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REPORT

STEAM GENERATOR TUBE RUPTURE

In support of WCAP-10698 Methodology to Resolve Licensing Condition No. 41 of the WBN Draft License

Revision 2

Prepared by [signature] Date 4/8/93

Reviewed by [signature] Date 4/9/93

Approved by [signature] Date 4-9-93

WP51/FML/SGTR/SGTR.COV

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REPORT

STEAM GENERATOR TUBE RUPTURE

In support of WCAP-10698 Methodology to Resolve Licensing Condition No. 41 of the WBN Draft License

Revision 1

Prepared by ALAN D. MAST Date 6/18/92

Reviewed by D. GREENMAN Date 6/18/92

Approved by [signature] Date 6/18/92

TVA

STEAM GENERATOR TUBE RUPTURE REPORT		REVISION LOG
Revision No.	**DESCRIPTION OF REVISION**	**Date Approved**
R1	This revision incorporated the recent changes to the WBN EOIs. The WBN EOIs have been reformatted, revised and renamed. They were revised to bring them into agreement with the Westinghouse Owners Group (WOG) procedures and are now called Emergency Operating Procedures (EOPs). Pages added: New Coversheet (Rev. 1), 23-46. Pages revised: 3-22, 47, 48, 51, 52, 54, 56, Attachment 1 - page 2, Attachment 4 - page. 2 Pages deleted: None.	
R2	This revision incorporates the addition of a backup air supply for the SG PORVs, updates step 3 of EOI E-3 to the latest version and makes other editorial changes. Pages added: New Coversheet (Rev. 2) Pages revised: 48, 49, 50, 54, 55, 56, 1a Attachment 2 Pages Deleted: None.	

TABLE OF CONTENTS

THIS REPORT PACKAGE CONTAINS 68 SHEETS.

I. PURPOSE

To provide Watts Bar plant-specific information in support of WCAP-10698 methodology to mitigate the Steam Generator Tube Rupture (SGTR) design basis event as required to satisfy portions of licensing condition No. 41 of the Watts Bar draft license (Reference 13).

II. SCOPE

This report addresses the following items:

1. Comprehensive Equipment Lists identifying the principal systems, equipment, and instruments utilized in mitigating the SGTR overfill and off-site dose events are presented in Section VI. A separate column in these lists identifies backup systems and equipment (possible non-safety grade) which are available to provide the desired information or action within a time period compatible with the prevention of SGTR overfill. R1

   The first list (Table VI-1) is in response to the Emergency Operating Instruction (EOI) E-3 used for some of the scenario simulations. The second list (Table VI-2) is in response to the Emergency Operating Procedure (EOP) E-3.

2. A verification of source of motive power for the pressurizer and steam generator PORVs (Section VII).

3. A determination of whether the motive power and valve controls for the pressurizer and steam generator PORVs are safety grade (Section VII).

4. A list of single failures and equipment failures which may impact SGTR overfill and off-site dose mitigation based on review of WCAP-10698 and Supplement 1 (Section VIII). R1

5. List of SGTR event scenarios considered to be the most important based on a review of WCAP-10698 and Supplement 1 and a review of other utility efforts (Section IX). Include Action Plan for simulations.

6. Discuss quality of Radiation Monitoring System with respect to identifying the SGTR event in affected SG (Section X).

7. Specify whether or not SG chemistry sampling is an acceptable means of identifying the ruptured SG and provide the anticipated time duration for obtaining the sample results. (Section XI).

III. BACKGROUND

The analysis of the design basis steam generator tube rupture (SGTR) accident for Watts Bar is presented in Chapter 15 of the Final Safety Analysis Report (FSAR). The accident is the complete severance of a single steam generator tube that results in the leakage of reactor coolant into the secondary side of the steam generator. The event can be modeled on the plant simulator to include a design basis SGTR event break size of 200 to 1000 gpm.

It is assumed in the FSAR that the accident diagnosis and isolation procedure can be completed by the control room operators within thirty (30) minutes of the tube rupture initiation. However, following the SGTR event that occurred at the Ginna Plant in January 1982, it appeared that the time required for the operators to terminate the leakage into the ruptured steam generator was longer than thirty (30) minutes. Therefore, the validity of the traditional assumptions, particularly that of operator action time, has been questioned. Additionally, the qualification of certain equipment that is used to mitigate a SGTR may not conform to the licensing basis criteria.

In order to resolve the concerns over the potential for overfill and offsite dose following a SGTR, as cited by the Nuclear Regulatory Commission (NRC), a subgroup of utilities in the Westinghouse Owner's Group (WOG) was formed to address the issues on a generic basis. The subsequent Westinghouse generic analyses of a SGTR event with the inclusion of operator action times are documented in WCAP-10698, "SGTR Analysis Methodology to Determine the Margin to Steam Generator Overfill", and Supplement 1 to WCAP-10698, "Evaluation of Offsite Radiation Doses for a SGTR Accident", and WCAP-11002, "Evaluation of Steam Generator Overfill due to a SGTR Accident". | R1

The Westinghouse methodology for inclusion of operator actions used in WCAP-10698 and its Supplement is based mainly on the operator action times taken during the simulation of SGTR recovery operations. The simulations were performed as part of the validation of Revision 1 of the Emergency Response Guidelines (ERGs) using the Seabrook Plant training simulator. Extended operator action times were used in WCAP-11002 to postulate an overfill event. Plant-specific differences in design and equipment could impact the operator action times and plant response time required to complete the recovery operations as a result of a postulated single failure. For example, the accessibility of the block valve on the ruptured steam generator power operated relief valve (PORV) which is failed open, ie., stuck open, can significantly affect the operator action times and subsequent recovery operations. Consequently, the NRC is requiring that plant-specific SG PORV block valve isolation times be provided to minimize offsite dose. | R1

III. BACKGROUND (Continued)

Recognizing the importance of plant-specific differences and their impact on operator actions, a plan was formulated to monitor and record response times of Watts Bar operators during simulator exercises (see Attachment 1 through 5). The response times will be recorded during a series of simulated SGTR events using the plant draft EOIs, EOPs, and training simulator. Prior to February 1992, the WB EOIs were the procedures to be used by plant operators in the mitigation of emergency events. These instructions were rewritten and distributed for training as Emergency Operating Procedures (EOPs). These EOPs have a new format and are more closely in agreement with the Westinghouse Owners Group (WOG) procedures. E-3 is the procedure of primary interest for this report because it deals with "Steam Generator Tube Rupture" events. Each event scenario will be performed by six (6) different operator crews. The scenarios include a base case and a selected set of single equipment failures identified in WCAP-10698 and Supplement 1 (See Table IX-1). R1

IV. ASSUMPTIONS

None.

R1

V. REFERENCES

1. TVA, Design Basis Document N3-14-4002, Revision 2, "System Description for the Condensate Polishing Demineralizer System", Watts Bar Nuclear Plant.
2. PAM Instrument Loop Evaluation Package for Steam Generator Level, Narrow Range, Ebasco Calculation WBPE 0038809046 (RIMS B18 890928 257).
3. TVA, DCN M-09727-A, System 3 Q-List Corrective Action Plan, RIMS B26 900525 823.
4. TVA, DCN M-07598-A, System 90 Q-List Corrective Action Plan, RIMS B26 900627800.
5. TVA, General Design Criteria Document WB-DC-40-24, Revision 2, "Radiation Monitoring", Watts Bar Nuclear Plant.
6. TVA, DCN M-10577-A, System 1 Q-List Corrective Action Plant, RIMS B26 900629801.
7. TVA, Flow Diagram 1-47W801-1, Rev. 3, CCD, "Main and Reheat Steam".
8. TVA, SOI-3.2, Auxiliary Feedwater System, Revision 13, Checklist 1.
9. TVA, DCN M-09333-A, System 68 Q-List Corrective Action Plan, RIMS B26 900427804
10. TVA, SOI-68.1, Reactor Coolant System, Revision 12.
11. TVA, Wiring Diagram 1-45W760-1-1, Rev. 1, Main Steam System.
12. TVA, Watts Bar Nuclear Plant, Unit 1, SOI-1.1, "Main Steam System", Revision 11.
13. Docket Nos. 50-390 and 50-391, Supplemental Safety Evaluation Report, NUREG-0847, Supplement No. 5, November 1990, Section 15.4.3, Steam Generator Tube Rupture. (SSER 5)
14. TVA, Watts Bar Nuclear Plant, Unit 1, Site Instruction, E-3, "Steam Generator Tube Rupture (SGTR)", Revision 3, DRAFT (EOI E-3). R1
15. TVA, System Description for Reactor Coolant system, N3-68-4001, Revision 2, Watts Bar Nuclear Plant
16. TVA, Wiring Diagram Reactor Coolant system Schematic Diagrams, 1-45W600-68-1, Rev. 0.
17. TVA, System Description for Main Steam System, N3-1-4002, Rev. 3, Watts Bar Nuclear Plant
18. WCAP-12334, Watts Bar Nuclear Plant Natural Circulation Cooldown Evaluation Program Report, Westinghouse Electric Corporation, September, 1990
19. TVA, Wiring Diagram Main Steam System Schematic Diagram, 1-45W600-1-4, R0.
20. TVA, DCN P-00548A, System 47, Q-List Corrective Action Plan, Drawing Number 91QL 47-63, Rev. 05, RIMS No. B26880803800
21. TVA, DCN M-09717-A, System 62, Q-List Corrective Action Plan, Drawing Number 92QL62-0, Rev. 0. RIMS No. B26900525831.

V. REFERENCES (Continued)

22. TVA DCN M-09719-A, System 63, Q-List Corrective Action Plan, Drawing Number 92QL63-0, Rev. 0. RIMS No. B26900525830
23. TVA, DCN M-09611-A, System 30, Q-List Corrective Action Plan, Drawing Number 92QL32-0, Rev. 0. RIMS No. B26900604814
24. TVA, DCN M-08245-A, System 74, Q-List Corrective Action Plan, Drawing Number 92QL74-0, Rev. 0. RIMS No. B26900309800
25. TVA, DCN M-07597-A, System 32, Q-List Corrective Action Plan, Drawing Number 92QL32, Rev. 1. RIMS No. T56911003949
26. TVA, DCN M-07695-B, System 70, Q-List Corrective Action Plan, Drawing Number 92QL32, Rev. 1, RIMS No. B26900510806
27. WCAP 10698, "SGTR Analysis Methodology to Determine the Margin to Steam Generator Overfill", December 1984.
28. WCAP 10698-P-A, Supplement 1, "Evaluation of Offsite Radiation Does for a Steam Generator Tube Rupture Accident", March 1986.
29. WCAP 11002, "Evaluation of Steam Generator Overfill Due to a Steam Generator Tube Rupture Accident", February 1986.
30. TVA, Watts Bar Nuclear Plant, Unit 1, Emergency Operating Procedure(EOP), "Steam Generator Tube Rupture", E-3, Draft (2/11/92).
31. TVA, DCN M-08198-A, System 72, Q-List, Corrective Action Plan, Drawing Number 92QL72, Rev. 1, RIMS No. B26 90 0306 825. R1
32. TVA, DCN M-09611-A, System 30, Q-List, Corrective Action Plan, Drawing Number 92QL30, Rev. 1, RIMS No. B26 90 0604 814.
33. TVA, DCN M-09407-A, System 65, Q-List, Corrective Action Plan, Drawing Number 92QL65, Rev. 1, RIMS No. B26 90 0523 820.
34. TVA, DCN M-07609-A, System 82, Q-List, Corrective Action Plan, Drawing Number 92QL82, Rev. 0, RIMS No. B26 90 0629 816.
35. TVA, DCN M-07601-A, System 57, Q-List, Corrective Action Plan, Drawing Number 929L57, Rev. 0, RIMS No. B26 90 0515 800.
36. TVA, ECN Modification Package E110009, Rev. 0, RIMS No. B26 89 0831 800.

VI. COMPREHENSIVE INSTRUMENT AND EQUIPMENT LIST

This section contains listings of all systems, components and instruments which are required to carry out each of the steps in WBN Procedure E-3.

Table VI-1 is based upon WBN EOI, E-3, and ES-3.1. R1

Table VI-2 is based upon WBN EOP, E-3. Many items in this table have a comparable item in Table VI-1. In those instances reference is made back to Table VI-1 rather than repeat the information.

TAB[illegible]1
COMPREHENSIVE EQUIP[illegible]ND INSTRUMENT LIST
FOR EMERGENCY OPERAT[illegible] INSTRUCTION (EOI), E-3

R1

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
1. Initiate REP per EPIP-1.				
2. Bypass Condensate DI	Valve 1-FCV-14-3	N (Ref. 1)		
3. Notify Chem Lab and Radcon				
4. Identify Ruptured SG a. Unexpected rise in SG level	SG Narrow Range Level: SG No. 1 (LT-3-38, LT-3-39, LT-3-42) SG No. 2 (LT-3-51, LT-3-52, LT-3-55) SG No. 3 (LT-3-93, LT-3-94, LT-3-97 SG No. 4 (LT-3-106, LT-3-107, LT-3-110)	Y (Ref. 2, 3)		
b. SG Discharge Monitors	RM-90-421, 422, 423, and 424	Y (Ref. 4, 5)		
c. SG Blowdown Monitors	RM-90-120, 121, or 124	N (Ref. 4, 5)		
d. RADCON Survey of Main Steam Lines	RADCON with hand held monitor			
e. RADCON survey of blowdown lines	RADCON with hand held monitor			
f. Chemistry Lab Sample	Chemistry sampling in accordance with TI-51.16. (Chemistry thought it would take between 15 and 30 minutes to sample and analyze sample).			

R1

R1

TAB[illegible]-1

COMPREHENSIVE EQUIP[illegible]ND INSTRUMENT LIST

FOR EMERGENCY OPERAT[illegible]INSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
5. Align Ruptured SG PORV. a. Controller in AUTO Set at 86%.	• SG PORV Control SG1 (1-PIC-1-6A) SG2 (1-PIC-1-13A) SG3 (1-PIC-1-24A) SG4 (1-PIC-1-31A)	N (Ref. 6) N (Ref. 6) N (Ref. 6) N (Ref. 6)	• Same as Step 5.C on SG Pressure Same as Step 5.C on SG PORV (Closed)	Y (Ref. 6)
b. HS is in P-AUTO	Same as 5a above.			
c. Check SG PORV closed when SG pressure <1125 psig	• SG1 Channel 1 Pressure (1-PT-0001-0002A) SG1 Channel 2 Pressure (1-PT-0001-0002B) SG2 Channel 1 Pressure (1-PT-0001-0009A) SG2 Channel 2 Pressure (1-PT-0001-0009B) SG3 Channel 1 Pressure (1-PT-0001-0020A) SG3 Channel 2 Pressure (1-PT-0001-0020B) SG4 Channel 1 Pressure (1-PT-0001-0027A) SG4 Channel 2 Pressure (1-PT-0001-0027B) SG1 VLV 1-PCV-001-005 (1-ZT-001-0005) SG2 VLV 1-PCV-001-0012 (1-ZT-001-0012) SG3 VLV 1-PCV-001-0023 (1-ZT-001-0023) SG4 VLV 1-PCV-001-0030 (1-ZT-001-0030)	Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6)	• Locally close SG PORV Isolation Valve (Manually close the SG PORV Block Valve on affected SG) Namely, SG1, 1-ISV-001-619 SG2, 1-ISV-001-620 SG3, 1-ISV-001-621 SG4, 1-ISV-001-622	 Y (Ref. 6, 7) Y (Ref. 6, 7) Y (Ref. 6, 7) Y (Ref. 6, 7)

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TABLE VI-1
COMPREHENSIVE EQUIPM[illegible] AND INSTRUMENT LIST
FOR EMERGENCY OPERA[illegible] NSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
6. Isolate Ruptured SG Blowdown.	• Verify Blowdown Isolation Valve on Ruptured S/G is CLOSED: SG1 (1-HS-001-0007/181) SG2 (1-HS-001-0014/182) SG3 (1-HS-001-0025/183) or SG4 (1-HS-001-0032/184)	 Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6)	• Manually Isolate SG Blowdown Vlv. SG1 (1-ISV-001-0816) SG2 (1-ISV-001-0817) SG3 (1-ISV-001-0818) SG4 (1-ISV-001-0819) With handwheel.	 Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6)
7. Ensure TD AFW Pump being supplied from intact SG				
a. If SG 1 ruptured, then close FCV-1-15 and ensure Auto swapover.	a. 1-FCV-001-0015,480, REAC MOV BD 1A2-A 1-HS-001-0015A 1-HS-001-0015B 1-HS-001-0015C	Y (Ref. 6) Y (Ref. 6, 11) Y (Ref. 6) Y (Ref. 6, 11)		
b. If SG 4 ruptured, then ensure FCV-1-16 closed and monitor to prevent Auto swapover.	b. 1-FCV-001-0016, 480, REAC MOV BD 1A2-A 1-HS-001-0016A 1-HS-001-0016B 1-HS-001-0016C	Y (Ref. 6) Y (Ref. 6, 11) Y (Ref. 6) Y (Ref. 6, 11)	• See Step 9, Principal Equipment • Ensure ONE MD AFW pump aligned to an intact SG, then STOP TD AFW pump: MD AFW Pumps: 1A-A, 1-PMP-003-0118 1B-B, 1-PMP-003-0128 • Then STOP TD AFW Pump: 1-PMP-003-0001A	Y (Ref. 3, 8) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3)

