

TRANSIENT ASSESSMENT PROGRAM REPORT
ON
CRYSTAL RIVER UNIT 3 REACTOR TRIP
OF
JUNE 16, 1981

Report Number - CR-3-81-10

Prepared and Released by
Florida Power Corporation

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12-1127044-00

CRYSTAL RIVER 3 - JUNE 16, 1981
REACTOR TRIP AND LOSS OF OFF-SITE POWER

ROOT CAUSE:

LIGHTING STRUCK ON THE 230 KV FEEDER LINE TO THE STARTUP TRANSFORMER CAUSED LOSS OF OFF SITE POWER. REACTOR TRIPPED ON LOSS OF POWER TO THE CONTROL ROD DRIVE.

PERFORMANCE ANOMALIES:

- LOSS OF OFF SITE POWER
- LOSS OF FORCED RC FLOW - NATURAL CIRCULATION QUICKLY ESTABLISHED AND MAINTAINED FOR ABOUT 9 HOURS.
- "A" EMERGENCY DIESEL GENERATOR STARTED, "B" EMERGENCY DIESEL GENERATOR DID NOT START. POWER TO B ENGINEERED SAFEGUARDS BUS REESTABLISHED BY OPERATOR ACTION BY CONNECTING TO UNITS 1 AND 2 STARTUP TRANSFORMER.
- LOSS OF MAIN FEEDWATER. EMERGENCY FEED PUMPS STARTED NORMALLY BUT STARTUP FEEDWATER VALVES DID NOT CONTROL STEAM GENERATOR LEVEL. OVERCOOLING RESULTED FROM OTSG OVERFILL WHICH WAS TERMINATED BY OPERATOR ACTION.
- LOSS OF INSTRUMENT AIR AND SERVICE AIR, ALSO AIR FAIL RELAYS TRIPPED.
- LOSS OF POWER TO UNITS 1 AND 2 DEMIN WATER TRANSFER PUMPS (POWERED FROM UNIT 3 WATER TREATMENT MOTOR CONTROL CENTER).
- ESFAS ACTUATION NOT REQUIRED, BUT 2 HPI PUMPS STARTED AND HPI INJECTED FROM BWST TO RCS THROUGH ALL 4 NOZZLES.
- DC SEAL OIL PUMP FAILED TO START CAUSING LOSS OF MAIN GENERATOR HYDROGEN.

GENERIC BENEFITS:

- DEMONSTRATED NATURAL CIRCULATION COOLING FOLLOWING REACTOR TRIP FROM 100% FP.
- PROVIDED COMPARISON EXPERIENCE FOR ATOG GUIDELINES FOR LOSS OF OFF SITE POWER.
- DEMONSTRATED OVERALL ADEQUACY OF PLANT PROCEDURES AND ABILITY OF OPERATORS TO RECOGNIZE AND CORRECT PLANT PROBLEMS NOT SPECIFICALLY ADDRESSED IN EITHER ATOG OR THE PLANT PROCEDURES.

I. SUMMARY

ON JUNE 16, 1981 CRYSTAL RIVER UNIT 3 WAS IN MODE 1 WITH REACTOR POWER AT 100% FULL POWER, GENERATING APPROXIMATELY 820 MWE. THE ICS WAS IN FULL AUTOMATIC. STATION LOADS WERE BEING POWERED FROM THE UNIT THREE STARTUP TRANSFORMER, EXCEPT FOR RC PUMPS WHICH WERE BEING CARRIED ON THE UNIT AUX TRANSFORMER.

AT APPROXIMATELY 2338 LIGHTNING STRUCK THE 230 KV FEEDER LINE, FROM THE FOSSIL PLANT SWITCHYARD, TO THE STARTUP TRANSFORMER. THE LIGHTNING STRIKE CLEARED THE BREAKERS IN THE FOSSIL PLANT SWITCHYARD (THE TWO TO THE UNIT 3 STARTUP TRANSFORMER) AND THE LOSS OF VOLTAGE ON THE SECONDARY SIDE CAUSED THE CR3 4160 VAC UNIT BUSES AND THE 4160 ES BUSES TO CLEAR THEIR FEEDERS.

