Reference 1) provides a technical basis to modify the surveillance test frequencies and allowable out-of-service times of the RPS from the generic technical specifications. The generic study also provides additional analyses of various known different RPS configurations to support the application of the generic basis on a plant specific basis. The generic basis and the supporting analyses were utilized in this plant specific evaluation. The results of the plant specific evaluation for BSEP are presented herein.

The original report was completed in April 1985. This Revision 1 incorporates changes made to the plant since that time.

2. EVALUATION METHOD

The plant specific evaluation of the modification of the surveillance test frequencies and allowable out-of-service time of the RPS was performed in the following steps:

a. Obtain plant specific information on the RPS from CP&L. The information includes the following:

   (1) Elementary Diagrams of the RPS and related systems.

   (2) RPS descriptions such as plant Final Safety Analysis Report (FSAR).

   (3) Technical specifications on the RPS.

   (4) RPS surveillance test procedures.

   The latest revisions of Items 1, 2 and 3 above were supplied by CP&L. Item 4 above was provided by CP&L in the form of a questionnaire identifying the differences between the procedure used in the generic evaluation and the procedure used at BSEP. Section I of the checklist in Appendix A was used to identify the data source of the plant specific information.

b. Construct the plant specific RPS configuration from the plant specific information. Sections "A" through "H" in Section II of the checklist were used for this process.

c. Compare the plant specific RPS configuration with the generic RPS configuration using the generic RPS elementary diagram, RPS description, technical specification requirements, and other generic inputs. Section III of the checklist was used for this process.

d. Classify the differences into three categories:

(1) Obvious items which have no effect on the reliability of the RPS. Examples of these "no effect" items are component name differences, symbol differences, and other minor non-functional differences. Disposition of the obvious "no effect" items does not require additional analysis.

(2) Potential differences which require considerable engineering judgment for disposition because of the functional differences. Examples of these potential differences are separate channels for manual scram as opposed to non-separate channel in the generic plant and dual redundant contacts per sensor relay in the applicable trip channels as opposed to a single set of contacts in the generic plant. The disposition of such items would require engineering assessment as shown in Appendix K of Reference 1.

(3) Potential differences which require additional analyses to evaluate the effect on the RPS failure frequency. Examples of such potential differences are using HFA relays as opposed to using Potter and Brumfield relays and Agastat relays in the generic evaluation. Disposition of these items would require additional analyses to compare with the generic results. These analyses are documented in Reference 1.

e. Compile a list of plant specific differences of Categories (2) and (3).

f. Assess the reliability effect of the differences identified in Step (e) on the generic results. The results of the assessment are documented in Section III of the checklist.

g. Document the results of the plant specific evaluation.

The above seven step process is documented in Appendix A of this report.

3. RESULTS OF RPS EVALUATION

The results of the plant specific evaluation of the RPS for BSEP are documented in Appendix A of this report. The results show that the RPS configuration of BSEP has the following differences which are classified Category (2) or (3):

[ ]

4. SUMMARY AND CONCLUSIONS

A plant specific evaluation of modifying the surveillance test frequencies and allowable out-of-service time of the RPS from the technical specifications of BSEP has been performed. The evaluation utilized the generic basis and the additional analyses documented in Reference 1. The results indicated that the RPS configuration for BSEP has several differences compared to the RPS configuration in the generic evaluation. These differences and the assessment of their effects on the RPS failure frequency are shown in Appendix A. The analysis reported in Reference 1 shows that these differences would not significantly affect the improvement in plant safety due to the changes in the technical specifications based on the generic analysis. Therefore, the generic analysis in Reference 1 is applicable to BSEP.

5. REFERENCES

(1) "Technical Specification Improvement Analyses for BWR Reactor Protection System", General Electric Company, NEDC-30851P, May 1985.

