

O Cleared 1977

SITE PROBLEM REPORT - 1978 *LP Unit* SABCOCK & WILCOX SPR #372

CUSTOMER Toledo Edison Company	ORIGINATOR F.R. Faist	DATE 10/4/77	DOC. ID. CONT. NO. 13-620-0014	SPR NO. 372	REV. NO. 0
VENDOR N/A	P.A. NO. N/A	PART NO./TASK NO. GROUP NO. SEQ. NO. 51/010/001			
TITLE (MAX 30 CHARACTERS) SFRCS Trip/Reactor Trip/Coolant Spill			PROBLEM CONTACT C. C. England <i>cc England</i>		

DESCRIPTION OF PROBLEM:

See attachments.

PROBLEM IDENTIFICATION

235

POOR ORIGINAL

STATUS-ACTION TO DATE, INCLUDING PERSONS CONTACTED: W. E. Spangler (Lynb.), J. G. Evans (TECo) aware of problem. B&W Engineering aware of problem. Meeting held in Lynb. on 9/29/77. NRC (NRR) aware of problem. Meeting held at DB-I on 9/30/77.

FURTHER ACTION RECOMMENDED BY SITE PERSONNEL: 1. B&W Engineering to evaluate transient data and determine effects on B&W supplied equipment. 2. Recommend transient category classification. 3. Provide recommended follow up action.

RESOLUTION: *See attached letters from J.A. Lauer to C.R. Dornick dated Nov 1 and Nov 7, 1977 (attached)*

RESOLUTION

PREPARED BY <i>Gary Holsted</i>	DATE 11-9-77	APPROVED BY <i>J.A. Lauer</i>	DATE 11-9-77
REVIEWED BY <i>K.R. Ellis</i>	DATE 11-9-77		

COST CATEGORY <input type="checkbox"/> NORM OTHER <input checked="" type="checkbox"/>	FIELD CHANGE REQ <input type="checkbox"/> YES NO <input checked="" type="checkbox"/>	F.C.A. NO. 04- <i>N/A</i>	SIGNIF. DEFICIENCY <input type="checkbox"/> YES NO <input checked="" type="checkbox"/>
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SITE COMPLETION REPORT:
BWT-1582 dated Nov. 1, 1977 and BWT-1561, dated Nov. 7, 1977, satisfy the action required to complete this problem report.

COMPLETION

DEVIATIONS: <input checked="" type="checkbox"/> NONE	SPR REV NO. <input type="checkbox"/>
DATE COMPLETED: 1/6/78	
COMPLETED BY P. C. Rouse <i>P. C. Rouse</i>	DATE 1/6/78
<i>F. R. Faist</i> F. R. Faist 1/6/78	

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Description of Problem
SPR #372
620-0014
10/4/77

On 9/24/77, approximately 1800, TECo reduced reactor power from 15% to 9% and shut down the turbine to repair a leak in the main steam line at an instrument connection between the turbine stop valves and the high pressure turbine.

At 2134 on 9/24/77, startup FW valve to OTSG #2 was closed by the steam & FW rupture control system (SFRCS) for an as yet undetermined reason. (ICS flow control was on manual at the time). At 21:34:44 the operator received a low level alarm on #2 OTSG. Before he could take corrective action, the steam & feedwater rupture control system (SFRCS) tripped on low SG level, closing the MSIV's and main FW isolation valves. #2 Aux. FW pump started, but only came up to 2600 RPM, insufficient to supply enough feedwater to steam generators. At 2136 the operator noticed that pressurizer level had risen to 290" (Normal = 200"), and manually tripped the reactor. The electromatic relief valve lifted (appeared to open & close 9 times) and failed to close. RCS pressure dropped to 1600 psig initiating Safety Features Actuation System (SFAS). This started high pressure injection, and closed numerous containment isolation valves, including the pressurizer quench tank cooling lines. With the electromatic relief valve still open and no cooling to the Quench Tank, the quench tank rupture disc ruptured, relieving water/steam to containment. The operators closed the electromatic relief isolation valve and stabilized RCS pressure and began a normal cooldown. During the sequence of events, RCS pressure went as low as 875 psig. Tave was as high as 577°F and as low as 505°F, and a steam bubble was formed in the RCS.