THE ABOVE ACTION RESULTED IN A REACTOR TURBINE TRIP. THE TURBINE TRIP CAUSED A LOSS OF 6900 VAC FEED TO THE RC PUMP BUSES AND WITH THE ALTERNATE SUPPLY TO THE RCP BUSES TRIPPED (THE STARTUP TRANSFORMER) A LOSS OF RC FLOW WAS EXPERIENCED.

THE LOSS OF VOLTAGE TO THE 4160 VAC ES BUSES CAUSED THE DIESELS TO CRANK. THE "A" EMERGENCY DIESEL CAME TO SPEED AND LOADED THE "A" 4160 AND 480 VAC ES BUSES AS DESIGNED THE "B" EMERGENCY DIESEL FAILED TO START. THE OPERATORS SUBSEQUENTLY POWERED THE "B" ES BUSES FROM THE FOSSIL PLANT STARTUP TRANSFORMER.

THE UNIT WAS STABILIZED IN THE HOT STANDBY MODE AT APPROXIMATELY THIRTY MINUTES INTO THE TRANSIENT.

II. TRANSIENT ASSESSMENT

A. SEQUENCE OF EVENTS

THE FOLLOWING IS AN ABBREVIATED SEQUENCE OF EVENTS FOR THIS REACTOR TRIP TAKEN FROM THE ALARMS TYPER AND LINE PRINTER.

SEQUENCE OF EVENTS MONITOR

THE FOLLOWING ALARMS FROM THE SEQUENCE OF EVENTS MONITOR ARE CONSIDERED SIGNIFICANT TO THIS TRANSIENT. WHEN QUESTION MARKS ARE PRINTED, THE SEQUENCE OF EVENTS MONITOR BUFFER HAS OVERLOADED AND THE ORDER OF ALARMS AND TIME ARE LOST. THE SIGNIFICANCE IS THAT THE EVENTS DID OCCUR.

PLANT COMPUTER ALARMS

THE FOLLOWING ALARMS WERE FROM THE PLANT COMPUTER. THESE ALARMS APPEAR TO PROVIDE THE BEST SEQUENCE OF EVENTS FOR THIS OCCURRENCE.

COMPUTER ALARMS

<u>TIME</u>	<u>ALARM</u>	
2338:08	BATTERY CHARGER A IN SERVICE	No
2338:08	BATTERY CHARGER B IN SERVICE	No
2338:08	BATTERY CHARGER C IN SERVICE	No
2338:08	BATTERY CHARGER D IN SERVICE	No
2338:08	BATTERY CHARGER E IN SERVICE	No
2338:08	BATTERY CHARGER F IN SERVICE	No
2338:08	STARTUP BANK BREAKER 1691	OPEN
2338:08	STARTUP BANK BREAKER 1692	OPEN
2338:08	BREAKER 3203	OPEN
2338:08	BREAKER 3204	OPEN
2338:08	BREAKER 3205	OPEN
2338:08	BREAKER 3206	OPEN
2338:08	CRD TRIP CONFIRMED	YES
2338:08	AUTO STOP	TRIP
2338:08	RC PUMP A1 SPEED	LOW
2338:08	RC PUMP A2 SPEED	LOW
2338:08	RC PUMP B1 SPEED	LOW
2338:08	RC PUMP B2 SPEED	LOW
2338:08	BATTERY A VOLTAGE	247.1
2338:08	BATTERY B VOLTAGE	231.5
2338:08	120 VAC REG INST BUS 3A (VBDP-1)	DEAD
2338:08	120 VAC REG INST BUS 3B (VBDP-2)	DEAD
2338:08	500KV GENERATOR BREAKER 1661	OPEN
2338:08	500KV GENERATOR BREAKER 1662	OPEN
2338:08	BREAKER 3101	OPEN