APPENDIX A

RPS EVALUATION CHECKLIST FOR BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

Section I - RPS Plant Specific Data Source

Utility: Carolina Power & Light

Plant: Brunswick Steam Electric Plant, Units 1 & 2

Source Number

1. RPS Elementary 791E414RM, Rev 18, 15 sh.
2. RPS IED 731E624BB, Rev. 7, sh. 2 and 3 (of 3)
3. RPS MG Set Control System Elementary 944E683, Rev. 1, 1 sh.
4. RPS Interconnection Scheme Elementary 791E415RM, Rev. 2, 3 sh.
5. RPS Design Specification 22A1480AC, Rev. 7
6. FSAR Updated FSAR, Section 7.2
7. Technical Specifications Section 3/4.3.1
8. Surveillance Test Procedure Checklist EDT BOA-8521
9. Others RPS IED, 732E174, Rev. 9, 4 sh.
10. CP&L Fax with comments, 7/20/94.

Section II - RPS Configuration Data

A. RPS System

	Data	Data* Source
1. Number of trip systems	2	(1,6)
2. Number of logic channels per trip system		
– For Automatic Scram	2	(1,6)
– For Manual Scram	1	(1,6)
3. Power supply source for each channel	MG Set	(3,6)
4. Operation mode		
– De-energize to trip	Yes	(1,6)
5. Logic arrangement		
– one-out-of-two twice	Yes	(1,6)
6. Electrical Protection Assemblies (EPAs)	Yes	(3)
7. Design requirement	IEEE-279	(5,6)

* The numbers shown in the data source column refer to the documents listed in Section I.

Section II - RPS Configuration Data

B. RPS Sensors

	Type	Total Number	Number/RPS Channel	Data Source
1. Identify the type, total number, and number per RPS channel for the following RPS sensors.				
– APRM	Analog	6	2	(1,5)
– Turbine Stop Valve	Switch	4	2	(1,5)
– Turbine Control Valve	Switch	4	1	(1,5)
– MSIV Position	Switch	8	4	(1,5)
– MSL Radiation	Gamma Detector	4	1	(1,5)
– Level 8 (High Water Level)	N/A	N/A	N/A	N/A
– Level 3 (Low Water Level)	Analog	4	1	(1,5)
– SDV Level				
Type 1 (Analog)	Electronic Switch	4	1	(6)
Type 2	Float Switch	4	1	(6)
– High Reactor Pressure	Analog	4	1	(1,5)
– High Drywell Pressure	Analog	4	1	(1,5)
– Manual Trip	Switch	4	1	(1,5)
– Mode Switch Trip	Switch	4	1	(1,5)
– Low Condenser Vacuum	N/A	N/A	N/A	N/A

Section II - RPS Configuration Data

B. RPS Sensors (Continued)

	Data	Data Source
2. Turbine Stop Valve closure logic arrangement 3 out of 4 closure		(1,6)
3. Turbine Stop Valve closure monitoring Position switches		(2,6)
4. Turbine Control Valve fast closure monitoring Oil Pressure Switches		(2,6)
5. MSIV closure logic arrangement 3 out of 4 closure		(1,6)
6. Diversity in SDV level sensors Float switches and analog switches		(6)
7. Number of MSL 4		(2)
8. List of available bypasses		(1,5,6)
- IRM Trip Bypass	Yes	
- Noncoincident Neutron Monitoring System Trip Bypass	Yes	
- RPV High Water Level RPS Trip Bypass	Not Applicable	
- Turbine Stop Valve RPS Trip Bypass	Yes	
- Turbine Control Valve RPS Trip Bypass	Yes	
- MSIV Closure RPS Trip Bypass	Yes	
- SDV High Water Level Trip Bypass	Yes	
- Reactor Mode Switch "Shutdown" mode Trip Bypass	Yes	

Section II - RPS Configuration Data

C. Sensor Relays

	Data	Data Source
1. Types of relays	GE Type HFA	(1)
2. Number of pairs of contacts per relay in the trip channel	2	(1)
3. List type of relay for each RPS sensor		(10)