Upon entering containment, the following was noted:

1. The electromatic relief valve is still open, although the solenoid went to the close position indicating the pilot or the valve is stuck. See SPR 369.
2. The relief from the Pzr. Quench Tank tore off approximately a 10' high x 20' circumferential section of insulation from the #2 OTSG. The paint from the then exposed areas of the steam generator was blasted away.
3. There is water in the catch pans on 2-1 and 2-2 reactor coolant pumps. The operators indicate that the level in the RCP oil catch tanks is higher.
4. SFAS closed off both CCW and seal injection to the reactor coolant pumps. The operators apparently re-established seal injection within the 2-minute time delay and the pumps did not trip. 1-1 and 2-2 RCP were tripped manually.

POOR ORIGINAL

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The following design problems contributed to this incident:

1. An SFRCS actuation does not trip the reactor. RCS High Pressure greater than 2255 psig could probably been avoided had the reactor tripped simultaneously with bottling up of the OTSG's.
2. The operators have no indication that the electromatic relief valve is lifted. It took them approximately 20 minutes to realize that the valve was still relieving. By that time, RCS pressure had dropped to less than 1600 psi, and SFAS actuated.
3. A similar incidence of the SFRCS causing the S/U FW valve to go closed happened on 9/2/77. See SPR #367.

CORRECTIVE ACTION:

1. Repair electromatic relief valve.
2. Repair pzz. quench tank rupture disc.
3. Repair OTSG insulation.
4. TECo to determine cause of problems with feedwater that caused SFRCS trip and take corrective action. TECo also considering taking action to correct design problems mentioned above.
5. B&W Engineering should evaluate consequences of steam impinging on outside of steam generator shell from quench tank rupture. OTSG shell temperature before the incident was 518°F. Any inspection or corrective action required should be identified by Engineering.
6. B&W Engineering aid in reviewing events that led to incident and consequences of incident and identify further action required.

CCE:nlf

POOR ORIGINAL

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DAVIS-BESSE I

LOSS OF FW/RCS DEPRESSURIZATION TRANSIENT

on 9/24/77

List of Concerns:

1. Electromatic Relief - can rapid cycling of valve cause damage that would result in pilot vlv/stem binding up mechanically in "open position".

Resolution: Crosby (B&W)

2. Startup FW Valve Inadvertent Closure on 1/2 Trip of SFRCS - no explanation of cause of 1/2 trip.

Resolution: TECo

3. SFRCS - when actuated caused a "loss of FW" to both OTSG, and auto start of steam driven aux. FW pumps. B&W Engineering should pursue logic of SFRCS system and its impact on primary system, i.e. Loss of FW (SFRCS initiation) should trip reactor!).

Resolution: B&W

4. Fuel Assemblies/Pins -

- a. Exceeded fuel in compression limits and rapid depressurization.
- b. Flashing steam in core due to low RCS pressure high temperature during blowdown.
- c. TECo requested to analyze RCS samples for failed fuel, however, may not be detectable until heatup.
- d. Fuel Assembly Lift Forces - 2 phase fluid, 4 RCP's were running during transient, RCS temp. greater than 500°F (lift temp normal conditions).

Resolution: B&W

5. RCS -

- a. Rapid depressurization.
- b. Rapid cooldown (exceeded 100°F/hr. rate of change.) RV & Pzr.
- c. Formation of steam pockets in hot legs (and core) with RCP's running.
- d. Pzr. greater than 290 in. with reactor critical.
- e. Pzr. level greater than 320 in. with RCP's running.
- f. Boric Acid on external pipe surfaces, RCP casings.