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TABLE VI-1
COMPREHENSIVE EQUIPM[illegible]ND INSTRUMENT LIST
FOR EMERGENCY OPERAT[illegible]NSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
8. CLOSE Ruptured S/G MSIV and BYPASS valve.	SG MSIVS:		If MSIV or Bypass cannot be closed, then CLOSE:	
	SG1: 1-HS-001-0004A	Y (Ref. 6, 12)	• Intact S/G MSIVs and bypasses (same as left column).	
	(1-FSV-001-0004A)	Y (Ref. 6, 12)	• Steam Dump Valves (and Steam Dump Solenoids)	N (Ref. 17)
	SG2: 1-HS-001-0011A	Y (Ref. 6, 12)	Train A Solenoid / Dump Valve	
	(1-FSV-001-0011A)	Y (Ref. 6, 12)	1-FSV-1-103A, 125 V DC BATT Bd I / 1-FCV-1-103	
	SG3: 1-HS-001-0022A	Y (Ref. 6, 12)	1-FSV-1-104A / 1-FCV-1-104	
	(1-FSV-001-0022A)	Y (Ref. 6, 12)	1-FSV-1-105A / 1-FCV-1-105	
	SG4: 1-HS-001-0029A	Y (Ref. 6, 12)	1-FSV-1-106A / 1-FCV-1-106	
	(1-FSV-001-0029A)	Y (Ref. 6, 12)	1-FSV-1-107A / 1-FCV-1-107	
	SG BYPASS VLVS:		1-FSV-1-108A / 1-FCV-1-108	
	SG1: 1-HS-001-0147 (1-FCV-001-0147)	Y (Ref. 6, 12)	1-FSV-1-109A / 1-FCV-1-109	
	SG2: 1-HS-001-0148 (1-FCV-001-0148)	Y (Ref. 6, 12)	1-FSV-1-110A / 1-FCV-1-110	
	SG3: 1-HS-001-0149 (1-FCV-001-0149)	Y (Ref. 6, 12)	1-FSV-1-111A / 1-FCV-1-111	
	SG4: 1-HS-001-0150 (1-FCV-001-0150)	Y (Ref. 6, 12)	1-FSV-1-112A / 1-FCV-1-112	
			1-FSV-1-113A / 1-FCV-1-113	
			1-FSV-1-114A / 1-FCV-1-114	
			Train B Solenoid / Dump Valve	N (Ref. 17)
			1-FSV-1-103 B & D, 125 VDC, Batt Bd II / 1-FCV-1-103	
			1-FSV-1-104 B & D / 1-FCV-1-104	
			1-FSV-1-105 B & D / 1-FCV-1-105	
			1-FSV-1-106 B & D / 1-FCV-1-106	
			1-FSV-1-107 B & D / 1-FCV-1-107	
			1-FSV-1-108 B & D / 1-FCV-1-108	
			1-FSV-1-109 B & D / 1-FCV-1-109	
			1-FSV-1-110 B & D / 1-FCV-1-110	
			1-FSV-1-111 B & D / 1-FCV-1-111	
			1-FSV-1-112 B & D / 1-FCV-1-112	
			1-FSV-1-113 B & D / 1-FCV-1-113	
			1-FSV-1-114 B & D / 1-FCV-1-114	

TABLE VI-1
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING INSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
8. (Continued)			• 1-PCV-47-180, High Pressure Steam Seal Shutoff Valve.	N (Ref. 20)
			• Steam Header Traps (Local): 1-DRV-01A-532, SG Loop 3	Y (Ref. 6)
			1-DRV-01A-534, SG Loop 2	Y (Ref. 6)
			1-DRV-01A-536, SG Loop 1	Y (Ref. 6)
			1-DRV-01A-538, SG Loop 4	Y (Ref. 6)
			And 1-ISV-01A-540, Drain	Y (Ref. 6)
			1-ISV-01A-541, Drain	Y (Ref. 6)
			1-ISV-01A-542, Drain	Y (Ref. 6)
			1-ISV-01A-543, Drain	Y (Ref. 6)
			• If at least on intact SG can not be isolated from Ruptured SG, THEN go to ECA-3.1, "SGTR and LOCA-Subcooled Recovery".	
			<u>HP Steam to MSR's</u> 1-HS-001-135A, MSR A2 HP Stm Isol	N (Ref. 6)
			1-HS-001-137A, MSR B2 HP Stm Isol	N (Ref. 6)
			1-HS-001-139A, MSR C2 HP Stm Isol	N (Ref. 6)
			1-HS-001-141A, MSR A1 HP Stm Isol	N (Ref. 6)
			1-HS-001-143A, MSR B1 HP Stm Isol	N (Ref. 6)
			1-HS-001-145A, MSR C1 HP Stm Isol	N (Ref. 6)
			1-HS-001-235A, MSR A2 HP Stm Bypass Isol	N (Ref. 6)
			1-HS-001-237A, MSR B2 HP Stm Bypass Isol	N (Ref. 6)
			1-HS-001-239A, MSR C2 HP Stm Bypass Isol	N (Ref. 6)
			1-HS-001-241A, MSR A1 HP Stm Bypass Isol	N (Ref. 6)
			1-HS-001-243A, MSR B1 HP Stm Bypass Isol	N (Ref. 6)
			1-HS-001-245A, MSR C1 HP Stm Bypass Isol	N (Ref. 6)
			<u>MFW Pump Turbines HP Stop Valves</u> 1-FCV-001-36 - Pump A	N (Ref. 6)
			1-FCV-001-43 - Pump B	N (Ref. 6)

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TABLE VI-1

COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST

FOR EMERGENCY OPERATING INSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
9. When Ruptured SG NR level is > 10% [35% ADV CNTMT], THEN isolate AFW to Ruptured SG. 2	• HS SG3 1-3-148 (& 148A) 125V DC Vital Battery Bd II • HS SG2 1-3-156 (& 156A) 125V DC Vital Battery Bd I • HS SG1 1-3-164 (& 164A) 125V DC Vital Battery Bd I • HS SG4 1-3-171 (& 171A) 125V DC Vital Battery Bd II	Y (Ref. 3) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3)	• MAINTAIN AFW flow to Ruptured SG until NR level is > 10% [35% ADV CNTMT]. Same as principal instrument entry.	Y (Ref. 3) R1
10. Check Pzr PORVs Closed	1-XS-068-340C 1-XS-068-334C	Y (Ref. 9) Y (Ref. 9)	If RCS pressure < 2235 psig, THEN close Pzr PORV or block valve. 1-XS-68-340C OR 1-XS-068-333 1-XS-68-334C OR 1-XS-068-332 If PZR PORV or block valve can NOT be closed, THEN GO TO ECA-3.1, "SGTR and LOCA - Subcooled Recovery".	Y (Ref. 9)
11. CHECK Pzr Safety Valves CLOSED. a. Tailpipe temp. or acoustic monitor NORMAL.	1-XI-68-363 1-XI 68-364 1-XI-68-365 1-TI-68-328 1-TI-68-329 1-TI-68-330	N (Ref. 9) N (Ref. 9)	If Pzr Safety Valves NOT closed, THEN go to ECA-3.1, "SGTR and LOCA-Subcooled Recovery".	N (Ref. 9)
12. CHECK Ruptured SG pressure. a. Press > 675 psig. b. Press STABLE or INCREASING.	Steam Generator Pressure Transmitters SG1-PT-1-1B PT-1-2A SG2-PT-1-9A PT-1-9B SG3-PT-1-20A PT-1-20B SG4-PT-1-27A PT-1-27B	Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6)	a. Go to ECA-3.1, "SGTR and LOCA-Subcooled Recovery". b. If Ruptured SG is also faulted, THEN go to ECA-3.1, "SGTR and LOCA-Subcooled Recovery".	

TABLE VI-1
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST FOR EMERGENCY OPERATING INSTRUCTION (EOI), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
13. INITIATE RCS Cooldown				
*a. DETERMINE maximum temperature from Table below.	1-TI-068-0001 & 0001C (SG Loop 1) 1-PT-1-1B & -2A 1-TI-068-024A & 0024C (SG Loop 2) 1-PT-1-9A & -9B 1-TI-068-0043 & 0043C (SG Loop 3) 1-PT-1-20A & -20B 1-TI-068-068-0065 & 0065C (SG Loop 4) 1-PT-1-27A & -27B	Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6) Y (Ref. 6)		
*b. INITIATE rapid RCS cooldown to maximum temperature.	Same as Step c backup equipment below on right side of this page.	Y (Ref. 6)		
c. IF condenser available, THEN USE steam dumps from intact SGs.	For base case the LOOP is included, therefore, condenser steam dumps are not available.		c. If condenser NOT available, THEN use intact SG PORV. • SG1 Vlv 1-PCV-001-0005 (1-ZT-001-0005) • SG2 Vlv 1-PCV-001-0012 (1-ZT-001-0012) • SG3 Vlv 1-PCV-001-0023 (1-ZT-001-0023) • SG4 Vlv 1-PCV-001-0030 (1-ZT-001-0030)	 N (Ref. 6) N (Ref. 6) N (Ref. 6) N (Ref. 6)

* TABLE - MAXIMUM TEMPERATURE FOR RCS DEPRESSURIZATION

RUPTURED SG PRESS.	MAX. RCS TEMPERATURE FOR INTACT SG LOOPS
1100 psig	515 °F
1000 psig	505 °F
900 psig	490 °F
800 psig	480 °F
700 psig	460 °F
600 psig	445 °F

R1

R1

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
14. DEPRESSURIZATION RCS to ≤ Ruptured SG Press.				
a. MAINTAIN subcooling > 40°F.	• RCS Subcooling Monitor 1-XI-68-100 1-XI-68-110	 Y (Ref. 36) Y (Ref. 36)		
b. USE normal pzr sprays.	• 1-PM-068-340J • 1-PM-068-340K	N (Ref. 9) N (Ref. 9)	b. IF normal sprays NOT available, THEN USE one pzr PORV and NOTE the following: 1-XS-068-340C 1-XS-068-334C 1. Upper head may void 2. MINIMIZE cycling PORV 3. PRT may rupture If both normal sprays AND PORVs NOT available, THEN USE aux spray: 1-X1-068-0340B (Open). If RCS press control can NOT be established, THEN GO TO ECA-3.3, "SGTR Without Pzr Pressure Control".	Y (Ref. 9) Y (Ref. 9) Y (Ref. 9)
c. IF Pzr level ≥ 70%, THEN STOP depressurization.	1-PM-068-340J 1-PM-068-340K 1-XS-068-340C 1-XS-068-334C	N (Ref. 9) N (Ref. 9) Y (Ref. 9) Y (Ref. 9)	c. IF RCS uncontrolled depressuriztion can NOT be stopped, THEN CONSIDER following actions: STOP RCP associated with failed spray valve. CLOSE pzr PORV block valve: 1-FCV-068-0332 or 1-FCV-068-0333. ISOLATE aux spray by closing FCV-62-90 or 91.	 Y (Ref. 9) Y (Ref. 21)

R1

TABL[illegible]

COMPREHENSIVE EQUIPM[illegible]ND INSTRUMENT LIST

FOR EMERGENCY OPERATIN[illegible]NSTRUCTION (EOI), E-3

R1

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
15. CHECK if SI can be terminated.				
a. RCS subcooling > 40•°F	1-XI-68-100 1-XI-68-110	Y (Ref. 36) Y (Ref. 36)	a. DO NOT TERMINATE SI: GO TO ECA-3.1, "SGTR and LOCA-Subcooling, Recovery"	
b. RCS press STABLE or INCREASING	1-PI-68-342A 1-PI-68-334 1-PI-68-322	N N N	b. DO NOT TERMINATE SI" GO TO ECA-3.1, "SGTR and LOCA - Subcooling Recovery"	
c. NR level in at least one intact SG > 10% [35% ADV CNTMT] OR Total AFW flow to intact SG > 470 gpm	<u>SG Narrow Range Level:</u> SG No. 1 (LT-3-38, LT-3-39, LT-3-42) SG No. 2 (LT-3-51, LT-3-52, LT-3-55) SG No. 3 (LT-3-93, LT-3-94, LT-3-97) SG No. 4 (LT-3-106, LT-3-107, LT-3-110) SG2 1-FI-003-0155 B/A SG1 1-FI-003-0163 B/A SG4 1-FI-003-0170 B/A SG3 1-FI-003-0147 B/A	Y (Ref. 2, 3) Y (Ref. 2, 3) Y (Ref. 2, 3) Y (Ref. 2, 3) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3)	c. DO NOT TERMINATE SI: GO TO ECA-3.1, "SGTR and LOCA-Subcooling Recovery"	
d. Pzr Level > 20% [50% ADV CNTMT]	1-LT-068-0320 1-LT-068-0321	Y (Ref. 9) Y (Ref. 9)	d. IF all SI termination criteria satisfied EXCEPT pzr level, THEN; • MAINTAIN ECCS flow • CONTINUE RCS cooldown and depressurization until pzr level > 20% [50% ADV CNTMT] WHEN criteria satisfied, THEN GO TO ES-3.1, "SI Termination Following SGTR"	
16. GO TO ES-3.1, "SI Termination Following SGTR"				

R1

WP5.1/COMPINST.WB/Debra

TAB[illegible]1
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING INSTRUCTION (EOI), ES-3.1

ES-3.1, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (ES-3.1, STEP #)	SAFETY RELATED (REF)
ES-3.1: SI Termination Following SGTR				
CAUTION:	IF offsite power is lost after SI reset, manual action will be required to restart the SI and RHR pumps.			
1. RESET/Block SI	1-HS-63-134A 1-HS-63-134B	Y (Ref. 22) Y (Ref. 22)	CHECK P-4 Interlock per SI-3.1.37	
2. RESET Phase A &.B	1-HS-30-63D 1-HS-30-63E 1-HS-30-64D 1-HS-30-64E	Y (Ref..23) Y (Ref. 23) Y (Ref. 23) Y (Ref. 23)		
3. STOP ECCS Pumps and place in AUTO.				
a. RHR Pumps	1-HS-74-10A, 20A 1-HS-74-10B, 20B	Y (Ref. 24) Y (Ref. 24)		
b. SI Pumps	1-HS-63-10A, 15A 1-HS-63-10B, 15B	Y (Ref. 22) Y (Ref. 22)		
c. All <u>except</u> one CCP.	1-HS-62-108A, 1A-A 1-HS-62-104A, 1B-B	Y (Ref. 21) Y (Ref. 21)		

R1

R1

TABLE 1
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING INSTRUCTION (EOI), ES-3.1

ES-3.1, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (ES-3.1, STEP #)	SAFETY RELATED (REF)
4. ENSURE Cntmt AIR in service				
a. Air compressors RUNNING	Absence of alarm			
b. Air supply valves OPEN	Valve 1-FCV-32-80 Valve 1-FCV-32-102 Valve 1-FCV-32-110	Y (Ref. 25) Y (Ref. 25) Y (Ref. 25)		
5. ALIGN Charging				
a. CLOSE	Valve 1-FCV-62-89	Y (Ref. 21)		
b. OPEN charging line	Valve 1-FCV-62-90 Valve 1-FCV-62-91	Y (Ref. 21) Y (Ref. 21)		
c. OPEN Valve	Valve 1-FCV-62-85 OR Valve 1-FCV-62-86	Y (Ref. 21) Y (Ref. 21)		
d. OPEN seal water return	Valve 1-FCV-62-61 Valve 1-FCV-62-63	Y (Ref. 21) Y (Ref. 21)		
6. ISOLATE BIT				
a. CLOSE BIT outlet	Valve 1-FCV-63-25 And Valve 1-FCV-63-26	Y (Ref. 22) Y (Ref. 22)		

R1

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COMPREHENSIVE EQUIP[illegible] AND INSTRUMENT LIST

FOR EMERGENCY OPERATING INSTRUCTION (EOI), ES-3.1

R1

ES-3.1, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (ES-3.1, STEP #)	SAFETY RELATED (REF)	
7. ESTABLISH Charging Flow					
a. ADJUST valves to establish following:					
1. Seal flow 6-12 gpm per RCP	RCP 1: 1-FI-62-8 RCP 2: 1-FI-62-21 RCP 3: 1-FI-62-34 RCP 4: 1-FI-62-47	N (Ref. 21) N (Ref. 21) N (Ref. 21) N (Ref. 21)			
2. Charging flow	1-FI-62-93	N (Ref. 21)			
8. ENSURE ECCS not required			Manually OPERATE ECCS pumps and charging as necessary, IF level or subcooling continue to decrease, THEN GO TO ECA-3.1, "SGTR and LOCA-Subcooled Recovery"		R1
a. Pzr level > 20% (50% ADV CNTMT)	1-LT-68-320 1-LT-68-321	Y (Ref. 9) N (Ref. 9)			
b. RCS Subcooling > 40°F	1-XI-68-100 1-XI-68-110	Y (Ref. 36) Y (Ref. 36)			
9. ESTABLISH Letdown			If letdown can NOT be established, THEN ESTABLISH excess letdown:		
a. ENSURE charging flow established	1-FI-62-93	Y (Ref. 21)			
b. OPEN letdown valves	1-FCV-62-69 1-FCV-62-70 1-FCV-62-77	Y (Ref. 21) Y (Ref. 21) Y (Ref. 21)			
c. PLACE HIC-62-81 in MANUAL and 25% OPEN	1-HIC-62-81	N (Ref. 21)	OPEN 1-FCV-70-143 1-FCV-70-85	Y (Ref. 26) Y (Ref. 26)	
d. OPEN letdown orifices as required			OPEN 1-FCV-62-54 1-FCV-62-55 1-FCV-62-56	Y (Ref. 21) Y (Ref. 21) Y (Ref. 21)	

TAB[illegible]2
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
1. REFER to EPIP-1, Emergency Plan Classification Logic	See Item 1, Table VI-1			
2. BYPASS Condensate DI	See Item 2, Table VI-1			
3. DISPATCH RADCON to survey secondary plant	See Item 3, Table VI-1			
4. NOTIFY CHEM LAB to obtain samples for identifying or confirming ruptured SG	See Item 3, Table VI-1			

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COMPREHENSIVE EQUIP[illegible] AND INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3.1

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
5. CHECK if RCPs should remain in service:				
a. Phase B isolation not actuated	1-XX-55-6C & 6D	N	a. STOP all RCPs	
			RC Pumps	
			RCP 1: 1-MTR-68-8, 1-HS-68-8AA	N (Ref. 9)
			RCP 2: 1-MTR-68-31, 1-HS-68-31AA	N (Ref. 9)
			RCP 3: 1-MTR-68-50, 1-HS-68-50AA	N (Ref. 9)
			RCP 4: 1-MTR-68-73, 1-HS-68-73A	N (Ref. 9)
b. RCS pressure greater than 1400 psig	PI-68-322	N (Ref. 9)	b. IF RCS pressure decreasing uncontrolled, THEN; ENSURE at least one charging pump or SI pump injecting.	
	PI-68-323	N (Ref. 9)		
	PI-68-334	N (Ref. 9)		
	PI-68-340A	N (Ref. 9)		
	1-XX-55-6E & 6F	N	Charging Pumps	
			1-FI-63-170	N (Ref. 22)
			SI Pumps	
			1-FI-63-151	N (Ref. 22)
			1-FI-63-20	N (Ref. 22)
			WHEN injection flow established, THEN; STOP all RCPs.	