	Potter & Brumfield	Agastat	HFA	CR 105/305
- APRM			x	
- Turbine Stop Valve			x	
- Turbine Control Valve			x	
- MSIV Position			x	
- MSL Radiation			x	
- Level 3			x	
- SDV Level			x	
Type 1 (Analog)			x	
Type 2 (Switch)			x	
- High Reactor Pressure			x	
- High Drywell Pressure			x	
- Manual Trip				x
- Mode Switch Trip				x
- Low Condenser Vacuum			N/A	
- Level 8			N/A	

Section II - RPS Configuration Data

D. Scram Contactors

	Data	Data Source
1. Types of scram contactors	GE Type CR105 or CR305	(10)
2. Total number of scram contactors	8*	(1)
3. Number of scram contactors per channel	2	(1)

*The above 8 scram contactors are for the auto trip systems only. The manual scram channels have their own scram contactors (total of 4 contactors with 2 per channel).

E. Air Pilot Solenoid Valves

	Data	Data Source
1. Number of solenoid valves per control rod drive	2	(6,9)
2. Number of solenoid operators per valve	1	(6,9)

Section II - RPS Configuration Data

F. Backup Scram

		Data	Data Source
1.	Type of scram contactors for Backup Scram Valves	GE Type CR105 or CR305	(10)
2.	Number of scram contactors per Backup Scram Valve	6	(1)
3.	Same RPS scram contactors are used to actuate Backup Scram Valves	Yes	(1)
4.	Operator mode		
	- energized to trip	Yes	(1)
5.	Test requirement for Backup Scram Valves	Not specified in Tech. Spec.	(7)

Section II - RPS Configuration Data

G. RPS Tech. Spec. Requirements

	Data Source
1. Calibration Frequency for LPRM	
At least once per effective full power month using the TIP system	(7)
2. Calibration frequency for trip units.	
Once a month	(7)
3. Frequency of Logic System Functional Tests	
Once per 18 months	(7)
4. Allowable time to place an inoperable channel or trip system in the tripped conditions when the number of operable channels is less than the required minimum operable channels per trip system.	
Within 1 hour	(7)
5. Exception to item 4.	
Tech Spec does not specify exception.	(7)
6. Allowable time to place a trip system in the tripped conditions when the number of operable channels is less than the required minimum operable channels for both trip systems.	
Within 1 hour	(7)
7. Exception to item 6 due to surveillance test.	
Two hours for surveillance	(7)
8. Complete the Table on the following page.	(7)

REACTOR PROTECTION SYSTEM INSTRUMENTATION REQUIREMENTS

	Channel Check		Channel Functional Test		Channel Calibration		Minimum Operable Channels Per Trip System	
Functional Unit	Generic Model	Plant Specific	Generic Model	Plant Specific	Generic Model	Plant Specific	Generic Model	Plant Specific
1. Average Power Range Monitor:								
a. Flow Biased Simulated Thermal Power - High	S,D	S	S/U,W	S/U,W	W,SA,R	W,Q	3	2
b. Neutron Flux - High	S	S	S/U,W	S/U,W	W,SA	W,Q	3	2
c. Inoperative	N/A	N/A	W	W	N/A	N/A	3	2
2. Reactor Vessel Steam Dome Pressure - High	S	D	M	M	R	R,M*	2	2
3. Reactor Vessel Water Level - Low, Level 3	S	D	M	M	R	R,M*	2	2
4. Reactor Vessel Water Level - High, Level 8	S	N/A	M	N/A	R	N/A	2	N/A
5. Main Steam Line Isolation Valve - Closure	N/A	N/A	M	M	R	R	4	4
6. Main Steam Line Radiation - High	S	S	M	M	R	R	2	2
7. Drywell Pressure - High	S	D	M	M	R	R,M*	2	2
8. Main Condenser Vacuum - Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*Monthly calibration of trip units only, transmitters are calibrated at least once per 18 months.