Resolution: B&W

POOR ORIGINAL

List of Concerns - continued:

6. OTSG - (#2) A OTSG had approximately 10x20 ft. insulation blown off.
- a. Stress conditions in shell - 500 - 550°F steam inside, ambient (80-90°F) air temp & 212°F steam impinging on outside.
 - b. Boric Acid deposits on OTSG Shell.
 - c. Loss of FW to both OTSG's - (see item.#3).
 - d. Boiling of A OTSG dry, possibly B OTSG also.
 - e. Rapid depressurization of RCS on OTSG's.
 - f. Differential Temperature and Pressure conditions across OTSG tubes due to transient on RCS and Steam Side - OTSG.
 - g. Damage to shell thermocouples.

Resolution: TECo

Resolution: (a - f) = B&W

7. RCP's -
- a. Rapid depressurization, initiation of SFAS.
 - b. Loss of Seal Injection and Seal Return for approximately 2 1/2 minutes, to three RCP's, 4th RCP approx. 6 minutes. CCW not lost during transient.
 - c. NPSE limits possibly exceeded.
 - d. Operated four RCP's without seal injection and controlled bleedoff line closed for approximately 2 1/2 minutes.

Resolution: B&W

8. RCPM's -
- a. RCPM A2 operating in steam environment. Possibility of finding water in the oil. TECo to investigate.
 - b. Air Cooler fouling due to Boric Acid crystallization.
 - c. Moisture in motor windings - TECo to re-meggar.

Responsibility: B&W to check with Westinghouse.

9. CRDM's - tripped with no problem. Total gas in solution at time of incident approximately 22 cc/kg. Some gas may have come out of solution and collected in CRDM's. During cooldown on 9/26/77, CRDM Groups 1 - 4 pulled to 100% for shutdown margin. Rods were apparently run in rather than tripped after cooldown.

Resolution: Recommend putting N₂ overpressure in Pzm and reventing all CRDM's on next heatup. B&W evaluation.

POOR ORIGINAL

TIME		EVENT (FROM COMPUTER ALARM PRINTER)	COMMENT
21:34:20	-1:47	Main Steam Line Iso. Vlv. Solenoid Trouble	Half Trip of SFRCS - closed startup FW valve to #2 OTSG.
21:34:37	-1:30	SG 2 S/U Range Lvl Low (setpoint = 24")	Level was 40.67" before 21:34:20; now level 23.80".
21:34:56	-1:10	RCP 2-2 Disc CLG. WR Temp HI (setpoint 560.6) (T_c)	CLG Temp. was 556 at 21:34:20.
21:35:16	- :51	RC Pzr. Level HI (setpoint 213")	Level was 203.1 at 21:34:20.
21:35:18	- :49	SG SU Range Low Level CH 2 Trip	SFRCS Trip.
21:35:23	- :44	MN STM Iso. Vlv. Closed	Isolation Valves closed by SFRCS.
21:35:25	- :42	RC Loop 2 HLG NR Temp High (setpoint 565.3)	HLG Temp. 569.1.
21:35:32	- :35	RC Pzr. Level HI	222.5"
21:35:45	- :22	SG 1 Out Stm Press. High	1022 psig.
21:35:51	- :16	MN FW Stop Vlv. Closed	Closed by SFRCS.
21:35:55	- :12	RC Pzr. Power Rlf. Vlv. Out Temp. High	Electromatic Relief Vlv. Lifted
21:36:04	- :03	AFF Disc Vlv. to SG Open	Aux. Feed Pump Begins Supply of Water to SG's.
21:36:07	0:00	CRD Trip Confirm	Reactor Tripped Manually Due to HI Pzr. Level.
21:36:26	0:19	RPS Trip Low Pressure	Reactor already tripped.
21:37:17	1:10	SFAS Trip RC less than 1600 psi	
21:37:18	1:11	High Pressure Inj. Valves not closed	Valves opened by SFAS.
21:37:18	1:11	Pzr. Quench Tank Out Vlv. closed.	Valve closed by SFAS.
21:37:19	1:12	RCP Seal Return Iso. Vlv. Closed.	
21:37:20	1:13	RCP Seal Inj. Iso. Valve Closed.	
21:37:22	1:15	Letdown Iso. Vlv. closed.	
21:37:34	1:27	High Pressure Inj. Flow Normal	