COMPUTER ALARMS

TIME	ALARM	
2338:08	BREAKER 3102	OPEN
2338:12	480V HEATING AUX BUS	DEAD
2338:13	480V PLANT AUX BUS	DEAD
2338:13	480V TURB AUX BUS A	DEAD
2338:13	480V TURB AUX BUS B	DEAD
2338:13	480V REACTOR AUX BUS A	DEAD
2338:13	480V REACTOR AUX BUS B	DEAD
2338:13	480V INTAKE AUX BUS A	DEAD
2338:13	480V INTAKE AUX BUS B	DEAD
2338:15	4160V BUS A	DEAD
2338:15	480V ENGD SAFGRDS BUS B	DEAD
2338:16	CIRC WATER PUMP 3A	OFF
2338:16	CIRC WATER PUMP 3B	OFF
2338:16	CIRC WATER PUMP 3C	OFF
2338:16	CIRC WATER PUMP 3D	OFF
2338:16	6900V BUS A	DEAD
2338:16	6900V BUS B	DEAD
2338:16	4160V BUS B	DEAD
2338:16	4160V ENGD SAFGRDS BUS A	DEAD
2338:16	4160V ENGD SAFGRDS BUS B	DEAD
2338:16	480V ENGD SAFGRDS BUS A	DEAD
2338:16	BREAKER 3392	OPEN
2338:16	RC PUMP 3A1	STOP
2338:16	RC PUMP 3B1	STOP
2338:16	RC PUMP 3A2	STOP
2338:16	RC PUMP 3B2	STOP
2338:23	EMERGENCY GENERATOR A RUNNING	YES

COMPUTER ALARMS

TIME	ALARM	
2338:25	4160V ENGD SAFGRDS BUS A	ENERG
2338:25	480V ENGD SAFGRDS BUS A	ENERG
2338:40	HIGH PRESSURE INJECTION REQUIRED	NO
2339:00	DH PUMP B	STOP
2341:29	MAKEUP PUMP A	OFF
2341:33	MAKEUP PUMP A	RUN
2342:15	BREAKER 3212	CLOS
2342:16	BREAKER 3212	OPEN
2342:20	BREAKER 3212	CLOS
2342:26	4160V ENGD SAFGRDS BUS B	ENRG
2342:26	480V ENGD SAFGRDS BUS B	ENRG
2342:35	MAKEUP PUMP C	RUN
2343:05	HEAT/COOL RATE EXCESSIVE	YES
2343:13	HEATING RATE (DEG F/HR)	146.9
2347:02	480V PLANT AUX BUS	ENRG
2347:11	BREAKER 3392	CLOS
2349:37	MAKEUP PUMP C	OFF
2351:37	480V HEATING AUX BUS	ENRG
2351:37	120VAC REG INST BUS 3A (VBOP-1)	ENRG
2351:37	BREAKER 3395	CLOS
2351:40	480V REACTOR AUX BUS A	ENRG
2351:56	PRESS RELIEF VLV RCV-110 OUT TEMP	246.5
2355:49	120VAC REG INST BUS 3B (VBOP-2)	ENRG
2355:49	BREAKER 3396	CLOS
2355:53	480V REACTOR AUX BUS B	ENRG
2356:39	NUCLEAR SVC CLNG WTR TNK LVL (FT)	7.79
2358:26	PRESS RELIEF VALV RCV-8 OUT TEMP	200.8
0000:37	AIRSIDE SEAL OIL BACKUP PUMP	RUN
0000:40	AIRSIDE SEAL OIL BACKUP PUMP	OFF