REACTOR PROTECTION SYSTEM INSTRUMENTATION REQUIREMENTS

Functional Unit	Channel Check		Channel Functional Test		Channel Calibration		Minimum Operable Channels Per Trip System	
	Generic Model	Plant Specific	Generic Model	Plant Specific	Generic Model	Plant Specific	Generic Model	Plant Specific
9. Scram Discharge Volume Water Level - High								
Type 1 - Analog	S	N/A	M	Q	R	R	2	2
Type 2 - Switch	N/A	N/A	M	Q	R	R	2	2
10. Turbine Stop Valve - Closure	N/A	N/A	M	M	R	R	4	2
11. Turbine Control Valve Fast Closure Valve Trip System Oil Pressure - Low	N/A	N/A	M	M	R	R	2	2 (Unit 2:4)
12. Reactor Mode Switch Shutdown Position	N/A	N/A	R	R	N/A	N/A	2	1
13. Manual Scram	N/A	N/A	M	Q	N/A	N/A	2	1

S=Shift
D=Daily
W=Weekly

M=Monthly
Q=Quarterly
R=Refueling Outage

S/U=Startup
N/A=Not Applicable

Section II - RPS Configuration Data

H. RPS Surveillance Tests Procedure

	Data Source
1. The following components are all tested as part of an individual channel functional test: a. Individual channel sensor(s), e.g., Transmitters and Trip Units, switches, flux or radiation sensors. b. Associated logic relay(s) c. Associated scram contactors List any plant specific differences from the above. RESPONSE For 1.a. above, flux sensors are generally not included in the Channel Functional Test. Additionally other sensors such as Thermocouples may not be included. These differences are consistent with the T/S definition for Channel Functional Test.	(8)
2. When an individual sensor channel is in test or repair, is associated logic channel tripped or is the sensor channel jumpered? State which of the two conditions applies to your plant. If any other condition exists in your plant, describe. RESPONSE For repair, the logic channel is tripped. For surveillance test, the logic channel is jumpered with exception that the last check of the channel (e.g., calibration) would provide for a test of the channel with the jumper removed by performance of the Channel Functional Test.	(8)

Section II - RPS Configuration Data

H. RPS Surveillance Tests Procedure (Continued)

	Data Source
3. For those plants which do not place individual channels in a tripped condition during test or repair, it is assumed in the GE analysis that only the individual sensor and associated logic relay is placed in an inoperable condition during test or repair of the individual channel. If this assumption is not true for your plant, list the components (from sensor to scram contactors) which are placed in inoperable condition during test or repair. RESPONSE This assumption is true for Brunswick.	(8)
4. The following number of individual scram contactor actuations are assumed in the GE analyses for each channel functional test: a. APRM channel functional tests - 2 actuations per scram contactor pair in each trip logic channel. b. MSIV closure channel function tests - 4 actuations per scram contactor pair in each trip logic channel. c. Other channel functional tests - 1 actuation per scram contactor pair in each trip logic channel. List any differences from the above for your specific plant RESPONSE 4.a. - 1 actuation per scram contactor pair. 4.b. - 1 actuation per scram contactor pair. 4.c. - No difference from that stated.	(8)

Section II - RPS Configuration Data

H. RPS Surveillance Tests Procedure (Continued)

	Data Source
5. Do plant procedures allow simultaneous inoperable conditions (failed condition) of diverse sensors in a given logic channel? RESPONSE As allowed by BSEP T/S 3.3.1.a, any number of sensors in a trip system may be inoperable provided the sensor is placed in the tripped condition. For example, a high pressure and a low level instrument in the A trip system (A1 or A2) may be inoperable as long as both channels (or the A trip system) are tripped within one hour. Operation may continue indefinitely with a half-scram condition; however, both channels must be returned to operable condition prior to returning the trip system to normal.	(8)

Section III - Assessed Reliability Effect of RPS Configuration Differences

BWR Generic Model	Plant Specific Difference	Assessed Reliability Effect
A. RPS System		
1. Generic model has two trip systems.	No difference	
2. Generic model has two logic channels per trip system for automatic scram.	No difference	
3. During operation, the trip systems are energized and trip when de-energized.	No difference	
4. The RPS logic is one-out-of-two twice, i.e., one out of two logic channels will trip an individual system and trip of both systems is required for scram.	No difference	
5. Generic model has Electrical Protection Assemblies (EPAs).	No difference	
6. Each RPS channel can be manually tripped from the Control Room using the manual scram circuits.	Separate channel for manual scram, but each auto-scram channel can also be manually tripped by interrupting the power to the RPS.	