POOR ORIGINAL

TIME	AT	EVENT (FROM COMPUTER / RM PRINTER)	COMMENT
:37:40	1:33	RCP Seal Inj. & Seal Return Flow Low	
:37:45	1:38	RCP 1-1, 1-2, & 2-2 3rd Seal Cav. Press. High	1370, 1096 & 1042 RCS Press = 1490 psi
:38:15	2:08	RC M.U. Flow Normal	
:38:15	2:08	RCP 2-2 3rd Seal Cavity Press. 822.2	
:38:30	2:23	RCP Seal Return Flow Normal	
:39:12	3:05	Pzr. Quench Tank Press. High	
:39:26	3:19	RCP 2-2 CLG Temp. Low	Temp = 553.9
:40:22	4:15	Containment Normal Sump Pump On	Rupture Disc had blown.
:40:34	4:27	High Pressure Inj. Turned Off	
:42:07	6:00	NI 1 & NI 2 High Startup Rate	4.609 DPM
:43:11	7:04	RCP 1-1 and 2-2 tripped	
:54:46	18:39	Pzr. Quench Tank Normal/Iso. Vlv. Open	
:03:21	27:14	SG 1 DNCMR in AVG Temp. 275.4	
:08:54	32:47	Pzr. Level Normal	
:12:32	36:25	RC Pzr. Avg. Lvl. Low	152.5"
:22:56	46:49	Start HPI #2	Started by operators to help recover Pzr. Level.

POOR ORIGINAL

807

TIME	AT	EVENT	COMMENTS															
21:35:18	-0:49	SFRCS Trip	Closed FW and Main Steam Isolation Valves															
21:36:07	0:00	Reactor Trip	Manual Trip															
21:37:17	1:10	SFAS Trip	RCS Pressure < 1600 psi															
21:37:19	1:12	RCP Seal Ret. Isol Vlv. Closed																
21:37:20	1:13	RCP Seal Inj. Flow Low																
21:37:22	1:15	RC MU Isolation Vlv Closed																
21:37:32	1:25	RCP 1-1 & 2-2 Seal Ret. Vlv. Closed																
21:37:33	1:26	RCP 2-1 Seal Ret. Vlv. Closed																
21:37:34	1:25	RCP 1-2 Seal Ret. Vlv. Closed																
21:37:40	1:33	<table border="0"> <thead> <tr> <th></th> <th><u>SEAL INJ. FLOW</u></th> <th><u>SEAL RET. FLOW</u></th> </tr> </thead> <tbody> <tr> <td>1-1</td> <td>.0165</td> <td>.4046</td> </tr> <tr> <td>1-2</td> <td>.7856</td> <td>\$</td> </tr> <tr> <td>2-1</td> <td>.0009</td> <td>.1188</td> </tr> <tr> <td>2-2</td> <td>.0211</td> <td>\$</td> </tr> </tbody> </table>		<u>SEAL INJ. FLOW</u>	<u>SEAL RET. FLOW</u>	1-1	.0165	.4046	1-2	.7856	\$	2-1	.0009	.1188	2-2	.0211	\$	
	<u>SEAL INJ. FLOW</u>	<u>SEAL RET. FLOW</u>																
1-1	.0165	.4046																
1-2	.7856	\$																
2-1	.0009	.1188																
2-2	.0211	\$																
21:37:45	1:38	RCP 1-1 3rd Seal Cavity Press. 1370 RCP 1-2 3rd Seal Cavity Press. 1096 RCP 2-2 3rd Seal Cavity Press. 1042	RCS Pressure = 1679. Had come down from 2259 in past 1 min. 30 sec.															
21:38:15	2:08	RC MU Flow Normal																
21:38:15	2:08	RCP 2-2 3rd Seal Cavity Press. 822.2	RCS Pressure = 1532															
21:38:20	2:13	RCP Seal Return Iso. Vlv. Opened																
21:38:35	2:28	All Seal Return Valves Opened																