SIGNIFICANT SEQUENCE OF EVENTS
MONITOR ALARMS

TIME	ALARM
2339:45	BKR 1692 AIR PRESS LOW (LP SYS)
2339:45	BKR 1692 AIR PRESS LOW (HP SYS)
2339:45	230 KV BKR 1691 TRIP OP
2339:45	PLT LINE PRIM DIFF OP
2339:45	FW PP 3B TURB MN OIL PP 3B1 TRIP
2339:45	STEP UP XFMR PHASE B CONT CKT PWR FAIL
?????	INV 3A BATT SUPP
?????	TG EMERG BRG OIL PP DC AUTO START
?????	MU & P PP 3B TRIP
?????	STEP UP XFMR PHASE A AUX PWR FAIL
?????	TG EMERG BRG OIL PP OVRLD
?????	RC PRESS LOW NARROW RANGE
?????	RC PRESS HI NARROW RANGE
?????	TURB REMOTE TRIP
?????	TURB TRIP L/O RLY ACT
?????	INV 3B BATT SUPP
?????	RC PRESS HI
?????	STEPUP XFMR PHASE A EMERG AUX PWR FAIL
?????	RC PRESS LOW
?????	RC FLOW LOOP A LOW
?????	STEPUP XFMR PHASE A CONT CKT PWR FAIL
?????	U/A XFMR NORM AUX PWR FAIL
?????	BATT 3A2 DISCH LTI
?????	CW PP3A TRIP

SIGNIFICANT SEQUENCE OF EVENTS
MONITOR ALARMS

TIME	ALARM
?????	SU XFMR NORM AUX PWR FAIL
?????	SU XFMR EMERG AUX PWR FAIL
?????	MU FLO HI
?????	RC FLOW LOOP B LOW
?????	CRD AC BKR A OPEN
?????	CW PP 3D TRIP
?????	CW PP 3C TRIP
?????	CRD AC BKR B OPEN
?????	230 KV BKR 1692 TRIP OP
?????	230 KV BKR 1691 TRIP OP

B. PLANT PERFORMANCE

1. PRETRIP REVIEW

CRYSTAL RIVER UNIT THREE WAS OPERATING AT APPROXIMATELY 100% FULL POWER WITH THE ICS IN FULL AUTO. THE UNIT WAS GENERATING APPROXIMATELY 820 MW. THE ONLY UNUSUAL LINEUP WAS THE "B" DECAY HEAT PUMP RECIRCING THE BWS IN PREPARATION FOR SAMPLING THE TANK AS REQUIRED BY SP320 OPERABILITY OF BORON FLOW PATHS SURVEILLANCE.

A THUNDERSTORM HAD BEEN IN THE AREA FOR TWO TO THREE HOURS.

2. INITIATING EVENT

A LIGHTNING STRIKE ON THE FEEDER LINE FROM THE 230KV SWITCHYARD TO THE UNIT 3 STARTUP TRANSFORMER. THE STRIKE CLEARED THE FEEDER BREAKERS FROM THE SWITCHYARD AND THE FEEDER BREAKERS TO THE 6900 VAC AND 4160 VAC BUSES. THE BUS BREAKERS TRIPPING CAUSED AN UNDERVOLTAGE ON BOTH UNIT AND ENGINEERED SAFEGUARDS BUSES. THE REACTOR COOLANT PUMPS WERE BEING POWERED FROM THE UNIT AUXILIARY TRANSFORMER. LOSS OF THE UNIT BUSES AND THE ES BUSES LED TO A LOSS OF POWER TO THE CRD SYSTEM INITIATING A REACTOR/TURBINE TRIP. THIS TRIP CAUSED UNIT AUXILIARY TRANSFORMER UNDER VOLTAGE AND LOSS OF 6900 VAC RC PUMP BUS.

AT THIS TIME CR3 HAS EXPERIENCED A LOSS OF OFFSITE POWER. THE UNIT HAS NO FEEDERS COMING INTO THE BUSES FROM OFFSITE CLOSED AND THE UNIT IS WITHOUT POWER EXCEPT FOR DC POWER AND 120 VAC VITAL POWER FROM THE INVERTERS. THE REGULATED INSTRUMENT BUSES ARE POWERED FROM NONVITAL SOURCE AND TRIP AT THIS TIME CAUSING A LOSS OF SECONDARY PLANT INSTRUMENTATION SIGNALS.

3. PLANT POST TRIP RESPONSE

REFER TO FIGURES 1 THROUGH 7 FOR THE PLANT RESPONSE.