TABLE VI-2
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

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E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
6. IDENTIFY Ruptured SG based on any of the following: • Unexpected rise in SG level • SG blowdown rad monitor recorder high radiation • steam line rad monitor high radiation • RADCON survey • CHEM LAB sample CAUTION: NOTE:	See Item 4, Table VI-1 If turbine-driven AFW pump is the only available source of feed flow, then steam supply to the turbine-driven AFW pump must be maintained. WHEN ruptured SG identified THEN; PERFORM STeps 7 thru 12.			
7. ENSURE TD AFW pump being supplied from intact SG	See Item 7, Table VI-1		IF both SG1 and SG4 ruptured, THEN; ENSURE at least one MD AFW pump aligned to an intact SG, and ISOLATE steam to the AFW pump. See Item 7, Table VI-1.	
8. ENSURE ruptured SG blowdown isolated. CAUTION:	See Item 6, Table VI-1 At least one SG must be maintained available for RCS cooldown.		See Item 6, Table VI-1	

TABLE VI-2
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
9. ENSURE ruptured SG PORV aligned: a. ENSURE controller in AUTO set at 89% b. ENSURE HS in P-Auto c. WHEN ruptured SG pressure less than 1160 psig, THEN; • ENSURE ruptured SG PORV closed OR • OBTAIN RADCON support, and locally CLOSE isolation valve.	See Item 5, Table VI-1		See Item 5, Table VI-1	
10. CLOSE ruptured SG MSIV and bypass valve.	See Item 8, Table VI-1		See Item 8, Table VI-1	

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E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
11. IF ruptured SG releases to atmosphere THEN; NOTIFY plant personnel over PA system				
CAUTION:	If any ruptured SG is also faulted, feed flow should remain isolated in subsequent steps.			
12. MONITOR ruptured SG level: a. IF SG is both ruptured and faulted, THEN; GO to Step 13 b. WHEN ruptured SG NR greater than 10% [35% ADV], THEN; ISOLATE AFW to ruptured SG	See Item 9, Table VI-1		See Item 9, Table VI-1	
13. MONITOR pzr PORVs and block valves: a. Pzr PORVs CLOSED	See Item 10, Table VI-1		a. IF pzr press less than 2335 psig, THEN; ENSURE pzr PORV or associated block valve CLOSED. See Item 10, Table VI-1	
b. At least one block valve OPEN.	1-HS-68-332A 1-HS-68-333A	Y (Ref. 9) Y (Ref. 9)	b. See Item 10, Table VI-1	

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COMPREHENSIVE EQUIPM[illegible]ND INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
14. CHECK pzr safety valves CLOSED · Tailpipe temperatures or accoustic monitors normal	See Item 11, Table VI-1		See Item 11, Table VI-1	
15. CHECK SG pressure: · All SG press. controlled or increasing · All SG press greater than 150 psig.	See Item 12, Table VI-1		If faulted SG has not been isolated, and faulted SG is <u>not</u> needed for RCS cooldown, THEN; GO to E-2, Faulted Steam Generator Isolation	
16. MONITOR CST volume greater than 200,000 gal.	1-LS-2-229A 1-LT-2-230	N N	Initiate CST refill. If CST volume decreases to less than 10,000 gal. THEN; ENSURE ERCW aligned to AFW. 1-FCV-3-136A&B 1-FCV-3-179A&B 1-FCV-3-116A&B 1-FCV-3-126A&B	 Y (Ref. 3) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3)
17. MONITOR intact SG NR levels: a. At least one intact SG NR greater than 10% [35% ADV] b. SG NR less than 50% and controlled	See Item 9, Table VI-1		a. ENSURE feed flow greater than 470 gpm. SG1: 1-FI-003-0163 B/A SG2: 1-FI-003-0155 B/A SG3: 1-FI-004-0147 B/A SG4: 1-FI-005-0170 B/A b. If level in any unisolated SG continues to increase with no feed flow, THEN; GO to Step 6.	 Y (Ref. 3) Y (Ref. 3) Y (Ref. 3) Y (Ref. 3)
18. CONTROL intact SG NR levels between 10% and 50% [35% and 50% ADV]	See Item 15, Table VI-1		See Item 15, Table VI-1	

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TABLE [illegible]
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
19. MONITOR all AC busses ENERGIZED by offsite power. CAUTION:	 Manual action may be required to restart SI and RHR pumps if offsite power is lost after SI reset.		If power is lost to any electrical board, THEN; • RESTORE offsite power using AOI-35, loss of offsite power. • RESTORE power to affected AC boards using the applicable system operating instructions.	
20. RESET SI, and CHECK the following: • SI actuated permissive DARK • AUTO SI blocked permissive LIT	See ES-3.1 Item 1, Table VI-1		Notify IMs to block Auto SI using 0, Auto SI block. See ES-3.1, Item 1, Table VI-1	
21. RESET Phase A and Phase B	See ES-3.1 Item 2, Table VI-1		See ES-3.1, Item 2, Table VI-1	
22. ENSURE containment air in service a. Aux. air pressure greater than 70 psig [M-15]. b. Cntmnt air supply valves OPEN [M-15] • FCV-32-80 • FCV-32-102 • FCV-32-110	See ES-3.1 Item 4, Table VI-1 0-PI-32-104A 0-PI-32-105A	 N N		

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TABL[illegible]

COMPREHENSIVE EQUIPME[illegible]ND INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
23. DETERMINE if RHR pumps should be stopped: a. CHECK RCS pressure greater than 180 psig b. STOP RHR pumps, and PLACE in A-Auto c. IF RCS press decreases to 180 psig, THEN; manually restart RHR pumps	See Item 15.b, Table VI-1 See ES-3.1, Item 3, Table VI-1 RHR Pump 1A-A, 1-HS-74-10A 1B-B, 1-HS-74-20A	 Y (Ref. 24) Y (Ref. 24)	a. If press less than or equal to 180 psig THEN; GO to Step 24.	
24. CHECK *ruptured* SG isolated from intact SGs	See Item 8, Table VI-1		See Item 8, Table VI-1	
25. MONITOR ruptured SG pressure greater than 200 psig	See Item 12, Table VI-1		See Item 12, Table VI-1	

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
26. DETERMINE target incore temp. based on ruptured SG press., for use during RCS cooldown (See Table below)	See Item 13, Table VI-1		See Item 13, Table VI-1	
CAUTION:	The 1400 psig RCP trip criteria is <u>not</u> applicable during a controlled RCS cooldown and depressurization.			

Ruptured SG Press (Psig)	Target Incore Temp (°F)
1100	505
1000	495
900	480
800	465
700	450
600	430
500	405
400	380
300	345
200	330

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TABL[illegible]2
COMPREHENSIVE EQUIPM[illegible]ND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
27. INITIATE RCS cooldown to target incore temp. determined from Step 26: a. USE condenser steam dumps to cooldown incore temp. to target. b. WHEN RCS pressure less than 1970 psig THEN; ENSURE Auto SI blocked. c. DO NOT continue this instruction <u>until</u> incore temp. less than or equal to target. d. MAINTAIN incore temp. less than or equal to target.	See Item 13, Table VI-1 See Item 15.b, Table VI-1		a. See Item 13, Table VI-1 IF intact SG <u>not</u> available, THEN; perform <u>one</u> but not both of the following: a) USE faulted SG OR b) GO TO ECA-3.1, SGTR and LOCA-Subcooled Recovery	
28. MONITOR ruptured SG press. at least 250 psig above the press of the SGs used for cooldown	See Item 12, Table VI-1		GO TO ECA-3.1, SGTR and LOCA-Subcooled Recovery	
29. CHECK RCS subcooling greater than 60°F <u>CAUTION:</u>	See Item 15a, Table VI-1 Cycling of the pzr PORV should be minimized to increase PORV reliability		Go to ECA-3.1, SGTR and LOCA-Subcooled Recovery	

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TABL[illegible]
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
30. **INITIATE RCS** depressurization to minimize break flow, and refill pzr: a. CHECK pzr level less than 65% b. MAINTAIN RCS subcooling greater than 40°F c. USE normal pzr sprays	See Item 14, Table VI-1		See Item 14b, Table VI-1 a. *If pzr greater than or equal to 65%* THEN; GO TO Caution prior to Step 32 c. IF normal sprays <u>not</u> available THEN; USE one pzr PORV, and monitor the following: · Vessel head void formation · PRT rupture IF both normal sprays <u>and</u> pzr PORVs <u>not</u> available, THEN; use Aux. spray.	
<u>CAUTION:</u>	As RCS pressure approaches *ruptured* SG press., the depressurization rate should be adjusted to prevent rapid changes in SG press and level.			

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
31. DETERMINE if RCS depressurization should be stopped: a. CONTINUE RCS depressurization until one of the following: • RCS press. less than ruptured SG OR • Pzr level increases to greater than 65% OR • RCS subcooling decreases to less than 40°F b. CHECK Pzr level greater than 10% [20% ADV] c. WHEN depressurization criteria satisfied, THEN; ENSURE the following: 1) Normal pzr spray valves closed 2) Aux. spray valves closed 3) Pzr PORVs closed	See Items 14 & 15.b, Table VI-1		See Item 14 & 15.b, Table VI-1 b. MAINTAIN ECCS injection <u>and</u> control RCS press. less than ruptured SG press. until pzr level greater than 10% [20% ADV]. c. Perform the following as applicable: 1) STOP RCP associated with failed spray valve 2) ISOLATE aux. spray by closing FCV-62-90 or FCV-62-91. 3) CLOSE associated PORV block valve: 1-FCV-68-332 or 1-FCV-68-333	Y (Ref. 21) Y (Ref. 9)

TABLE V[illegible]

COMPREHENSIVE EQUIPMENT [illegible] INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
CAUTION:	SI should be terminated as quickly as possible after termination criteria are met to prevent ruptured SG overfill.			
32. CHECK SI termination criteria: a. RCS subcooling greater than 40°F. b. Secondary heat sink available with either: 1) Total feed flow greater than 470 gpm available OR 2) At least one intact SG NR greater than 10% [35% ADV]. c. RCS press stable or increasing. d. Pzr level greater than 10% [20% ADV].	See Item 15, Table VI-1		a. GO TO ECA-3.1, SGTR and LOCA-Subcooled Recovery. b. GO TO FR-H.1, Loss of Heat Sink c. GO TO ECA-3.1, SGTR and LOCA-Subcooled Recovery d. IF level less than or equal to 10% [20% ADV] THEN; GO to Step 25.	
33. STOP ECCS pumps and place in A-Auto · RHR pumps · SI pumps · All but one charging pump	See ES-3.1, Item 3, Table VI-1			

TABLE V

COMPREHENSIVE EQUIPMENT [illegible] INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
34. ALIGN charging a. CLOSE RCP seal flow control FCV-62-89 b. OPEN charging isolation FCV-62-90 and FCV-62-91 c. ENSURE charging FCV-62-85 or FCV-62-86 OPEN d. OPEN seal return FCV-62-61 and FCV-62-63	See ES-3.1, Item 5, Table VI-1			
35. CLOSE BIT outlet valves FCV-63-25 and FCV-63-26	See ES-3.1, Item 6, Table VI-1			
36. CONTROL Charging Flow: a. ADJUST FCV-62-89 and FCV-62-93 to establish: · Seal injection flow between 8 and 13 gpm for each RCP. · Pzr level stable or increasing.	See ES-3.1, Item 7, Table VI-1			
37. ENSURE ECCS flow not required: a. RCS subcooling greater than 40°F b. Pzr level greater than 10% [20% ADV]	See Item 15, Table VI-1		Manually operate ECCS pumps as necessary. GO TO ECA-3.1, SGTR and LOCA-Subcooled Recovery	

TABLE V
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
38. DETERMINE if containment spray should be stopped:	See ES-3.1, Item 8, Table VI-1			
a. CHECK spray pumps running	Pump A, 1-FI-72-34 Pump B, 1-FI-72-13	N (Ref. 31) N (Ref. 31)	a. IF spray pumps <u>not</u> running, THEN, GO TO Step 39.	
b. CHECK containment pressure less than 2.0 psid	<u>Inside Containment</u> 1-PDT-30-42 1-PDT-30-43 1-PDT-30-44 1-PDT-30-45	 Y (Ref. 32) Y (Ref. 32) Y (Ref. 32) Y (Ref. 32)	b. WHEN containment pressure less than 2.0 psid, THEN, PERFORM substeps 38c thru f.	
	<u>RB Annulus</u> 1-PDT-65-80 1-PDT-65-82 1-PDT-65-90 1-PDT-65-97	 Y (Ref. 33) Y (Ref. 33) Y (Ref. 33) Y (Ref. 33)		
c. RESET cntmt spray signal				
d. STOP cntmt spray pumps and place in A-Auto	CS Pump A, 1-HS-72-27A CS Pump B, 1-HS-72-10A	Y (Ref. 31) Y (Ref. 31)		
e. CLOSE cntmt spray discharge valves FCV-72-2 and FCV-72-39	e. FCV-72-2 FCV-72-39	Y (Ref. 31) Y (Ref. 31)		
f. ENSURE miniflow valves FCV-72-13A and FCV-72-34A in Auto	f. FCV-72-13A FCV-72-34A	Y (Ref. 31) Y (Ref. 31)		

WP5.1/COMPINST.WB/Debra

TABLE [illegible]
COMPREHENSIVE EQUIPMEN[illegible]D INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
39. DETERMINE if letdown can be established: a. CHECK pzr level greater than 20% [35% ADV]	See Item 15, Table VI-1		a. WHEN pzr level greater than 20% [35% ADV], THEN, perform Substep 396 GO TO Step 40	
b. ESTABLISH letdown:	See ES-3.1, Item 9, Table VI-1		b. ESTABLISH excess letdown	
1) OPEN letdown isolation valves:			a) OPEN FCV-70-143	Y (Ref. 26)
			b) OPEN FCV-70-85	Y (Ref. 26)
2) PLACE letdown press. controller HIC-62-81 in manual at 25% open			c) OPEN FCV-62-54	Y (Ref. 21)
			d) OPEN FCV-62-55	Y (Ref. 21)
			e) ENSURE FCV-62-59 in NORMAL	Y (Ref. 21)
			f) MAINTAIN excess letdown heat exchanger outlet temp. less than 200°F. 1-TI-62-58.	N (Ref. 21)
3) OPEN orifice isolation valve as needed:	1-FCV-62-72	Y (Ref. 21)	g) OPEN FCV-62-56	Y (Ref. 21)
	1-FCV-62-73	Y (Ref. 21)		
	1-FCV-62-74	Y (Ref. 21)		
	1-FCV-62-76	Y (Ref. 21)		
4) ADJUST HIC-62-81 for desired press., 320 psig at normal letdonw temp.				
5) PLACE HIC-62-81 in Auto				
40. ENSURE VCT makeup in Auto, and set for present RCS boron concentration.	1-HS-62-140A -140B	N (Ref. 21) N (Ref. 21)		