Section III - Assessed Reliability Effect of RPS Configuration Differences

BWR Generic Model	Plant Specific Difference	Assessed Reliability Effect
B. Sensors		
1. Generic model has Analog Trip Unit/Transmitter for pressure and level sensors.	No difference	
2. Minimum number of sensors is one per RPS channel for each scram variable.	No difference	
3. Generic model has eight APRM monitors with two per RPS channel.	Six APRM monitors with two monitors shared by two channels.	
4. Stop Valve Closure trip logic is a reduced two-of-four required for trip.	No difference	
5. Stop Valve Closure is monitored by limit switches.	No difference	
6. Turbine Control Valve fast closure is monitored by control oil pressure.	No difference	
7. MSIV closure trip logic requires isolation of three out of four steam lines to scram.	No difference	
8. Generic model has a Level 8 (High Reactor Water Level) Trip.	No level 8 trip	

Section III - Assessed Reliability Effect of RPS Configuration Differences

BWR Generic Model	Plant Specific Difference	Assessed Reliability Effect
B. Sensors (Cont'd)		
9. Generic model has diverse Scram Discharge Volume (SDV) level sensors.	Different type of switches are used to provide diversity.	
10. Generic model has 4 main steamlines.	No difference	
11. Generic model does not have a direct scram on low condenser vacuum.	No difference	
C. Sensor Relays		
1. For all transients there are at least two scram variables with different type logic relays (either AGASTAT or Potter & Brumfield).	All scram variables have HFA type relays.	
2. Each sensor relay has a single pair of contacts in the applicable trip channel.	Each sensor has two pairs of contacts in the applicable trip channel.	
D. Scram Contactors		
1. All Scram Contactors are one type (GE Type CR105).	BSEP Units 1 & 2 use both GE Type CR105 & GE Type CR305 Scram Contactors.	
2. Eight scram contactors (two per RPS channel) perform the trip function.	No difference	

Section III - Assessed Reliability Effect of RPS Configuration Differences

BWR Generic Model	Plant Specific Difference	Assessed Reliability Effect
E. Air Pilot Solenoid Valves		
1. Generic model has dual solenoid operators for each individual HCU air pilot valve. De-energizing both solenoids results in a scram of the individual control rod.	Two HCU valves with single solenoid operators. Tripping of both valves is required for individual control rod scram.	
F. Backup Scram		
1. Actuation of Backup Scram Valves are controlled by same output scram contactors as RPS.	Back-up scram valves actuations are controlled by scram contactors from both the manual and auto-scram system.	
2. Trip logic for backup scram valves is an energized to trip versus de-energized to trip for individual HCU air pilot valves.	No difference	
3. Backup scram valves are tested during shutdown at least once per 18 months.	Test requirements for the backup scram valves are not specified in the plant Technical Specifications.	

Section III - Assessed Reliability Effect of RPS Configuration Differences

BWR Generic Model	Plant Specific Difference	Assessed Reliability Effect
G. Technical Specifications and Surveillance Test Procedure:		
1. Generic Model uses BWR6 Standard Technical Specifications which requires: Allowable out-of-service time: 1 hr Test time: 2 hours Test frequency: 1W for APRM 1M for others Calibration Frequency: 1M for trip units R for transmitters	See Section II.G of this Appendix for plant specific differences.	
2. Generic Model assumes two actuations per scram contactor pair in each trip logic channel for the APRM channel functional test and four actuations for the MSIV Closure Channel functional tests, and one actuation for the other scram variables. This leads to 272 total actuations of each scram contactor per year.	One actuation per scram contactor pair is performed for all channel functional tests of all scram variables. The total actuations are estimated to be 148 per year for each scram contactor.	