AS CAN BE SEEN FROM THE ATTACHED FIGURES, RC FLOW TOOK ABOUT THREE MINUTES TO COAST DOWN AND ABOUT ONE AND A QUARTER MINUTES INTO THE TRANSIENT NATURAL CIRC FLOW WAS BEGINNING TO TAKE OVER. THE TRANSITION CAN BE SEEN BY USING THE PLOT OF REACTOR T VS TIME, WHERE T BEGINS TO INCREASE NATURAL CIRCULATION FLOW IS BEGINNING TO PREDOMINATE. THIS FLOW IS BEING SET UP BY THE EMERGENCY FEEDWATER SYSTEM FILLING THE OTSG'S.

THE STARTUP CONTROL VALVES USED TO CONTROL LEVEL ON LOSS OF 4 RCP'S SHOULD HAVE FILLED THE STEAM GENERATORS TO 50% ON THE OPERATING RANGE. IN FACT, BOTH OTSG'S OVERFILLED. THE OVERFILL WAS DUE TO THE LOSS OF INSTRUMENT AIR CAUSING AN AIR LOCK ON THE STARTUP VALVES. THE OPERATIONS PERSONNEL RECOGNIZED THE PROBLEM AND ISOLATED THE STARTUP CONTROL VALVES AND SUBSEQUENTLY CONTROLLED STEAM GENERATOR LEVELS USING THE EMERGENCY FEEDWATER BLOCK BYPASS VALVES.

REALIZING THAT A LARGE COOLDOWN WOULD BE EXPERIENCED THE "A" MAKEUP PUMP WAS PLACED IN SERVICE, POWERED BY THE "A" EMERGENCY DIESEL, AND THE INJECTION VALVE TO THE COOLED NOZZLE WAS OPENED. PRESSURIZER LEVEL CONTINUED TO DROP AND THE DECISION WAS MADE TO USE BOTH NOZZLES FROM THE "A" MAKEUP PUMP. FLOW APPEARED TO BE LOW TO THE OPERATOR EVEN THOUGH PUMP LOAD INDICATED 110%. HE THEN SHUT DOWN THE "A" MAKEUP PUMP AND VERIFIED THE VALVE LINEUP AND RESTARTED THE "A" PUMP. LATER THE OTHER TWO INJECTION NOZZLES WERE OPENED IN AN ATTEMPT TO INCREASE FLOW. AT ABOUT 4 MINUTES INTO THE TRANSIENT THE "C" MAKEUP PUMP WAS

STARTED AND PRESSURIZER LEVEL CONTROL ESTABLISHED. A REVIEW OF THE MAKEUP PUMP CAPACITY CURVES SHOWS THAT THE INDICATED FLOWS WERE CORRECT FOR THE PRESSURES IN THE SYSTEM AND THE FLOW NOZZLES BEING USED.

UPON THE LOSS OF 4160 ES BUS VOLTAGE, BOTH DIESELS ATTEMPTED TO START AS THEY WERE DESIGNED. THE "A" EMERGENCY DIESEL WAS SUCCESSFUL AND LOADED PROPERLY. HOWEVER, THE "B" EMERGENCY DIESEL EXPERIENCED A "START FAIL" TRIP. THE "B" 4160 ES BUS AND ASSOCIATED 480 VES BUS WERE THEN POWERED FROM THE FOSSIL PLANT STARTUP TRANSFORMER. THE "B" EMERGENCY DIESEL WAS LATER TESTED AND ONE OF TWO 7 SECOND TIME DELAY "START FAIL RELAYS," WAS FOUND TO TRIP AT FIVE AND 8/100 SECONDS. THE EARLY TRIP OF THE ENGINE BY THE RELAY MAY NOT HAVE ALLOWED THE UNIT TO COME TO REQUIRED SPEED AND LUBE OIL PRESSURE. THE START FAIL RELAYS WERE RESET AND TESTED AND THE "B" EMERGENCY DIESEL HAS BEEN SUCCESSFULLY TESTED.