TABLE V

COMPREHENSIVE EQUIPMENT [illegible] INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
41. ALIGN charging pump suction to VCT:				
a. OPEN VCT outlet valves	LCV-62-132 LCV-62-133	Y (Ref. 21) Y (Ref. 21)		
b. CLOSE RWST valves	LCV-62-135 LCV-62-136	Y (Ref. 21) Y (Ref. 21)		
c. ENSURE HSs in A-P Auto	Recip. 1C : 1-HS-62-101A Cent. 1B-B: 1-HS-62-104A Cent. 1A-A: 1-HS-62-108A	N (Ref. 21) Y (Ref. 21) Y (Ref. 21)		

TABLE [illegible]

COMPREHENSIVE EQUIPMEN[illegible]D INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
CAUTION:	RCS and Ruptured SG press. must be maintained less than Ruptured SG PORV setpoint (1160 psig).			
CAUTION:	Cycling of the pzr PORV should be minimized to increase PORV reliability.			
42. CONTROL RCS press and makeup flow to minimize RCS-to-secondary leakage:				
a. MAINTAIN pzr level between 20% and 65% [35% and 65% ADV]:	See Item 15.d, Table VI-1			
• ADJUST charging flow	See ES-3.1, Item 7, Table VI-1			
• OPERATE letdown orifice valves as needed	See Item 39, Table VI-2			
• ADJUST letdown press. control valve	See Item 9, Table VI-1			
b. MAINTAIN RCS press. at ruptured SG press:	See Item 14, Table VI-1		b. See Item 14, Table VI-1. IF letdown in service, THEN, USE aux. spray.	
• Control pzr heaters	1-HS-68-341A 1-HS-68-341D	Y (Ref. 9) Y (Ref. 9)	IF letdown not in service THEN, use one pzr PORV, and MONITOR the following: • Vessel head void formation • Pzr level increases • PRT rupture	
• USE pzr normal sprays as necessary				

TABLE [illegible]

COMPREHENSIVE EQUIPMEN[illegible]D INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
43. DETERMINE shutdown board alignment: a. CHECK offsite power available b. ENSURE all shutdown boards energized by offsite power c. PLACE any unloaded DG in standby using SOI-82, Diesel Generators	1-EI-57-39 1-EI-57-66	N (Ref. 35) N (Ref. 35)	a. RESTORE offsite power using AOI-35, loss of offsite power	
44. MINIMIZE secondary system contamination: a. ENSURE turbine bldg. sump aligned to unlined holding pond b. ISOLATE unlined holding pond from diffuser pond c. MINIMIZE leakage or drainage to turbine building sump d. ENSURE condensate DI bypassed e. CHECK hotwell activity NORMAL	a. Local alignment of several manual valves b. Local alignment of several manual valves c. Local alignment of several manual valves d. 1-FCV-14-3 e. 1-RM-90-99 1-RM-90-119	d. N (Ref. 1) e. N (Ref. 4) N (Ref. 4)	a. IF unable to align to unlined holding pond, THEN NOTIFY Chem Lab to periodically sample turbine building sump. e. PLACE dump back valve to CST in MANUAL, and CLOSE valve	

TABLE [illegible]
COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
45. MAINTAIN RCS press. at ruptured SG press.				
a. CONTROL pzr heaters as necessary	1-HS-68-341A 1-HS-68-341D	Y (Ref. 9) Y (Ref. 9)		

TABLE

COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
NOTE:	Loop 2 RCP is the preferred RCP for operation.			
46. DETERMINE RCP status:				
a. CHECK at least one RCP running.	RC Loop 1: 1-FT-68-6A, -6B, -6D RC Loop 2: 1-FT-68-29A, -29B, -29D RC Loop 3: 1-FT-68-48A, -48B, -48D RC Loop 4: 1-FT-68-71A, -71B, -71D 1-XX-55-6C & 6D	Y (Ref. 9) Y (Ref. 9) Y (Ref. 9) Y (Ref. 9)	a. DETERMINE if an RCP can be started 1) REFER to SOI-68.2, Reactor Coolant Pumps 2) IF RVLIS less than 95% THEN, ESTABLISH the following to accommodate void collapse: · Pzr level greater than 90% · RCS subcooling greater than 80°F 3) WHEN RCP start conditions established, THEN, START one RCP.	
			IF an RCP can not be started, THEN, MONITOR natural circulation: · RCS subcooling 1-XI-68-100, 1-XI-68-110 · SG pressure stable or decreasing See Table VI-1, Item 12 · T-hot stable or decreasing	
			1-TI-68-1 1-TI-68-24A 1-TI-68-43 1-TI-68-65	Y (Ref. 9) Y (Ref. 9) Y (Ref. 9) Y (Ref. 9)
			· Incore T/Cs stable or decreasing · T-cold at saturation temp. for SG press.	
			1-TI-68-18 1-TI-68-41 1-TI-68-60 1-TI-68-83	Y (Ref. 9) Y (Ref. 9) Y (Ref. 9) Y (Ref. 9)
			IF natural circulation not established, THEN, INCREASE feed flow and steam dump flow	

TABLE

COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST
FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
47. STOP all but one RCP	See Item 5, Table VI-2			
48. INITIATE BOP realignment: · REFER to AOI-17, Turbine Trip				
49. ENSURE nuclear instrumentation operation: a. CHECK intermediate range flux less than 10^{-10} amps b. CHECK source range monitors energized c. SELECT one SRM and one IRM on NR-45 d. ENSURE audio count rate operation			a. WHEN intermediate range flux less than 10^{-10} amps, THEN, PERFORM substeps 49b thru d. GO TO Step 50. b. EVALUATE manual restoration of source range operation.	

TABLE V

COMPREHENSIVE EQUIPMENT AND INSTRUMENT LIST

FOR EMERGENCY OPERATING PROCEDURE (EOP), E-3

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
50. INITIATE surveillance and reports: a. NOTIFY IMs to check P-4 contacts using SI-3.1.37, verification of P-4 interlock. b. IF reactor power decreased by greater than or equal to 15% THEN, NOTIFY Chem Lab to sample RCS using SI-4.10, Radioactive Gaseous. c. PERFORM shutdown margin calc using SI-1.3, shutdown margin. d. INITIATE PAI-2.04 Reactor Trip Report. e. NOTIFY NRC of reactor trip using SSP-4.05, NRC reporting requirements.	P-4 contacts			

E-3, Step #	PRINCIPAL INSTRUMENTS AND EQUIPMENT	SAFETY RELATED (REF)	BACKUP EQUIPMENT (E-3, STEP #)	SAFETY RELATED (REF)
51. GO TO appropriate post-SGTR cooldown method: a. GO TO ES-3.1, Post-SGTR Cooldown Using Backfill OR b. GO TO ES-3.2, Post SGTR Cooldown by Ruptured SG Depressurization.	ES-3.1, Post SGTR Cooldown Using Backfill, is the preferred cooldown instruction due to reduced radiation releases; however, this cooldown method will be slow. ES-3.2, Post-SGTR Cooldown by Ruptured SG Depressurization, should not be used because the ruptured SG will be depressurized to the secondary system. Only in an extreme emergency which requires a rapid RCS cooldown should ES-3.2 be considered.			

VII. PRESSURIZER AND STEAM GENERATOR PORVs

a. Pressurizer PORVs: The pressurizer PORVs are used in the optimal recovery to depressurize the reactor coolant system (RCS) if normal pressurizer spray is unavailable (i.e., during loss of offsite power) and when high point venting is required.

The Pressurizer PORVs (PCV-68-334 and PCV-68-340A) are Target Rock Model Number 82-UU-001 pilot actuated to open Solenoid valves which respond to a signal from the pressure sensing system or to manual control. A coincident high pressure signal from two independent channels is needed for the actuation of each PORV. The valves are in compliance with NUREG-0737 (Section II.B.1) for high point venting of the pressurizer. PCV-68-340A and PCV-68-334 are safety grade with control power supplied from 1E power 125V dc vital battery board I (Train A) and vital battery board II (Train B), respectively (Reference 15 and 16).

b. Steam Generator PORVs: The SG PORVs provide a means for plant cooldown by discharging steam to the atmosphere when either the condenser, the condenser circulation water pumps, or the steam dump valves are not available (Reference 17) such as during loss of offsite power. The unit cooldown can be administratively controlled to minimize the amount of steam released from the affected steam generator (Reference 17).

The SG PORVs are Copes-Vulcan (Requisition No. 76K51-83081) 900 lb. pressure class air operated fail- closed globe valves. The valves are Safety Class 2a (TVA Class B), seismic Category I and environmentally |R1
qualified. The limiting failure is loss of air supply on power, however, the valves can be operated by manual action within one hour after trip (Operator action outside containment), (Reference 17 and 18). None of these controls are safety grade and are not redundant, i.e., not single failure proof.

The SG-PORVs have two-step control provisions. There are redundant pressure sensors and pressure controllers set to automatically start opening the SG-PORVs when the main steamline pressure exceeds 1125 psig and have them fully open when the pressure is 1190 psig. The proportional band for the SG-PORV pressure controllers is 65 psig. Additionally, whenever the steam pressure exceeds 1140 psig,

VII. PRESSURIZER AND STEAM GENERATOR PORVS (Cont'd)

and the rate of pressure increase is faster than the SG-PORV pressure controller can respond to, a pressure switch will open the SG-PORVs to the 100% open position. The valves may be manually operated from a local control station via a manual valve controller which regulates the air signal on the valves' positioners. Again, none of these controls are safety grade. However, a pair of safety grade solenoid valves are integrated with the SG-PORV MCR handswitches to allow for operator action for quick-opening and positive closing of the SG-PORVs in the event there are malfunctions in any of the non-safety grade SG-PORV controls (Reference 17).

A recent design modification for WBN Unit 1 added a backup air supply for the SG PORvs. (A similar modification is planned for Unit 2.) This backup supply consists of cylinders of compressed nitrogen that are locally connected to the control air lines for the SG PORVs through anarrangement of check valves and solenoid-operated isolation valves. If the normal control air supply to a SG PORV is lost, the backup compressed nitrogen can be manually aligned to permit continued operation of the SG PORV via its remote control circuitry. The addition of this design modification significantly reduces the possible need to operate a SG PORV manually. R2

Table VII-1 below summarizes the SG PORV 1E power supply sources (Reference 19). R2

TABLE VII-1

SG	POWER OPERATED RELIEF VALVE	CONTROL POWER TRAIN	1E POWER SUPPLY BOARD
4	PCV-1-30	B	125V dc Supply Battery BD IV-C40
1	PCV-1-5	A	125V dc Supply Battery BD III-C13
2	PCV-1-12	B	125V dc supply Battery BD II-B30
3	PCV-1-23	A	125V dc Supply Battery BD I-C15

R2

VIII. SINGLE FAILURES AND EQUIPMENT FAILURES LIST

A review of WCAP-10698 and WCAP-10698 Supplement 1 was performed to identify single failures/equipment failures which may adversely impact SGTR overfill and offsite dose mitigation. The following list presents the postulated failures with respect to decrease in margin to overfill.

PRINCIPAL EQUIPMENT
(Single Failure)

- AFW Level Control Valve | R2
- Ruptured Steam Generator PORV
- Main Steam Isolation Valve
- Steam Supply Valve for Turbine-Driven AFW Pump
- Main FW Flow Control Valve
- Emergency Diesel
- Intact SG PORV
- Pressurizer PORV
- SI Pump Switches
- BIT Isolation Valves

A number of single failures are identified which have nearly the same net impact on the conservative base case margin to overfill. For most single failures, the largest contribution to the decrease in margin to overfill is the increase in operator action time required to implement contingency actions. However, the worst single failure (with respect to margin to overfill) for the WCAP-10698 reference plant is the failure of a PORV on an intact steam generator to open, which increases the time necessary to cool the reactor coolant system and leads to the largest net decrease in margin to overfill.

VIII. SINGLE FAILURES AND EQUIPMENT FAILURES LIST (Continued)

Other single failures/equipment failures which were considered limiting with respect to decrease in margin to overfill are as follows: |R2

1. Failure of the AFW level control valve to close (stuck open) could lead to an increase of feedwater flow delivered to the ruptured steam generator. The additional flow delivered depends on the time required to perform contingency actions and the AFW flow capacity. The impact on margin to overfill is the increase in operator action time. |R2

2. Failure of one PORV to open on an intact steam generator decreased the available steam dump capacity by about 33 percent. Consequently, the increased cooldown time is expected to be bounded by the WCAP-10698 reference plant LOFTRAN-II results.

3. Failure of a pressurizer PORV to close would require the operator to isolate the failed valve by closing the associated block valve. Such a failure could also lead to upper head voiding which could potentially delay operator actions to terminate safety injection flow due to uncertainty with respect to reactor coolant inventory.

The results of the WCAP-10698 Supplement 1 evaluation indicate that the worst single failure with respect to the offsite dose is a failure to close (stuck-open) PORV on the ruptured steam generator. The radiation exposure for this single failure is dependent upon the time it takes to isolate the stuck-open PORV.

IX. SGTR EVENT SCENARIO LIST

A List of SGTR scenarios considered to be the most important based on a review of WCAP-10698 and Supplement 1 for which operator action and plant response times are required is presented in Table IX-1.

The SGTR event occurring at hot full power (HFP) followed by a loss of offsite power (LOOP) coincident with the reactor trip is considered to be the base case scenario as shown in Table IX-1. It is conservatively assumed that the accident is the complete severance of a single tube which occurs at end of life (EOL) core conditions in all scenarios.

The LOOP assumption tends to prolong the recovery operations, such as RCS cooldown and depressurization, which increases the total primary to secondary leakage and is therefore conservative.

The single equipment failure scenarios were selected from those considered in WCAP-10698 which were shown to be limiting or potentially limiting. The first single failure scenario shown in Table IX-1 (Scenario 3) was presented in WCAP-10698 and WCAP-10698 Supplement 1 to be the most limiting in terms of the radiological dose release to the environment. The second single failure (Scenario 4) was presented in WCAP-10698 to be the limiting event with respect to the increase in time necessary to cool the reactor coolant system and leads to the largest net decrease in margin to overfill. The third, and fourth single failure scenarios in Table IX-1 (Scenarios 5, and 6) were presented in WCAP-10698 to be almost equally limiting with respect to decrease to margin to overfill (the margin to steam generator overfill is defined as the steam space volume remaining below the steam generator outlet nozzle when the primary to secondary leak is terminated).

A failure to close the main steam line isolation valve (MSIV) upon occurrence of a ruptured steam generator (shown as Scenario 7 in Table IX-1) has also been shown in WCAP-10698 to be as limiting as the above three cases with respect to decrease in margin to overfill. Additionally, a failure in the main feedwater control valve to the faulted steam generator is shown in WCAP-10698 to be potentially limiting. The effects of this failure on the affected SG is similar to the failure of the auxiliary feedwater (AFW) control valve (shown as Scenarios 5 in Table IX-1) which can increase the feedwater delivery to the ruptured SG, thereby increasing water level. Considering the periods of operations for these two systems following a SGTR event, it is shown in WCAP-10698 that the failure of the AFW control valve is bounding. Therefore, the failure of main feedwater control valve is not included in Table IX-1.

IX. SGTR EVENT SCENARIO LIST (Continued)

In Attachment 1 through 6 to this report a plan is delineated for performing and documenting a varied group of control room operators responding to SGTR event scenarios using the WBN E-3 procedure and plant simulator. Nuclear Engineering requested that each event scenario listed in Attachment 2 be performed by 6 different 5 person operator crews to obtain realistic/representative sets of action/response times. The remaining attachments include recommendations to Operations to ensure that each SGTR event scenario is documented accordingly to substantiate the basis for plant specific operator action times used in resolving the SSER 5 Licensing Condition 41 of the Watts Bar draft license. |R1

A review of other utilities efforts on SGTR is presented in the following summary:

Plant Vogtle: The SGTR licensing submittal prepared for the Vogtle plants is considered to be the most comprehensive as deemed by Westinghouse and the NRC. An in-house RETRAN analysis of their plant was performed and then in conjunction with WCAP-10698 a SGTR scenario list was developed. The scenario list consisted of eight cases (some of which were performed four times by five sets of operator trainee crews).

The NRC had questions on the Plant Vogtle submittal and required them to install reach rods on their SG PORV isolation valves for closure of stuck open PORV. Additionally, lighting (for loss of offsite power cases) and approach ways were added to ensure safe access to the isolation valves.

South Texas Project: The SGTR licensing submittal experienced difficulties in meeting the 30 or so minute criteria for the single failure stuck open SG PORV when transition was made to a contingency EOP from E-3. The project plants have Westinghouse Model E type steam generators which potentially experience SG tube uncovery problems. Westinghouse has resolved that issue with a current computer model.

Shearon Harris: A Westinghouse three-loop SG plant. The NRC reviewed their initial SGTR submittal and required the Shearon Harris plant to qualify their pressurizer PORVs to safety grade status. Additionally, the SG PORVs were qualified to safety grade status by making them single failure proof.