POOR ORIGINAL

TIME	AT	EVENT	COMMENTS
21:38:40	2:33	<u>Seal Return Flow</u> 1-1 .7714 gpm 1-2 .6295 gpm 2-1 .8724 gpm 2-2 1.986 gpm	
21:38:45	2:38	1-1 3rd Seal Cavity Press. 443.9 1-2 3rd Seal Cavity Press. 411.9	RCS Pressure = 1422
21:39:10	3:03	RCP 2-2 Seal Ret. Flow .6684 gpm	
21:39:12	3:05	Seal Inj. Isolation Valves Opened	
21:39:40	3:33	<u>Seal In Flow</u> 1-1 4.616 gpm 1-2 4.911 gpm 2-2 4.130 gpm 2-1 4.847 gpm	
21:40:22	4:15	Pzr. Quench Tank Rupture Disc Blew	
21:40:27	4:20	RCP 2-2 Mtr. Vib. High	RCS Press. = 1200 psig RCS Temp. = 545°F This is pump nearest Pzr. Quench Tank
21:43:11	7:04	Manually Tripped 1-1 and 2-2 RCP's 1-2 Mtr. Power = 5244 KW 2-1 Mtr. Power = 4910 KW	RCS Press. = 980 psig RCS Temp. = 540°F
21:43:41	7:34	1-2 Mtr. Power = 4095 KW	
21:43:48	7:41	RCP 1-1 Mtr. Stop	

10 51

POOR ORIGINAL

TIME	ΔT	EVENT	COMMENTS
22:12:14	36:07	RC MU Flow High	Flow Imbalance Starved RCP Seal Inj.
22:12:14	36:07	RCP Seal Inj. Flow Low	Flow Imbalance Starved RCP Seal Inj.
22:12:29	36:22	RCP 2-2 Seal Ret. Vlv. Closed	No Seal Inj. Return. Vlv. went closed on idle pump.
22:12:37	36:30	RCP 1-1 Seal Ret. Vlv. Closed	Same
22:12:40	36:33	RCP 1-1 Seal In Flow Low (Set Pt. = 3.3 gpm)	Flow = 2.26 gpm
22:12:40	36:33	RCP 2-2 Seal In Flow Low	Flow = .50 gpm
22:13:10	37:03	RCP 1-1 Seal Inj. Flow Normal	Flow = 3.609
22:13:10	37:03	RCP 2-2 Seal Inj. Flow Normal	Flow = 3.665
22:13:15	37:08	RCP 1-1 3rd Seal Cavity Press. High (9142)	
22:15:40	39:33	RCP 1-1 Seal In Flow Normal (4.496)	
22:15:40	39:33	RCP 2-2 Seal In Flow Normal (4.343)	
22:17:45	41:38	RCP 1-2 3rd Seal Cav. Press. (1239) High	
22:19:10	43:03	RCP 1-1 Seal In Flow Low (2.845)	
22:19:10	43:03	RCP 2-2 Seal In Flow Low (2.003)	
22:22:00	45:53	RCP 1-1 Seal Ret. Flow High	
22:22:10	46:03	RCP 1-1 Seal Ret. Flow Normal (.6169)	
22:22:15	46:08	RCP 1-1 3rd Seal Cavity Press. (298.5) Normal	
22:22:29	46:22	RCP 1-1 & 2-2 Seal Return Vlv. Closed	
22:22:45	46:38	RCP 1-1 3rd Seal Cavity Press. 908.1 High	