UPON LOSS OF BOTH MAIN FEEDWATER PUMPS THE EMERGENCY FEEDWATER PUMPS STARTED AND THE FEEDWATER BLOCK VALVES OPERATED AS DESIGNED. THE OPERATORS TOOK EARLY ACTION TO PREVENT OVERFEED BY CLOSING THE EMERGENCY FEEDWATER BLOCK BYPASS VALVES. UPON SEEING THE STEAM GENERATOR OVERFILL SITUATION, THE OPERATIONS PERSONNEL TOOK TWO APPROPRIATE ACTIONS, 1) SHUT THE EMERGENCY FEEDWATER BLOCK VALVES AND TOOK LEVEL CONTROL USING THE EMERGENCY FLOW BYPASS VALVES, AND 2) TRIPPED THE STEAM DRIVEN EMERGENCY FEED PUMP TO PREVENT WATER INDUCTION TO THE PUMP. EMERGENCY FEEDWATER FLOW WAS THEN SUPPLIED AS REQUIRED USING THE ALREADY OPERATING MOTOR DRIVEN EMERGENCY FEED PUMP.

OTHER PROBLEMS EXPERIENCED DURING RECOVERY PHASE INCLUDE:

- A) INABILITY TO MAINTAIN NUCLEAR SERVICE WATER SURGE TANK LEVEL DEMIN WATER PUMPS SUPPLIED AS NON VITAL LOAD.
- B) WITH LOSS OF CIRCULATING WATER TO THE CONDENSER THE TURBINE SPEED DROPPED RAPIDLY CAUSING LOSS OF SEAL OIL TO MAIN GENERATOR SEAL OIL PUMP FAILED TO START DUE TO CLOGGED ORIFICE IN INSTRUMENT LINE. THIS ALLOWED THE GENERATOR HYDROGEN TO ESCAPE TO THE TURBINE BUILDING.
- C) WHEN THE UNIT BUSES EXPERIENCED THE LOSS OF POWER, THE WATER TREATMENT MOTOR CONTROL CENTER (MCC) WAS WITHOUT POWER, DEMIN WATER COULD NOT BE TRANSFERRED FROM THE WATER TREATMENT PLANT INTO CR3.
- D) THE CHEM-RAD AREA LOST VENTILATION AND WITH A HOT ENVIRONMENT AND SOMEWHAT UNSTABLE VOLTAGE SUPPLIES THE RADIOCHEMISTRY INSTRUMENT ACTION WAS INOPERABLE. COULD NOT GET PRIMARY SAMPLES AND COULD NOT GET ANALYZED.
- E) FAILURE OF LIGHTNING ARRESTOR SYSTEM TO PREVENT STRIKE CLEARING STARTUP TRANSFORMER.

THE UNIT WAS MAINTAINED IN THE HOT STANDBY MODE. POWER WAS REESTABLISHED INTO THE PLANT THROUGH THE STARTUP TRANSFORMER AT APPROXIMATELY 0436. NATURAL CIRCULATION WAS MAINTAINED UNTIL APPROXIMATELY 0830 THE MORNING OF THE 17TH OF JUNE, WHEN 4 RC PUMPS WERE RESTARTED. THE REASON FOR WAITING TO GO ON FORCED FLOW WAS REESTABLISHMENT OF ADEQUATE SECONDARY PLANT CONDITIONS TO HANDLE THE ADDITIONAL HEAT LOADS AND ADDITIONALLY THE RC SYSTEM BEHAVIOR ON NATURAL CIRCULATION WAS EXCELLENT.

4. OPERATOR ACTION AND PROCEDURAL ADEQUACY

THE OPERATOR ACTIONS WERE APPROPRIATE AND ADEQUATE DURING THIS EVENT. THE ATTACHED TABLE IS A COMPARISON OF THE OPERATOR ACTION, PLANT PROCEDURES, AND DRAFT ATOG. THE ATOG COMPARISON WAS BASED IN PART ON THE OCONEE UNIT 3 ATOG AND INFORMATION SUPPLIED BY B&W LYNCHBURG FROM THE CR3 DRAFT ATOG NOW BEING PREPARED.