The NRC required them to reperform some scenarios and resubmit the licensing submittal since plant specific information was not generated (they decided to use WCAP times which seemed conservative to them).

IX. SGTR EVENT SCENARIO LIST (Continued)

Diablo Canyon: The SGTR licensing submittal generated NRC questions in the following areas which required reperformance of additional SGTR scenarios by Operations:

1. Instrument/Plant response delay times seemed non-representative during some of the timed scenario evolutions.
2. Selection of limiting scenarios and limited number of operating crews performing scenarios (including randomness factor of performance).
3. Documentation and logging of operator action times.

TABLE [illegible]1
SGTR EVENT SCENARIO LIST
(Design Basis Single Tube Rupture at EOL Conditions)

SCENARIO NO.	SCENARIO ID	NO. OF CASES	CONCERN	DESCRIPTION	BASIS FOR SCENARIO SELECTION
1	SGTRA	1	Overfill	Hot Full Power (HFP) with Loss of Offsite Power (LOOP)	WCAP-10698, Section 4.2 Pg. 4-7 through 4-19 (Base case SGTR, DBA w/respect to overfill.
2	SGTRB	1	Overfill	HFP without LOOP.	WCAP-10698, Section 4.3 pg. 4-22 and Table 4.3-1, pg. 4-29. Note: Member utilities of the Westinghouse Owners Group (WOG) have been submitting these cases in their SGTR dockets so that effects of no LOOP may be evaluated both for plant response and operator action times.
3	SGTRC	1	Offsite Dose	HFP with LOOP and failure of ruptured SG PORV to close once opened (stuck open).	WCAP-10698-P-A, Supplement 1 pg. 23
4	SGTRD	1	Overfill	HFP with LOOP and failure of intact SG PORV to open.	WCAP-10698, Section 4.4.2 pg. 66, Section 4.5, pg. 4-95. WCAP-10698-P-A, Supplement 1, pg. 1, pg. 24.
5	SGTRE	1	Overfill	HFP with LOOP and Failure of AFW level control valve to ruptured SG to close once open (stuck open).	WCAP-10698, pg. 4-61. WCAP-10698-P-A, Supplement 1, pg. 24. |R2
6	SGTRF	1	Overfill	HFP with LOOP and Failure of Pressurizer PORV to close once open (stuck open).	WCAP-10698, pg. 4-73. WCAP-10698-P-A, Supplement 1, pg. 24.
7	SGTRG	1	Overfill	HFP with LOOP and Failure of MSIV on Faulted SG to close.	WCAP-10698, pg. 4-67. WCAP-10698-P-A, Supplement 1, pg. 24.

X. RADIATION MONITORING SYSTEM

Watts Bar provides radiation monitors for each of the main steam lines, the condenser vacuum pump exhaust, and the steam generator blowdown lines, specifically:

- RE-90-421A,B, RE-90-422A,B, RE-90-423A,B, and RE-90-424A,B are the main steam line monitors. The purpose of these monitors is to detect steam generator tube leakage and to monitor this potential release path. One detector is used on each main steam line upstream of the main steam line isolation and atmospheric dump valves. These monitors are safety grade (Reference 5).

- RE-90-129, RE-90-99, and RE-90-119 are the condenser particulate, iodine, and noble gas monitors. The purpose of these monitors is to continuously measure activity in the effluent release from the condenser vacuum exhaust (which is indicative of a primary to secondary system leak). These monitors are non-safety grade (Reference 5). | R2

- RE-90-120, RE-90-121 and RE-90-124 are the steam generator sample liquid effluent and process monitors. The purpose of these monitors are to monitor the liquid phase of the secondary side of the steam generators for activity in the event of a primary-to-secondary leak. These monitors are non-safety grade (Reference 5).

XI. STEAM GENERATOR CHEMISTRY SAMPLING

In Section 15.4.3 of Watts Bar SSER 5 entitled, " Steam Generator Tube Rupture", the NRC states that if the EOIs or EOPs specify steam generator sampling as a means of ruptured steam generator identification, provide the expected time period for obtaining the sample results and discuss the effect on the duration of the accident.

Step 3 of the latest version of EOI E-3, "Steam Generator Tube Rupture", specifies that the ruptured Steam Generator (SG) be identified by performing the following sub-steps: R2

a. Unexpected rise in SG level

b. SG discharge monitors RM-90-421, 422, 423, or 424

c. SG Blowdown Monitors RM-90-120, 121, or 124

d. RADCON Survey

e. Chem lab sample

R2

During SGTR the Chemistry lab would be notified by the Control Room to perform sub-step 'e' to sample secondary side in order to determine primary to secondary leakage. Step 4 of EOP, E-3 "Steam Generator Tube Rupture" specifies a similar requirement.

Chemistry has indicated that it would take 20 to 30 minutes to obtain and analyze the sample. Due to the constraint this duration would place on the event mitigation, the Chem Lab sample is not used for SGTR identification but is utilized as a means of SGTR confirmation. Other utilities have also deleted the Chem Lab sample from their emergency operating procedures as a method of identifying the ruptured steam generator.

ATTACHMENT 1

SGTR SCENARIO CHECKLIST

The observer uses this checklist to ensure that each scenario exercise is properly documented. Each scenario should have a unique ID, for example:

Scenario ID: SGTRA (See Attachment 2)

The scenario IDs are shown in the SGTR Scenario List given in Attachment 2. In addition, the Observer provides the Simulator Instructor with the Simulator Instructor Checklist and appropriate Scenario Run Sheet given in Attachment 3. Since all Scenario Run Sheet 5 are given in Attachment 3, special attention must be given to providing the correct sheet to the Simulator Instructor. Finally, the Observer gives the Simulator Instructor a copy of the Observer Instructions and Data Sheet package given in Attachment 4.

A list of scenario crew members (Attachment 5) is given as a guide for the Observer to ensure that all of the crew members are present prior to initiation of a scenario.

For each scenario, the following sequence should be observed:

OBSERVATIONS	COMMENTS
1. The Observer takes up a position in the simulator room that provides him with an unobstructed view of the entire control room. For each exercise, a data sheet (given in Attachment 4) should be used in recording observations and clock times as shown on the simulator (computer). Ensure that the scenario ID is properly displayed on all forms.	
2. Supply the Simulator Instructor with the Simulator Checklist and Scenario Run Sheet (given in Attachment 3) to initialize the simulator and properly align the control board.	
3. Ensure the simulator instructor synchronizes the clock (to zero) then activates the simulation and computer data recording program.	

OBSERVATIONS	COMMENTS

4. Prior to commencement of scenario, the Simulator Instructor briefs one full operating crew on current plant operating, equipment status, and operating instructions. Additionally, identify the responsibilities of each of the crew members to ensure that they comply with the positions given in the Crew Member List (Attachment 5).

5. After a short duration (a minute or two of "steady-state" operation), the malfunctions specified on the Scenario Run Sheet for this case are input at the instructor's console.

6. The operators respond to indicated plant conditions using the EOIs or EOPs. The shift supervisor is requested to speak to the reactor operator(s) clearly and loudly. R1

7. Observations and clock times are recorded by the Observer using the Observer Instruction Sheet and Observer Data Sheets given in Attachment 4. At some appropriate time, determined by the Observer, the event scenario is terminated. Conditions for termination of the exercise are also included on the Observer Instruction Sheet.

8. All data for each scenario is to be cataloged by assigned scenario ID for future reference and analysis:

   - Magnetic Tape
   - Scenario Run Sheet
   - Simulator Instructor Checklist
   - Observer Data Sheet
   - SGTR Scenario Checklist
   - Operator log sheets, recorder traces, etc.

9. Sign the checklist and file the entire package for this exercise in Watts Bar Document Control.

______________________ ______________
Observer's Signature Date

ATTACHMENT 2

SGTR SCENARIO LIST
(Design Basis Single Tube Rupture at EOL Core Conditions)

Scenario #	Scenario ID	# of Cases	Concern	Description
1	SGTRA	1	OVERFILL	Hot Full Power (HFP) with loss of offsite power (LOOP)
2	SGTRB	1	OVERFILL	HFP without LOOP.
3	SGTRC	1	OFFSITE DOSE	HFP with LOOP and failure of ruptured SG PORV to close once opened (stuck open).
4	SGTRD	1	OVERFILL	HFP with LOOP and failure of intact SG PORV to open.
5	SGTRE	1	OVERFILL	HFP with LOOP and failure of AFW level control valve to ruptured SG to close once open (stuck open).
6	SGTRF	1	OVERFILL	HFP with LOOP and failure of Pressurizer PORV to close once open (stuck open).
7	SGTRG	1	OVERFILL	HFP with LOOP and failure of MSIV on faulted SG to close.

ATTACHMENT 3

SIMULATOR INSTRUCTOR CHECKLIST

SCENARIO ID: _____ (Consult with Observer)

Note: The Simulator Department will decide on final contents and format of the "Simulator Instructor Checklist".

A typical Simulator Instructor Checklist may contain the following format:

1. Obtain the Scenario Run Sheet and fill in Scenario ID for this scenario. Verify the scenario ID, scenario description, and its conditions with the Observer.

2. Align control board devices. Note any required tag-out or other special instructions.

3. Verify that computer time is set to zero.

4. Check that fresh magnetic tape is mounted to record computer data at a pre-selected frequency interval. (The computer data are those parameters which are currently used for simulator qualification).

5. Check that Observer is ready and reconfirm scenario number with Observer.

6. Allow operating crew to enter. Announce shift turnover instructions, plant conditions, tag-outs, etc.

7. Allow approximately five minutes of operation time for crews to check the boards prior to activating the first MALFUNCTION.

8. Program desired MALFUNCTIONS.

9. Activate MALFUNCTIONS as specified on the Scenario Run Sheet (See next sheet).

10. "Signal" the occurrence of the tube rupture to the Observer in such a manner that is identified only by the Observer.

11. Respond to calls to operators in a positive manner. If there is any doubt about performing local actions, consult the Observer.

12. Terminate the scenario as requested by the Observer:

    - Freeze the board, and announce to crew.
    - Place an END-OF-FILE mark on the magnetic tape.
    - Mark and remove lineprinter paper.

SIMULATOR INSTRUCTOR CHECKLIST

SCENARIO ID: _____ (Consult with Observer)

13. Turn over event scenario data to Observer:

    - Rewind magnetic tape - Label tape with scenario ID.
    - Scenario Run Sheet.
    - Operator log sheets, recorder traces, etc.

14. Sign this Checklist and the corresponding Scenario Run Sheet and turn over to Observer.

_______________________________ ________

(Simulator Instructor Signature) Date

ATTACHMENT 3

SCENARIO RUN SHEET

SCENARIO ID: ____ (Consult with Observer)

EVENT	ACTION
Problem Time	Enter a 600* gpm tube rupture on the selected SG.
Reactor Trip	Enter loss of offsite power.

*Per discussion with Neil Lewis of Westinghouse, SGTR WOG Subgroup.

OBSERVER INSTRUCTION SHEET

SCENARIO ID: ___

1. Terminate exercise after:

   a. All ECCS flow is stopped, and

   b. Pressurizer and ruptured SG pressures are held equal for one to five minutes.

2. Verify that the simulator instructor has initialized the simulator to initial conditions in accordance with procedure guidelines.

3. Record data on "Observer Data Sheet" in black ink, sign, and date the form. Use simulator clock time to record clock times.

4. If an operators action or responses are not as expected, document what actually happened in the Comments Section of the form. Include problem time for each entry made.

5. Ensure that the immediate simulator room environment is maintained as realistic as possible.

ATTACHMENT 4

OBSERVER DATA SHEET

Scenario ID ______________ Date ______

Shift Supervisor ____________ Assistant Shift Supervisor ________ Reactor Operator __________

Balance of Plant Operator ____________ Shift Technical Advisor _____________

A. At problem time ________, the SG tube rupture occurred.

B. At problem time ________, the Reactor Trip was verified.

C. At problem time ________, the E-O instruction of the EOI * was entered. |R1

D. At problem time ________, still in E-O, Immediate Operator Actions completed.

E. At problem time ________, the E-3 instruction of the EOIs * was entered. |R1

F. At problem time ________, in accordance with E-3, the ruptured SG identified.

G. At problem time ________, in accordance with E-3, isolation of ruptured SG began.

H. At problem time ________, in accordance with E-3, isolation of the ruptured SG was completed as follows:

1. MSIV(s) and bypass valves shut
2. SG PORV setpoint adjusted
3. SG PORV verified closed
4. Steam to TDAFW pump isolated
5. SG blowdown isolated
6. AFW to ruptured SG stopped

I. At problem time ________, in accordance with E-3, rapid cooldown of RCS began using ______________. |R1

* Pertains to EOPs when they were used during the simulation.

ATTACHMENT 4

OBSERVER DATA SHEET (Continued)

Scenario ID ______________ Date ______

J. At problem time ________, in accordance with E-3, rapid cooldown of RCS completed.

K. At problem time ________, in accordance with E-3, rapid RCS depressurization began using ______________.

L. At problem time ________, in accordance with E-3, rapid RCS depressurization completed.

M. At problem time ________, in accordance with E-3, began securing all ECCS flow as follows:

1. RHR pumps stopped at time ___________.
2. SI pumps stopped at time ___________.
3. BIT isolated at time ___________.

N. At problem time ________, in accordance with E-3, completed securing all ECCS flows.

O. At problem time ________, pressurizer and ruptured SG pressures equalized.

All comments for specific problem times are to be entered in "Comments Section" on the following page.

______________________________ __________
Observer Signature Date

ATTACHMENT 4

Scenario ID ______________ **Date** ______

COMMENT SECTION

Problem Time	Comment

ATTACHMENT 5

SCENARIO CREW MEMBERS LIST

- Shift Operations Supervisor
- Assistant Shift Operations Supervisor
- Lead Reactor Operator
- Balance of Plant Operator
- Shift Technical Advisor

And

- Simulator Instructor
- Observer

50-390/391 WATTS BAR TVA

STEAM GENERATOR TUBE RUPTURE (SGTR) SCENARIOS UTILIZING OPERATOR CREWS AND EOPS ON PLANT SIMULATOR: In Support of WCAP-10698

Rec'd w/ltr 4/13/93....9304210094

ENCLOSURE 3

STEAM GENERATOR TUBE RUPTURE (SGTR) SCENARIOS
UTILIZING OPERATOR CREWS AND EOPs ON PLANT SIMULATOR

T80 920619 842

T80 920127 842

REPORT

STEAM GENERATOR TUBE RUPTURE

In Support of WCAP-10698 Methodology to Resolve Licensing Condition No. 41 of the WBN Draft License

Prepared by Walter S. Bodner Date 1-23-92

Reviewed by David B. Greenman Date 1-23-92

Approved by Paul Grossman Date 1-23-92

T80 920619 843

REPORT

STEAM GENERATOR TUBE RUPTURE (SGTR) SCENARIOS UTILIZING OPERATOR CREWS AND EOPS ON PLANT SIMULATOR

In support of WCAP-10698 Methodology to Resolve Licensing Condition No. 41 of the WBN Draft License

Prepared by Walter S. Bodnar Date 5-28-92

Reviewed by Alan D. Mast Date 5-28-92

Approved by [signature] Date 6-18-92

TABLE OF CONTENTS

I. PURPOSE

To provide a tabulation of recorded major operator action times, and determine a set of plant-specific operator action recovery times for the base case Steam Generator Tube Rupture (SGTR) scenario. In addition, to compile the recorded operator action recovery times for potentially limiting SGTR scenarios. This report provides plant-specific information in support of satisfying portions of licensing condition No. 41 of the Watts Bar draft license (Reference 8).

II. SCOPE

The following items are addressed in this report:

1. SGTR Event Scenario List (Section VI)
   a. Basis for Scenario List
   b. Performance of Event Scenarios from List (Table 1)

2. SGTR event recovery operations (Section VII)
   a. Identity the Ruptured SG
   b. Isolate the Ruptured SG
   c. Cooldown the RCS
   d. Depressurize the RCS
   e. Terminate SI to Stop Primary to Secondary Leakage

3. Tabulation of Operator Action Times (Section VIII)
   Tables 3 through 10.

4. Evaluation of Operator Action Times (Section IX)
   Tables 11 through 19.

5. SG PORV and Auxiliary FW Valve Isolation Times (Section X)
   a. SG PORV Manual Isolation Times (Table 20)
   b. Auxiliary FW Valve Isolation Times (Table 21)

6. Conclusions (Section XI)

III. INTRODUCTION

Section IX of the report on Steam Generator Tube Rupture (SGTR) (Reference 1) presented a list of SGTR scenarios considered to be the most important based on a review of WCAP-10698 and Supplement 1 (References 2 & 3) for which operator action and plant response times are required (see Table 1 of Section VI). In Attachments 1 through 6 (Reference 1) a plan was delineated for performing and documenting a varied group of control room operators responding to SGTR event scenarios using the Emergency Operating Instructions (EOIs) and plant simulator. Operations Training commenced the implementation of the plan by initiating the performance of the SGTR scenarios on the plant simulator during the January 9, 1992 requalification training of control room operators.