POOR ORIGINAL

TIME	AT	EVENT	COMMENTS
22:24:15	48:08	RCP 2-2 3rd Seal Cavity Press. 920.1 High	
22:25:45	49:38	RCP 2-2 3rd Seal Cavity Press. 741.2 Norm.	
22:26:15	50:08	RCP 2-2 3rd Seal Cavity Press. 1004 High	
22:26:45	50:38	RCP 2-2 3rd Seal Cavity Press. 778.9 Norm.	
22:27:15	51:08	RCP 2-2 3rd Seal Cavity Press. High 1064	
22:29:45	53:38	RCP 2-2 3rd Seal Cavity Press. Norm. 827.2	
22:30:41	54:34	RCP Seal In Flow Norm.	
22:32:45	56:38	RCP 2-2 3rd Seal Cavity Press. High (1143)	
22:33:45	57:38	" " " " Norm (867.1)	
22:34:15	58:08	" " " " HI 997.7	
22:35:45	59:38	" " " " Norm 855.6	
22:36:45	1:00:38	" " " " HI 1132	
22:37:15	1:01:08	" " " " Norm. 862.8	
22:37:45	1:01:38	" " " " HI 980	
22:38:45	1:01:38	" " " " Norm. 824.8	
22:39:45	1:02:38	" " " " HI 998.9	
22:41:15	1:05:08	" " " " Norm. 810.9	
22:41:45	1:05:38	" " " " HI 916.5	
22:43:15	1:07:08	" " " " Norm. 863.1	
22:44:15	1:08:08	" " " " HI 1021	
22:45:15	1:09:08	" " " " Norm. 874.7	
22:46:45	1:10:38	" " " " HI 1080	

POOR ORIGINAL

1275

TIME	AT	EVENT	COMMENTS
22:47:45	1:11:38	RCP 2-2 3rd Seal Cavity Press. Norm 829.8	
22:48:15	1:12:08	" " " " HI 983.7	
22:49:02	1:12:55	RCP 1-1 Seal Standpipe Level High	
22:49:15	1:13:08	RCP 2-2 3rd Seal Cavity Press. Norm. 812.1	
22:50:45	1:14:38	" " " " High 1113	
22:51:15	1:15:08	" " " " Norm. 839.6	
22:51:45	1:15:38	" " " " High 909.4	
22:52:15	1:16:08	" " " " Norm. 789.1	
22:52:45	1:16:38	" " " " High 901.7	
22:53:14	1:17:97	RCP 1-1 Seal Standpipe Level Norm.	
22:54:15	1:18:08	RCP 2-2 3rd Seal Cavity Press. Norm. 814	
22:56:15	1:20:08	RCP 2-2 " " " " High 978.2	
22:57:15	1:21:08	" " " " Norm. 849.2	
22:59:15	1:23:08	" " " " High 969.5	
22:59:34		1-1 Standpipe Level High	
22:59:35		" " " Norm.	
23:00:05		" " " High	
23:00:06		" " " Norm.	
23:00:18		" " " High	
23:00:21		" " " Norm.	
23:00:28		" " " HI	
23:00:30		" " " Norm.	

POOR ORIGINAL

13 of 51

TIME AT EVENT COMMENTS

23:00:45	1:24:38	RCP 2-2 3rd Seal Cav. Press. Norm. 752.2	
23:00:55		1-1 Standpipe Level High	
23:00:57		1-1 Standpipe Level Normal	
23:00:59		1-1 Standpipe Level High	
23:01:07		" " " Normal	
23:01:18		" " " High	
23:01:23		" " " Normal	
23:01:45	1:25:38	RCP 2-2 3rd Seal Cav. Press. High 976.8	
23:02:09		1-1 Standpipe Level High	
23:02:11		" " " Normal	
23:02:21		" " " High	
23:02:21		" " " Normal	
23:02:23		" " " High	
23:02:24		" " " Normal	

15
14
51

POOR ORIGINAL