Initially, the selected SGTR scenarios were performed using the EOIs. However, the EOIs were revised to be consistent with the Westinghouse Owner's Group (WOG) Emergency Response Guidelines (ERGs) Revision 1A, and were renamed Emergency Operating Procedures (EOPs). The new EOPs were distributed in draft form suitable for operator training in February 1992. Subsequent performance of SGTR scenarios using the new EOPs resulted in longer run times from time of event initiation to SI termination due to operator crew unfamiliarity and additional detail in the new EOPs. The longer times obtained during re-performance of scenarios using the new EOPs are considered to be conservative and bounding with respect to operator action recovery times from initiation to termination of event when compared with times obtained during scenario performance using the EOIs.

Tables 3 through 21 of this report presents tabulated operator action times recorded during performance of scenarios and determines a representative set of Watts Bar specific operator action times for the base case SGTR scenario. In addition, this report includes delays in operator action times associated with the identification of single equipment failures (i.e., the time to isolate a stuck open SG PORV block valve and time to isolate stuck open Auxiliary Feedwater Level Control Valve) and corrective action taken during the SGTR recovery operation (see Section VII and VIII of this report). The scenarios for which operator actions were recorded are described in Section VI. Section VIII provides the tabulated operator action times for the scenarios performed. Section IX presents the evaluation of major operator actions that are representative of Watts Bar. Section X presents a summary of conclusions.

IV. ASSUMPTIONS

None.

V. REFERENCES

1. TVA, Report Steam Generator Tube Rupture, Prepared by Ebasco, RIMS No. T80 92 0127 842

2. WCAP-10698, "SGTR Analysis Methodology to Determine the Margin to Steam Generator Overfill", December 1984

3. Supplement 1 to WCAP-10698, "Evaluation of Offsite Radiation Doses for a SGTR Accident", March 1986

4. WCAP-11002, "Evaluation of Steam Generator Overfill Due to SGTR Accident", February 1986

5. Watts Bar Nuclear Plant Emergency Operating Procedures (E-0, E-2, E-3, ES-3.2)

6. "Westinghouse Owners' Group Emergency Response Guidelines", Revision 1, September 1, 1983

7. "Westinghouse Owners' Group Emergency Response Guidelines, EOP E-3, Steam Generator Tube Rupture", Revision HP-1A, July 1, 1987

8. Docket Nos. 50-390 and 50-391, Supplemental Safety Evaluation Report, NUREG-0847, Supplement No. 5, November 1990, Section 15.4.3, Steam Generator Tube Rupture (SSER5)

VI. SGTR EVENT SCENARIO LIST

a. Basis for Scenario List

A List of SGTR scenarios considered to be the most important based on a review of WCAP-10698 and Supplement 1 for which operator action and plant response times are required is presented in Table 1.

A SGTR is conservatively assumed to be the double ended complete severance of a single steam genreator tube which occurs at the end-of-life (EOL) core condition. The SGTR event occurring at hot full power (HFP) followed by a loss of offsite power (LOOP) coincident with the reactor trip is considered here to be the base case scenario (Scenario 1), as shown in Table 1. Scenario 2 is the same as Scenario 1 but without LOOP, for comparison.

The LOOP assumption tends to prolong the recovery operations, such as RCS cooldown and depressurization, which increases the total primary to secondary leakage and is therefore conservative.

The single equipment failure scenarios were selected from those considered in WCAP-10698 which were shown to be limiting or potentially limiting. They are represented by Scenarios 3 through 7 in Table 1.

* Scenario 3 was presented in WCAP-10698 and WCAP-10698 Supplement 1 to be the most limiting in terms of the radiological dose release to the environment.

* Scenario 4 was presented in WCAP-10698 to be the limiting event with respect to the increase in time necessary to cool the reactor coolant system and leads to the largest net decrease in margin to overfill.

* Scenarios 5 and 7 were presented in WCAP-10698 to be almost equally limiting with respect to decrease in margin to overfill (margin to steam generator overfill is defined as the steam space volume remaining below the steam generator outlet nozzle when the primary to secondary leak is terminated). A failure of the main feedwater control valve to close following a SGTR was also discussed in the WCAP but since it was similar to Scenario 5, and was less severe, it was considered a lesser case and was not evaluated separately.

* Scenario 6 was presented in WCAP-10698 as less limiting than Scenarios 4, 5 and 7 with respect to the decrease in margin to overfill.

VI. SGTR EVENT SCENARIO LIST (Continued)

b. Performance of Event Scenarios from List (Table 1)

Operator crews performed during requalification training, twenty-five SGTR scenario cases using EOIs and twenty-three cases using the new EOPs.

The scenarios performed for this report are listed in Table 1. Scenarios 1, 2, 4 and 6 were performed using the EOIs. Scenario 1 was re-performed using the new EOPs to determine a set of operator action recovery times based on the averaged values of six groups of operator crews. Scenario 3 (Stuck Open SG PORV) and Scenario 5 (Stuck Open AFW Level Control Valve) were performed after the actual times to isolate the valves were obtained from plant operators and consequently were performed using the new EOPs. Scenario 7 (stuck open MSIV) was also performed using the new EOPs.

TABLE 1
SGTR SCENARIO LIST
(Design Basis Single Tube Rupture at EOL Core Conditions)

Scenario No.	Description	Concern	EOI Scenario ID	Data Table In Section VIII	(New) EOP Scenario ID	Data Table In Section VIII
1	Base Case: SGTR at Hot Full Power (HFP) with Loss of Offsite Power (LOOP).	Overfill	SGTRA	4	STRA	3
2	Base Case without LOOP.	Overfill	SGTRB	5	-	-
3	Base Case + Single Failure: Ruptured SG PORV fails open.	Offsite Dose	-	-	SGTRC	6
4	Base Case + Single Failure: Intact SG PORV fails closed.	Overfill	SGTRD	7	STRD	7
5	Base Case + Single Failure: AFW LCV on ruptured SG fails open.	Overfill	-	-	SGTRE	8
6	Base Case + Single Failure: Pressurizer PORV fails open.	Overfill	SGTRF	9	-	-
7	Base Case + Single Failure: MSIV fails open on ruptured SG.	Overfill	-	-	STRG	10

VII. SGTR EVENT RECOVERY OPERATIONS

Following a SGTR event, the Control Room operators are required to perform recovery actions which stabilize the plant, isolate the ruptured steam generator and terminate the primary to secondary flow of reactor coolant by equalizing the pressures. These operator actions are specified in the plant Emergency Operating Procedures (EOPs).

The Watts Bar Plant EOPs (Reference 5) are based on Revision 1 and 1A of the ERGs which represent recent and comprehensive guidelines for emergency response to SGTR events and other accidents. Revision 1A to the ERGs was issued in July, 1987 (Reference 7) and represents the most recent WOG update to the guidelines.

In response to an event resulting in a reactor trip or safety injection (SI) initiation, the control room operator enters the EOPs with the E-0 (Reactor Trip or Safety Injection) procedure. The operator actions in E-0 include the verification of automatic actuations and diagnostics to determine the selection of the appropriate recovery procedure. If there are indications that a SGTR exists, the operator is directed to the E-3 (Steam Generator Tube Rupture) procedure which contains the appropriate actions required for the recovery from an SGTR. The action steps specified in E-3 include the requirements to equalize the RCS and SG pressures, and thereby terminate the primary to secondary leakage. After the E-3 action steps are completed, the plant should be cooled and depressurized to cold shutdown conditions using the appropriate sections of the plant EOPs. However, since these actions are implemented after primary to secondary leakage has been terminated, they are not considered in the evaluation of major operator action times addressed in this report. There are five major actions required in order to stop the primary to secondary leakage which are given in the E-3 procedure. The following subsections address the five major recovery actions:

a. Identify the Ruptured Steam Generator

Typically the first indication of a SGTR event is high secondary side activity as indicated by the main steam line radiation monitor, steam generator blowdown line radiation monitor, and condenser vacuum exhaust monitor. The ruptured steam generator can be identified by high activity in the corresponding main steam line or steam generator blowdown line. For an SGTR that results in high power reactor trip, the steam generator water level will decrease significantly but remains on the narrow range scale above the low level trip set point for all steam generators. The auxiliary feedwater (AFW) flow will commence to the steam generators, distributing approximately equal flows to all steam generators. In addition, the primary to secondary leakage adds inventory to the ruptured SG, thereby, returning narrow range level indication in that SG significantly earlier and continuing a more rapid increase in level than for the other SGs. This response provides confirmation of a SGTR event and also identifies the ruptured SG. Finally, in some cases the ruptured SG may be obvious prior to reactor trip due to a steam flow/feedwater flow mismatch alarm or steam generator level deviation alarms.

VII. SGTR EVENT RECOVERY OPERATIONS (Cont'd)

b. Isolate the Ruptured Steam Generator

After a tube rupture has been identified, recovery actions begin by isolating the ruptured SG from the intact steam generators and terminating feedwater flow to the ruptured steam generator. In addition to minimizing radiological releases, these actions also reduce the possibility of filling the ruptured SG with water by minimizing the accumulation of feedwater flow and, enabling the operator to establish a pressure differential between the ruptured and intact steam generators as a necessary step toward terminating primary to secondary leakage.

c. Cooldown the RCS

After isolation of the ruptured SG, the RCS is cooled as rapidly as possible to less than saturation at the ruptured SG pressure by dumping steam from only the intact steam generators. This ensures adequate subcooling in the RCS after depressurization to the ruptured steam generator pressure in subsequent actions. If offsite power is lost (as postulated in all scenarios except one), the RCS is cooled using the SG PORVs on the intact steam generators since both steam dump valves and condenser are unavailable. The RCS pressure will decrease during the cooldown as volumetric shrinkage allows for expansion of the steam space.

d. Depressurize the RCS

When the RCS cooldown is completed, SI flow will increase RCS pressure until break flow matches SI flow. Consequently, SI flow must be terminated to stop primary to secondary leakage. However, prior to SI termination adequate reactor coolant inventory must first be assured. This includes both sufficient reactor coolant subcooling and pressurizer inventory to maintain a reliable pressurizer level indication after SI flow is terminated. Since leakage from the primary side will continue after SI flow is stopped until RCS and ruptured SG pressures equalize, an "excess" amount of inventory is needed to ensure pressurizer level remains on span. The "excess" amount required depends on RCS pressure and reduces to zero when RCS pressure equals the pressure in the ruptured steam generators. To establish sufficient inventory, RCS pressure is decreased by condensing steam in the pressurizer using normal spray if the reactor coolant pumps (RCPs) are running. This will increase SI flow and will reduce break flow to the ruptured SG thereby increasing the pressurizer level. With the loss of offsite power the RCPs are stopped making the normal pressurizer spray unavailable . In this case, the RCS is depressurized using either a pressurizer PORV or auxiliary pressurizer spray supplied by CVCS in order to restore pressurizer inventory.

VII. SGTR EVENT RECOVERY OPERATIONS (Cont'd)

e. Terminate Primary to Secondary Leakage

The previous actions discussed above will have established adequate RCS subcooling, secondary side heat sink, and reactor coolant inventory following an SGTR to ensure that SI flow is no longer required. When these actions have been completed, SI flow must be terminated to prevent repressurization of the RCS and to terminate primary to secondary leakage. Primary to secondary leakage will continue after SI flow is stopped until RCS pressure and ruptured steam generator pressure equalize. Normal charging flow, letdown, and pressurizer heaters will then be controlled to prevent repressurization of the RCS and reinitiation of leakage into the ruptured steam generator.

Since these major recovery actions will be modeled in the Westinghouse LOFTRAN-II thermal-hydraulic analysis, it is necessary to establish the times required to perform these actions. Although the intermediate steps between the major actions will not be explicitly modeled, it is also necessary to account for the time required to perform these steps. It is noted that the total time required to complete the recovery operations consists of both operator action time and system, or plant, response time. For instance, the time for each of the major recovery operations (i.e., RCS cooldown, RCS depressurization, etc.) is primarily due to the time required for the system response, whereas the operator action time is reflected by the time required for the operator to perform the intermediate actions steps and to initiate the major recovery operations. Thus, the time which is required to complete each of the major recovery operations will be determined, as well as the operator action time required for the actions in the intervals between each of the major recovery operations (See Table 2). The times which are determined for each of these intervals for the base case scenario will then be used as the basis for the SGTR analysis to determine the margin to steam generator overfill.

TABLE 2

TIME INTERVALS FOR SGTR RECOVERY ACTIONS

1. Identification of ruptured SG
2. Operator action time to initiate isolation
3. Isolation of ruptured SG
4. Operator action time to initiate cooldown
5. Cooldown of RCS
6. Operator action time to initiate depressurization
7. Depressurization of RCS
8. Operator action time to initiate SI termination
9. SI termination and pressure equalization

VIII. TABULATION OF OPERATOR ACTION TIMES

The tabulated data obtained as a result of implementing a planned program (Reference 1) to record operator response times during performance of SGTR scenarios on the Watts Bar plant simulator is provided in this Section. The response times were recorded during the performance of scenario cases described in Section VI of this report. As stated in Section VII, operator actions beyond the termination of break flow were not considered here; therefore, the scenarios were terminated after operator crews were able to equalize the RCS and ruptured SG pressures which is in accordance with the methodology presented in WCAP-10698 and Supplement 1 (Reference 2 and 3, respectively).

The recorded operator action times (data sets) for all the SGTR scenario cases which are listed in Table 1 of Section VI, are presented in Table 3 through 10 of this Section. The times presented on the Observer Data Sheets (Attachment 4 of Reference 1) were recorded by Senior Reactor Operators (SROs) during the scenario performances. The time posted in the Tables for Entry A (Operator Action Description) corresponds to the simulator clock time at the time SG tube rupture occurred. Similarly, the time posted in the tables for Entry 0 (Operator Action Description) corresponds to the simulator clock time at the time when pressurizer and ruptured SG pressures were equalized. Likewise, all the intermediate timed steps in the data tables have specified operator action descriptions listed for a corresponding scenario ID designator.

Table 3 presents the results for Scenario 1 (six data sets) which is the base case, using the new EOPs. Table 4 presents the results for Scenario 1 (seven sets) performed using the EOIs. Table 5 presents the operator action times for Scenario 2 (eight sets) which was also performed using the EOIs. Table 6 presents the results of Scenario 3 (five sets) performed using the new EOPs. Table 7 presents the results of Scenario 4 (six sets) which was performed using the EOIs and one set (STRD01) using the new EOPs. Tables 8 and 10 present Scenarios 5 and 7 (five sets and six sets, respectively) which were performed using the new EOPs. Table 9 presents the results of Scenario 6 (four sets) which was performed using the EOIs. It is noted that the description of operator actions given in Tables 3 through 10 is subdivided into more detailed intervals than the major actions shown in Table 2. The more detailed intervals were used to measure the operator action times in accordance with WCAP-10698 and Supplement 1 in order to assist in the evaluation of the tabulated data. Some of the subintervals will be combined in Section VIII to obtain a preliminary set of representative/realistic major operator actions that could be used as input to subsequent SGTR events analyses.

VIII. TABULATION OF OPERATOR ACTION TIMES (Cont'd)

The operator action times presented in Table 3 through 10 of this section represent the scenario categories delineated in Table 1 of Section VI. Within each tabulated scenario presented in the tables, the operator action times did not vary significantly from crew to crew within a given category. The impact of unavailability of offsite power, as an initial condition of the scenarios, had a uniform innocuous affect with respect to increasing operator action times. As stated in Section III of this report, the operator action times obtained during performance of scenarios utilizing the new EOPs are more detailed utilizing latest WOG updates and therefore considered more representative with respect to operator action recovery times from initiation to termination of event when compared with times obtained using the earlier EOIs.

The maximum time required to achieve pressurizer and ruptured SG pressure equalization is 40 minutes for all cases performed using the new EOPs, except for the scenario involving the stuck open SG PORV single failure. For this case the ruptured SG PORV fails to close and it takes eleven minutes for operators to manually close the block valve (see Section X for details). Due to the additional time required to isolate the SG PORV on the ruptured SG in Scenario 3, water level in the ruptured SG drops significantly lower than in other postulated scenario cases, thereby, affecting RCS cooldown and depressurization recovery action criteria. Therefore, the time of RCS cooldown and depressurization for this scenario is considerably longer than that of the other scenarios as exemplified by the maximum run time of 60 minutes (this run time includes 12 minutes for RCS cooldown and 23 minutes for pressurizer/ruptured SG pressure equalization).

For Scenario 4 (Table 7), the impact of the failure of one intact SG PORV to open is that it requires a longer time to cooldown the RCS since only two operable intact SG PORVs are available. Six data sets were developed using the EOIs. The data set developed using the new EOP correlates well with respect to intermediate step times for recovery evaluations performed.

Scenario 5 (Auxiliary FW Level Control Valve Failure) indicates that operator action times for this case are not appreciably different from the Scenario 1 base case. The base case maximum run time was 41 minutes while Scenario 5 maximum run time was 37 1/2 minutes. It is concluded that the operators quickly recognized the failed open status of the AFW level control valve on the ruptured SG and took the appropriate corrective action. Actually, the prompt response would be to stop appropriate Auxiliary FW pump first, then isolate the associated manual valve on the level control valve, and later restart pump for cooldown of RCS.

Scenario 6 (Pressurizer PORV Stuck Open) was performed using the EOIs. The operators quickly recognized the pressurizer PORV was opened and closed the associated block valve. Scenario 7 (Failure of MSIV on Faulted SG to Close) maximum run time is 39 minutes which agrees with the base case Scenario 1. Here again, the operators quickly recognized the status of the MSIV and took the appropriate corrective action.

VIII. TABULATION OF OPERATOR ACTION TIMES (Cont'd)

Tables 3 through 10 comprise the tabulation of all operator action times recorded during the SGTR scenario exercises. Other information maintained as part of the documentation of each SGTR exercise are videotapes of the entire scenario recovery operation, a magnetic tape (and paper printout) generated by the simulator software, and completed Attachment 4 Data Sheets. The scenario times on the videotape and magnetic tape were synchronized, and the clock time recordings are based on the videotape timer displayed on the video monitor. The times reported in this section were taken from the mounted simulator clock.

Table 3
OPERATOR ACTION TIMES FOR SGTR BASE CASE

Operator Action Description	Times (Min)					
	Scenario ID: STRA (EOP) & STRG (EOP)					
	STRG01	STRA02	STRA03	STRA04	STRA05	STRA06
A. SG tube rupture occurred	07:35:00	15:44:00	07:43:00	15:50:00	08:08:00	07:41:00
B. Reactor trip verified	07:38:15	15:47:31	07:45:02	15:54:00	08:13:41	07:44:20
C. E-O instruction of the EOIs entered	07:39:34	15:48:00	07:46:24	15:55:35	08:14:20	07:45:20
D. In E-O, immediate operator actions complete	07:45:18	15:52:10	07:51:03	16:00:58	08:19:48	07:50:50
E. E-3 instruction of the EOIs entered	07:48:08	15:55:25	07:53:05	16:02:55	08:22:00	07:52:35
F. PER E-3, the ruptured SG identified	07:48:56	15:55:48	07:54:06	16:03:58	08:24:00	07:54:30
G. PER E-3, isolation of the ruptured SG began	07:50:05	15:56:28	07:54:42	16:04:20	08:24:02	07:54:55
H. PER E-3, isolation of the ruptured SG completed	07:53:00	15:57:10	07:57:00	16:07:25	08:26:10	07:57:45
I. PER E-3, rapid cooldown of RCS began	08:01:53	16:03:00	08:03:20	16:14:55	08:33:31	08:04:45
J. PER E-3, rapid cooldown of RCS completed	08:07:08	16:07:37	08:08:48	16:20:15	08:41:00	08:12:25
K. PER E-3, rapid RCS depressurization began	08:09:35	16:09:45	08:10:40	16:22:07	08:43:18	08:16:28
L. PER E-3, rapid depressurization completed	08:09:55	16:10:24	08:11:10	16:22:30	08:44:30	08:16:45
M. PER E-3, began stopping all ECCS flow	08:13:05	16:11:45	08:13:37	16:24:30	08:46:27	08:19:10
N. PER E-3, completed stopping all ECCS flows	08:15:08	16:13:42	08:15:10	16:26:30	08:48:20	08:20:49
O. Pressurizer and ruptured SG press. equalized	08:15:15	16:15:05	08:15:10	16:26:30	08:48:20	08:20:49

Table 4
OPERATOR ACTION TIMES FOR SGTR BASE CASE

Operator Action Description	Times (Min)						
	Scenario ID: SGTRA (EOI)						
	SGTRA1	SGTRA2	SGTRA3	SGTRA4	SGTRA6	SGTRA7	SGTRA10
A. SG tube rupture occurred	09:04	08:07:02	12:17:00	07:52:00	07:50:00	08:15:00	08:12:00
B. Reactor trip verified	09:07	08:11:43	12:20:24	07:55:00	07:52:12	08:20:35	08:14:10
C. E-0 instruction of the EOIs entered	09:08	08:12:48	12:21:40	07:56:24	07:53:03	08:21:40	08:15:20
D. In E-0, immediate operator actions complete	09:12	08:17:29	12:29:30	07:59:52	07:56:12	08:26:08	08:21:20
E. E-3 instruction of the EOIs entered	09:16	08:20:10	12:32:31	08:02:56	07:59:18	08:30:35	08:25:00
F. PER E-3, the ruptured SG identified	09:16	08:22:15	12:33:10	08:04:30	07:59:32	08:31:10	08:26:52
G. PER E-3, isolation of the ruptured SG began	09:18	08:23:07	12:33:20	08:05:10	08:01:26	08:31:23	08:27:10
H. PER E-3, isolation of the ruptured SG completed	09:18	08:24:43	12:34:13	08:05:40	08:02:16	08:34:21	08:30:03
I. PER E-3, rapid cooldown of RCS began	09:21	08:28:35	12:36:35	08:09:37	08:04:00	08:37:40	08:33:26
J. PER E-3, rapid cooldown of RCS completed	09:27	08:35:10	12:41:50	08:17:46	08:10:25	08:47:00	08:39:00
K. PER E-3, rapid RCS depressurization began	09:28	08:35:49	12:43:20	08:16:20	08:19:02	08:44:50	08:40:30
L. PER E-3, rapid depressurization completed	09:28	08:36:27	12:44:24	08:17:50	08:19:50	08:47:15	08:41:10
M. PER E-3, began stopping all ECCS flow	09:31	08:43:00	12:47:50	08:20:45	08:22:10	08:50:01	08:45:05
N. PER E-3, completed stopping all ECCS flows	09:36	08:45:34	12:50:15	08:23:41	08:24:13	08:53:50	08:48:30
O. Pressurizer and ruptured SG press. equalized	09:28	08:48:00	12:54:20	08:28:00	08:27:08	08:55:10	08:53:20

Table 5
OPERATOR ACTION TIMES FOR SGTR BASE CASE WITHOUT LOOP

Operator Action Description	Times (Min)							
	Scenario ID: SGTRB (EOI)							
	SGTRB1	SGTRB2	SGTRB3	SGTRB4	SGTRB5	SGTRB6	SGTRB8	SGTRB11
A. SG tube rupture occurred	10:30	09:15:00	13:20:00	08:50:00	10:30:00	08:50:00	09:50:00	09:25:00
B. Reactor trip verified	10:33	09:17:46	13:22:46	08:52:18	10:32:26	08:52:06	09:54:07	09:26:43
C. E-O instruction of the EOIs entered	10:33	09:18:50	13:23:20	08:53:00	10:33:13	08:52:20	09:54:52	09:27:45
D. In E-O, immediate operator actions complete	10:38	09:21:58	13:27:07	08:55:39	10:36:42	08:56:13	09:58:42	09:32:00
E. E-3 instruction of the EOIs entered	10:41	09:24:01	13:29:48	08:57:52	10:38:50	08:58:30	10:00:25	09:33:50
F. PER E-3, the ruptured SG identified	10:42	09:24:43	13:30:26	08:58:23	10:37:10	08:59:00	10:02:35	09:31:50
G. PER E-3, isolation of the ruptured SG began	10:42	09:25:17	13:31:20	08:58:58	10:40:35	08:59:18	10:02:54	09:36:00
PER E-3, isolation of the ruptured SG completed	10:43	09:26:17	13:32:22	09:00:16	10:41:50	09:01:00	10:03:55	09:37:15
I. PER E-3, rapid cooldown of RCS began	10:45	09:29:42	13:35:10	09:02:38	10:44:46	09:03:02	10:06:10	09:48:00
J. PER E-3, rapid cooldown of RCS completed	10:48	09:33:07	13:39:30	09:07:15	10:48:42	19:07:40	10:10:12	09:45:17
K. PER E-3, rapid RCS depressurization began	10:47	09:33:30	13:38:05	09:03:00	10:45:13	09:07:40	10:06:20	09:46:05
L. PER E-3, rapid depressurization completed	10:48	09:36:03	13:42:35	09:10:11	10:51:30	09:11:45	10:10:46	09:50:07
M. PER E-3, began stopping all ECCS flow	10:52	09:36:50	13:44:29	09:10:40	10:52:26	09:13:46	10:13:40	09:52:02
N. PER E-3, completed stopping all ECCS flows	10:55	09:38:39	13:47:30	09:12:27	10:54:15	09:15:35	10:15:27	09:54:06
O. Pressurizer and ruptured SG press. equalized	10:48	09:40:56	13:50:45	09:17:04	10:56:50	09:19:25	10:18:12	09:55:50

Table 6
OPERATOR ACTION TIMES FOR SGTR BASE CASE PLUS SINGLE FAILURE:
STUCK OPEN SG PORV ON RUPTURED SG

Operator Action Description	Times (Min)				
	Scenario ID: SGTRC (EOP)				
	SGTRC1	SGTRC2	SGTRC3	SGTRC4	SGTRC5
A. SG tube rupture occurred	15:38:45	07:25:00	15:47:00	07:48:10	15:37:30
B. Reactor trip verified	15:43:17	07:27:02	15:50:30	07:52:00	15:42:16
C. E-O instruction of the EOIs entered	15:44:42	07:27:43	15:51:30	07:52:30	15:43:36
D. In E-O, immediate operator actions complete	15:47:30	07:34:20	15:58:00	07:57:13	15:50:60
E. E-3 instruction of the EOIs entered	15:55:20	07:39:35	16:02:30	08:02:15	15:50:00 ** 15:51:50
F. PER E-3, the ruptured SG identified	15:56:04	07:39:35	16:04:15	08:03:09	15:57:03
G. PER E-3, isolation of the ruptured SG began	15:56:02	07:42:00	16:04:25	08:13:20	** 15:52:00
H. PER E-3, isolation of the ruptured SG completed	15:56:08	07:44:35	16:06:05	* 08:00:00	*** 15:57:00
I. PER E-3, rapid cooldown of RCS began	16:01:00	07:51:03	16:12:35	08:09:39	16:06:00
J. PER E-3, rapid cooldown of RCS completed	16:12:57	08:03:00	16:26:00	08:18:30	16:13:34
K. PER E-3, rapid RCS depressurization began	16:13:33	08:23:26	16:26:35	08:20:00	16:16:10
L. PER E-3, rapid depressurization completed	16:13:56	08:25:24	16:28:15	08:21:11	16:16:36
M. PER E-3, began stopping all ECCS flow	16:14:04	08:05:57	16:29:00	08:22:43	16:17:50
N. PER E-3, completed stopping all ECCS flows	16:15:55	08:07:33	16:30:40	08:25:00	16:19:05
O. Pressurizer and ruptured SG press. equalized	16:38:52	08:25:24	16:39:30	08:30:00	16:31:30

* TRANSITIONED TO E-2 WHERE S/G WAS ISOLATED.
** TRANSITIONED TO E-2 AND IN E-2.
*** IN E-2 S/G PORV WAS CLOSED LOCALLY.

Table 7
OPERATOR ACTION TIMES FOR SGTR BASE CASE PLUS SINGLE FAILURE:
PORV FAILS TO OPEN ON INTACT SG

Operator Action Description	Times (Min)						
	Scenario ID: SGTRD (EOI) & STRD (EOP)						
	SGTRD1	SGTRD2	SGTRD5	SGTRD6	SGTRD9	SGTRD12	STRD01
A. SG tube rupture occurred	13:04	10:02:00	09:37:00	09:41:00	10:45:00	10:22:00	10:14:00
B. Reactor trip verified	13:06	10:04:15	09:39:23	09:42:35	10:49:13	10:24:11	10:15:45
C. E-0 instruction of the EOIs entered	13:07	10:05:41	09:40:23	09:43:46	10:49:55	10:25:00	10:16:50
D. In E-0, immediate operator actions complete	13:10	10:09:56	09:44:35	09:47:48	10:55:48	10:29:46	10:20:48
E. E-3 instruction of the EOIs entered	13:13	10:11:34	09:46:59	09:50:52	10:58:35	10:33:00	10:23:05
F. PER E-3, the ruptured SG identified	13:13	10:12:12	09:47:57	09:51:15	11:00:02	10:35:50	10:24:12
G. PER E-3, isolation of the ruptured SG began	13:15	10:13:00	09:48:20	09:51:50	11:00:10	10:34:15	10:25:30
H. PER E-3, isolation of the ruptured SG completed	13:16	10:13:41	09:49:10	09:53:40	11:02:25	10:36:45	10:26:00
I. PER E-3, rapid cooldown of RCS began	13:18	10:15:50	09:50:35	09:56:00	11:04:45	10:38:52	10:31:05
J. PER E-3, rapid cooldown of RCS completed	13:26	10:22:21	09:57:10	10:03:50	11:11:41	10:45:35	10:38:35
K. PER E-3, rapid RCS depressurization began	13:26	10:21:04	09:55:43	10:06:22	11:12:40	40:46:30	10:39:30
L. PER E-3, rapid depressurization completed	13:28	10:21:37	09:57:20	10:06:40	11:13:34	10:47:20	10:39:55
M. PER E-3, began stopping all ECCS flow	13:29	10:28:38	10:00:53	10:06:54	11:17:04	10:51:46	10:42:18
N. PER E-3, completed stopping all ECCS flows	13:33	10:28:55	10:03:48	10:09:15	11:17:10	10:53:30	10:43:05
O. Pressurizer and ruptured SG press. equalized	13:28	10:31:41	10:09:11	10:14:00	11:24:10	10:58:32	10:46:30

Table 8
OPERATOR ACTION TIMES FOR SGTR BASE CASE PLUS SINGLE FAILURE:
RUPTURED SG AUX FEEDWATER LCV FAILS OPEN

Operator Action Description	Times (Min)				
	Scenario ID: SGTRE (EOP)				
	SGTRE1	SGTRE2	SGTRE3	SGTRE4	SGTRE5
A. SG tube rupture occurred	17:18:40	09:13:00	17:38:00	09:31:20	17:14:00
B. Reactor trip verified	17:20:22	09:14:29	17:40:35	09:33:38	17:16:10
C. E-0 instruction of the EOIs entered	17:21:10	09:15:23	17:41:40	09:34:40	17:11:46
D. In E-0, immediate operator actions complete	17:24:41	09:20:59	17:46:10	09:39:30	17:20:00
E. E-3 instruction of the EOIs entered	17:26:00	09:33:46	17:47:45	09:41:40	17:23:50
F. PER E-3, the ruptured SG identified	17:27:00	09:24:35	17:48:50	09:42:45	17:24:30
G. PER E-3, isolation of the ruptured SG began	17:29	09:25:00	17:49:15	09:43:20	17:24:35
H. PER E-3, isolation of the ruptured SG completed	17:32:00	09:36:00	18:00:38	09:58:30	17:36:30
I. PER E-3, rapid cooldown of RCS began	17:37:58	09:35:40	17:57:00	09:56:30	17:32:25
J. PER E-3, rapid cooldown of RCS completed	17:43:37	09:38:54	18:04:00	10:00:00	17:38:04
K. PER E-3, rapid RCS depressurization began	17:45:10	09:40:49	18:05:28	10:05:36	17:39:40
L. PER E-3, rapid depressurization completed	17:45:38	09:41:51	18:06:00	10:04:06	17:39:55
M. PER E-3, began stopping all ECCS flow	17:47:19	09:43:27	18:08:05	10:07:00	17:41:00
N. PER E-3, completed stopping all ECCS flows	17:48:46	09:48:52	18:08:35	10:08:58	17:42:04
O. Pressurizer and ruptured SG press. equalized	17:48:46	09:48:52	18:09:35	10:08:58	17:42:04

Table 9
OPERATOR ACTION TIMES FOR SGTR BASE CASE PLUS SINGLE FAILURE: STUCK OPEN PZR PORV

Operator Action Description	Times (Min)			
	Scenario ID: SGTRF (EOI)			
	SGTRF1	SGTRF2	SGTRF6	SGTRF13
A. SG tube rupture occurred	14:21	10:54:00	10:42:00	11:21:00
B. Reactor trip verified	14:23	10:56:02	10:44:26	11:24:20
C. E-O instruction of the EOIs entered	14:24	10:57:08	10:45:00	11:25:25
D. In E-O, immediate operator actions complete	14:29	11:01:04	10:49:38	11:29:30
E. E-3 instruction of the EOIs entered	14:31	11:03:00	10:53:20	11:33:20
F. PER E-3, the ruptured SG identified	14:32	11:03:55	10:53:45	11:34:30
G. PER E-3, isolation of the ruptured SG began	14:33	11:05:44	10:54:20	11:35:28
H. PER E-3, isolation of the ruptured SG completed	14:34	11:06:22	10:55:20	11:36:30
I. PER E-3, rapid cooldown of RCS began	14:350	11:07:58	10:57:30	11:39:20
J. PER E-3, rapid cooldown of RCS completed	14:41	11:12:30	11:03:00	11:44:30
K. PER E-3, rapid RCS depressurization began	14:40	11:11:15	11:04:50	11:45:33
L. PER E-3, rapid depressurization completed	14:42	11:12:10	11:06:30	11:46:30
M. PER E-3, began stopping all ECCS flow	14:43	11:17:15	11:07:50	11:49:38
N. PER E-3, completed stopping all ECCS flows	14:46	11:19:02	11:10:48	11:52:20
O. Pressurizer and ruptured SG press. equalized	14:42	11:21:36	11:13:11	11:57:00

Table 10
OPERATOR ACTION TIMES FOR SGTR BASE CASE PLUS SINGLE FAILURE:
MSIV FAILS OPEN ON RUPTURED SG

Operator Action Description	Times (Min)					
	Scenario ID: STRG (EOP)					
	STRG01	STRG02	STRG03	STRG04	STRG05	STRG06
A. SG tube rupture occurred	09:04	07:35:23	08:36:00	17:25:00	09:32:00	09:18
B. Reactor trip verified	09:07:05	17:37:00	08:39:38	17:28:15	09:34:55	09:20:59
C. E-O instruction of the EOIs entered	09:07:59	17:37:10	09:00:30	17:29:05	09:34:00	09:22:22
D. In E-O, immediate operator actions complete	09:11:55	17:42:59	09:04:12	17:34:05	09:41:00	09:27:23
E. E-3 instruction of the EOIs entered	09:14:50	17:45:37	09:05:30	17:35:50	09:43:00	09:30:00
F. PER E-3, the ruptured SG identified	09:15:50	17:46:40	09:06:46	17:37:05	09:43:50	09:32:20
G. PER E-3, isolation of the ruptured SG began	09:16:20	17:48:00	09:07:00	17:37:45	09:44:15	09:32:40
H. PER E-3, isolation of the ruptured SG completed	09:19:35	17:49:50	09:11:10	17:42:10	09:49:15	09:38:45
I. PER E-3, rapid cooldown of RCS began	09:26:20	17:59:00	09:16:12	17:48:10	09:56:42	09:42:55
J. PER E-3, rapid cooldown of RCS completed	09:30:00	18:03:10	09:21:35	17:53:30	10:04:15	09:49:35
K. PER E-3, rapid RCS depressurization began	09:30:50	18:05:40	09:22:50	17:55:00	10:05:26	
L. PER E-3, rapid depressurization completed	09:31:50	18:06:00	09:23:15	17:55:20	10:08:08	
M. PER E-3, began stopping all ECCS flow	09:34:12	18:07:52	09:25:10	17:57:10	10:09:31	09:53:15
N. PER E-3, completed stopping all ECCS flows	09:35:30	18:09:10	09:26:40	17:59:00	10:11:12	09:55:55
O. Pressurizer and ruptured SG press. equalized	09:38:25	18:09:30	09:26:40	17:59:00	10:11:12	09:55:55

IX. EVALUATION OF OPERATOR ACTION TIMES

Pertinent data presented in Section VIII is combined in this section to determine a set of plant-specific major operator action times for the SGTR base case. Major operator action times are developed in Tables 11-18 by the process described below and are summarized in Table 19.

Tables 11 through 18 present the time intervals between major operator actions, rounded off to the nearest minute, for the evaluated scenarios.

The data input for Tables 11 through 18 is developed from Tables 3 through 10 as follows:

1. Identify and Isolate Ruptured SG	Subtract time at A from time at H & round to nearest minute
2. Operator action time to initiate cooldown	Subtract H from I and round off
3. Cooldown of RCS	Subtract I from J and round off
4. Operator action time to initiate depressurization	Subtract J from K and round off
5. Depressurization of RCS	Subtract K from L and round off
6. Operator action time to initiate SI termination	Subtract L from M and round off
7. SI termination and pressure equalization	Subtract M from O and round off

The descriptions for major actions are similar to those for SGTR Recovery Actions presented in Table 2 of Section VII, except that the first three intervals presented in Table 2 are combined and shown as the first major action in Tables 11 through 18. Watts Bar's current E-3 procedure directs the operator to identify a ruptured SG by either an unexpected rise in any SG narrow range level or high radiation from any SG main steam line or blowdown line. In all scenario cases examined, the high radiation level alarms were received shortly after the initiation of the tube rupture event, and the unexpected water level increase was used to confirm the identification of the ruptured SG and the eventual isolation of the affected SG. This aggregate of collective functions performed by the operator crews have been combined into a single time interval.

As shown by comparison of Tables 11, 12 and 13, availability of offsite power resulted in shorter operator action times in identifying and isolating the ruptured steam generator. This stands to reason, since different equipment is called upon during recovery operations when a concurrent loss of offsite power occurs. For example, in

IX. EVALUATION OF OPERATOR ACTION TIMES (Continued)

the base case (i.e., Scenario 1) the EOPs direct the operator to use the intact SG PORV for RCS cooldown as opposed to using the steam dump valves and condenser that would be used if offsite power was available (i.e., Scenario 2).

The single equipment failure scenarios presented in Tables 14 through 18 show that, except for a few time intervals, the affects on operator action times are in agreement with those in the base case (Table 11). For the cases where rather large differences in a given time interval exist, the primary reason is due to complications which can be attributed to the associated equipment failure which impacts the timing of responses related to cooldown, depressurization, and pressure equalization. For example, a long period of cooldown for Scenario 3 in Table 14 compared with the base case in Table 11 can be explained by a large pressure differential between the RCS and ruptured SG caused by a stuck open SG PORV. In addition, the extended time requirement to equalize RCS and ruptured SG pressures is due to compliance with criteria presented in the procedure. For example, Step 31a in Procedure E-3 requires that one of the following three criteria be met, or continue RCS depressurization.

1) Pressurizer level increases to greater than 65%, OR
2) Subcooling margin decreases to less than 40°F, OR
3) RCS pressure is less than ruptured SG pressure.

The condition that is reached first is directly related to the single failure that is included in the scenario and has a significant impact on time to pressure equalization.

Finally, in the case of a stuck open SG PORV on the ruptured SG, it takes an additional five minutes (average) for the RCS cooldown because of the increased difference between the RCS and ruptured SG pressures due to the failed relief valve.

Table 19 presents a comparison of corresponding operator action times used in the generic study performed by Westinghouse and presented in WCAP-10698 (Reference 2). It is noted in Table 19 that the average operator action times for the base case are in good agreement with those of WCAP-10698 except for the period of RCS depressurization and SI termination and primary/secondary pressure equalization. The period of depressurization of RCS in WCAP-10698 is given as six minutes on average. The Watts Bar simulator depressurization time is much shorter due to a smaller delta pressure between RCS pressure and SG pressure as predicted by the simulator software.

During the RCS cooldown phase the simulator model responds by indicating a constant decrease in RCS pressure even though SI is injecting flow into RCS. RCS pressure will continue to drop until injection volume equals the volume lost through the tube rupture plus the shrinkage volume. Once the primary side target temperature was reached, the corresponding difference in primary and secondary pressures was about 200 psig. For the base case and other cases where the concurrent LOOP occurs, the pressurizer PORVs are used for primary side depressurization which occurs rapidly, hence, the short depressurization times.

Table 11
OPERATOR ACTION TIMES FOR SGTR BASE CASE

Major Operator Action Description	Times (Min)					
	Scenario ID: STRA (EOP) & SGTR (EOP)					
	STRA01	STRA02	SGTRA03	STRA04	STRA05	STRA06
1. Identify & Isolate Ruptured SG	18	13	14	17	18	17
2. Operator Action Time to Initiate Cooldown	9	6	6	7	7	7
3. Cooldown of RCS	5	5	5	5	7	8
4. Operator Action Time to Initiate Depressurization	2	2	2	2	2	4
5. Depressurization of RCS	1	1	1	1	1	1
6. Operator Action Time to Initiate SI Termination	3	1	2	2	2	2
7. SI Termination and Pressure Equalization	2	3	2	2	2	2

Table 12
OPERATOR ACTION TIMES FOR SGTR SGTRT BASE CASE

Major Operator Action Description	Times (Min)						
	Scenario ID: SGTRA (EOI)						
	SGTRA1	SGTRA2	SGTRA3	SGTRA4	SGTRA6	SGTRA7	SGTRA10
1. Identify & Isolate Ruptured SG	14	18	17	14	12	19	18
2. Operator Action Time to Initiate Cooldown	3	4	2	4	2	3	3
3. Cooldown of RCS	6	7	5	8	6	9	6
4. Operator Action Time to Initiate Depressurization	1	1	2	-	9	-	2
5. Depressurization of RCS	-	1	1	2	1	2	1
6. Operator Action Time to Initiate SI Termination	3	7	3	3	2	3	4
7. SI Termination and Pressure Equalization	5	5	6	7	5	5	8

Table 13
OPERATOR ACTION TIMES FOR SGTR BASE CASE WITHOUT LOOP

Major Operator Action Description	Times (Min)							
	Scenario ID: SGTRB (EOI)							
	SGTRB1	SGTRB2	SGTRB3	SGTRB4	SGTRB5	SGTRB6	SGTRB8	SGTRB11
1. Identify & Isolate Ruptured SG	13	11	12	10	12	11	14	12
2. Operator Action Time to Initiate Cooldown	2	3	3	2	3	2	2	4
3. Cooldown of RCS	3	3	4	5	4	5	4	4
4. Operator Action Time to Initiate Depressurization	-	1	-	-	-	-	-	1
5. Depressurization of RCS	1	3	5	7	6	4	4	4
6. Operator Action Time to Initiate SI Termination	4	1	2	1	1	2	3	2
7. SI Termination and Pressure Equalization	3	4	6	6	4	6	5	4

Table 14
OPERATOR ACTION TIMES FOR SGTR BASE CASE & STUCK OPEN SG PORV ON RUPTURED SG

Major Operator Action Description	Times (Min)				
	Scenario ID: SGTRC (EOP)				
	SGTRC1	SGTRC2	SGTRC3	SGTRC4	SGTRC5
1. Identify & Isolate Ruptured SG	17	20	19	12	20
2. Operator Action Time to Initiate Cooldown	5	7	7	10	9
3. Cooldown of RCS	12	12	13	9	8
4. Operator Action Time to Initiate Depressurization	1	20	1	2	3
5. Depressurization of RCS	1	2	2	1	1
6. Operator Action Time to Initiate SI Termination	1	-	1	2	1
7. SI Termination and Pressure Equalization	25	19	10	27	14

Table 15
OPERATOR ACTION TIMES FOR SGTR BASE CASE AND FAILURE OF INTACT SG PORV TO OPEN

Major Operator Action Description	Times (Min)						
	Scenario ID: SGTRD (EOI) & STRD (EOP)						
	SGTRD1	SGTRD2	SGTRD5	SGTRD6	SGTRD9	SGTRD12	STRD01
1. Identify & Isolate Ruptured SG	12	12	12	13	17	15	12
2. Operator Action Time to Initiate Cooldown	2	2	1	2	2	2	5
3. Cooldown of RCS	8	7	7	8	7	7	7
4. Operator Action Time to Initiate Depressurization	-	-	-	3	1	1	1
5. Depressurization of RCS	2	1	2	1	1	1	1
6. Operator Action Time to Initiate SI Termination	1	5	4	1	4	4	2
7. SI Termination and Pressure Equalization	4	5	8	7	7	7	4

Table 16
OPERATOR ACTION TIMES FOR SGTR BASE CASE AND STUCK OPEN AUX FEEDWATER LEVEL CONTROL VALVE

Major Operator Action Description	Times (Min)				
	Scenario ID: SGTRE (EOP)				
	SGTRE1	SGTRE2	SGTRE3	SGTRE4	SGTRE5
1. Identify & Isolate Ruptured SG	13	23	23	27	22
2. Operator Action Time to Initiate Cooldown	6	-	-	-	-
3. Cooldown of RCS	6	3	7	4	6
4. Operator Action Time to Initiate Depressurization	2	2	1	4	2
5. Depressurization of RCS	1	1	1	1	1
6. Operator Action Time to Initiate SI Termination	2	2	2	3	1
7. SI Termination and Pressure Equalization	1	5	1	2	1

Table 17
OPERATOR ACTION TIMES FOR SGTR BASE CASE
WITH STUCK OPEN PZR PORV

Major Operator Action Description	Times (Min)			
	Scenario ID: SGTRF (EOI)			
	SGTRF1	SGTRF2	SGTRF6	SGTRF13
1. Identify & Isolate Ruptured SG	13	12	13	16
2. Operator Action Time to Initiate Cooldown	1	2	2	3
3. Cooldown of RCS	6	5	6	5
4. Operator Action Time to Initiate Depressurization	-	-	2	1
5. Depressurization of RCS	2	1	2	1
6. Operator Action Time to Initiate SI Termination	1	5	1	3
7. SI Termination and Pressure Equalization	3	4	5	7

Table 18
OPERATOR ACTION TIMES FOR SGTR BASE CASE
AND FAILURE OF MSIV ON RUPTURED SG TO CLOSE

Major Operator Action Description	Times (Min)					
	Scenario ID: STRG (EOP)					
	STRG01	STRG02	STRG03	STRG04	STRG05	STRG06
1. Identify & Isolate Ruptured SG	16	14	15	17	17	21
2. Operator Action Time to Initiate Cooldown	7	9	5	6	7	4
3. Cooldown of RCS	4	4	5	5	8	7
4. Operator Action Time to Initiate Depressurization	1	3	1	2	1	-
5. Depressurization of RCS	1	1	1	1	3	-
6. Operator Action Time to Initiate SI Termination	2	2	2	2	1	-
7. SI Termination and Pressure Equalization	4	2	2	2	2	3

Table 19

MAJOR ACTION TIMES FOR SGTR BASE CASE SCENARIO

Major Action Description	AVG (MIN) WCAP+ 10698	AVG (MIN) WBN	MAX (MIN) WCAP+ 10698	MAX (MIN) WBN
1. Identify and Isolate Ruptured Steam Generator	10	*16.3	10	18
2. Operation Action Time to Initiate Cooldown	4	7	5	9
3. Cooldown of RCS	7	6.0	8	8
4. Operator Action Time to Initiate Depressurization	2	2.5	2	4
5. Depressurization	6	1	8	1.2
6. Operator Action Time to Initiate SI Termination.	1	2.2	1	3.2
7. SI Termination and Pressure Equalization	7	2.1	7	3.3
	37	37.1	41	46.7

* On the average, it took 3.6 minutes from time of SGTR accident initiation to time of reactor trip verification.

\+ ERG validation times from WCAP-10698, Table 2.3-1.

X. SG PORV AND AUXILIARY FW VALVE ISOLATION TIMES

Exercises utilizing plant operators were performed to determine actual in plant timed durations (in minutes) to manually isolate failed-open (stuck open) valves in support of SGTR scenario performance on the plant simulator. Specifically, the times to isolate the most remote failed-open (stuck open) SG PORV on the postulated ruptured steam generator and the times to manually close the isolation valve on the most remote failed-open (stuck open) Auxiliary Feedwater (AFW) level control valve.

The operators were called from the control room and instructed to leave their stations and travel to locations of the stuck open valve and manually close the associated block/isolation valve. Accessibility, habitability and radiological concerns regarding valve closures by the operators were factored into the overall times.

The timed durations were performed and the results are presented in this section in Table 20 for the SG PORV case and Table 21 for the Auxiliary FW case. The maximum operator isolation times for the SG PORV and AFW valve closures were utilized in the plant simulator model and are discussed in Section VIII and IX.

X. SG PORV AND AUXILIARY FW VALVE ISOLATION TIMES (Cont'd)

Table 20

SG PORV Manual Isolation Time

Run	S/G	ΔT Notification to Start of Closure	ΔT Start to Full Close	Total Time
1	#2	-	-	8 min
2	#2	- (Total time data is all that was taken)	-	6 min
3	#2	-	-	12 min
4	#3	4 min	2 min	6 min
5	#3	4 min	2 min	6 min
6	#3	7 min	4 min	11 min
7	#3	5 1/2 min	2 min	7 1/2 min

Event simulation will use data from run #6. Data considered to be most conservative since actual isolation time not provided in run #3.

X. <u>SG PORV AND AUXILIARY FW VALVE ISOLATION TIMES</u> (Cont'd)

Table 21

Auxiliary FW Valve Local Isolation Time

Run	S/G	ΔT Notification to Start of Closure	ΔT Start to Full Close	Total Time
1	#1	5 min	1 min	6 min
2	#1	5 min	1 min	6 min
3	#1	10 min	2 min	12 min
4a	#3	5 min	3 min	8 min
4b	#3	4 min	3 min	7 min
5	#3	5 min	Hold Order	
6	#3	Aborted due to hold order		
7	#3	5 min	3.3 min	8.3 min

Event simulation will use 5 mins to arrive at the valve location (Run 3 may have included briefing time) and 3 mins to close valve.

X. <u>SG PORV AND AUXILIARY FW VALVE ISOLATION TIMES</u> (Cont'd)

Table 21

Auxiliary FW Valve Local Isolation Time

Run	S/G	ΔT Notification to Start of Closure	ΔT Start to Full Close	Total Time
1	#1	5 min	1 min	6 min
2	#1	5 min	1 min	6 min
3	#1	10 min	2 min	12 min
4a	#3	5 min	3 min	8 min
4b	#3	4 min	3 min	7 min
5	#3	5 min	Hold Order	
6	#3	Aborted due to hold order		
7	#3	5 min	3.3 min	8.3 min

Event simulation will use 5 mins to arrive at the valve location (Run 3 may have included briefing time) and 3 mins to close valve.