THE OPERATOR ACTIONS INCLUDED ALL ITEMS ADDRESSED IN BOTH PLANT PROCEDURES AND DRAFT ATOG. IN ADDITION, THE OPERATOR RESPONDED TO PLANT SYMPTOMS NOT SPECIFICALLY ADDRESSED BY PROCEDURES.

THE ATTACHED TABLE INDICATES THAT THE OPERATOR ACTION, AND THE PLANT PROCEDURES ARE ADEQUATE TO PROVIDE THE MAJOR PLANT CONTROL INSTRUCTIONS NECESSARY TO MAINTAIN THE PLANT IN A SAFE CONFIGURATION DURING A LOSS OF OFFSITE POWER WITH FAILURE OF ONE EMERGENCY DIESEL GENERATOR.

THE PLANT STAFF IS TO BE COMMENDED FOR ITS ACTION BOTH DURING THE TRANSIENT AND THE QUALITY OF THE PLANT PROCEDURE AVAILABLE TO DEAL WITH THIS EVENT.

OPERATOR ACTION AND PLANT PROCEDURE COMPARISON

OPERATOR ACTION	PLANT PROCEDURES	DRAFT ATOG
<p>VERIFIED REACTOR AND TURBINE TRIP BY BOTH INDICATOR AND PARAMETERS</p>	<p>AP-110 REACTOR TRIP GP-101 COMPLETE TOSS OF EXTERNAL AC POWER</p>	<p>SECTION I</p>
<p>A. REACTOR HAD TRIPPED RODS WERE ON THE BOTTOM. POWER IS DECREASING</p>	<p>AP-110 VERIFY CRD TRIP TURBINE VALVES CLOSED, GENERATOR BREAKERS OPEN, AND ALL "ROD BOTTOM LIGHTS" ON, CLOSE LETDOWN. MAINTAIN >40"</p>	<p>A. TRIP THE REACTOR B. TRIP THE TURBINE II C. PROCEED TO SECT II</p>
<p>B. TURBINE HAD TRIPPED AND LOAD INDICATED "0" BREAKERS OPEN</p>	<p>IN PRESSURIZER LEVEL INDICATION</p>	<p>SECTION II</p>
<p>C. CLOSED LETDOWN ISOLATION</p>	<p>EP101</p>	<p>1. REACTOR POWER</p>
<p>D. STARTED A MAKEUP PUMP & VERIFIED FLOW</p>	<p>VERIFY AUTO ACTION INCLUDING AUTO START & LOADING OF BOTH DIESELS. IF NOT, ENERGIZE ES BUS(S) FROM UNIT 1&2 50 TRANSFORMER;</p>	<p>2. ALL RODS ON BOTTOM 3. TURBINE STOP VALVES CLOSED</p>
<p>E. WITH LOSS OF OFFSITE POWER IS NOT NECESSARY</p>	<p>VERIFY EFW FLOW AND LEVEL CONTROL; IF HPI HAS ACTUATED VERIFY SUBCOOLED MARGIN OR ECCS FLOW</p>	<p>4. LETDOWN FLOW 5. FEEDWATER RUNBACK 6. MNIX AND Y POWER ON 7. ICS POWER IS ON</p>
<p>F. OBSERVED B DIESEL FAILED TO START. ENERGIZED B4160V ES BUS FROM UNIT FOSSIL PLANT STARTUP TRANSFORMER</p>		<p>8. AUXILIARY POWER FROM SU TRANSFORMER. A. VERIFY AUTO START OF BOTH DIESELS; IF NOT LINE UP TO ALTERNATE POWER IF AVAILABLE. B. VERIFY EFW START & LEVEL CONTROL C. ENSURE MAKEUP PUMP START ADD SEAL INJECTION (ATOG DOES NOT SPECIFICALLY ADDRESS LOSS OF INSTRUMENT AIR OR MANY OF THE BOP PROBLEMS THE OPERATOR WAS FORCED TO DEAL WITH)</p>
<p>G. OPERATOR VERIFIED EFW FLOW. AND TOOK MANUAL CONTROL WHEN STARTUP VALVES FAILED TO CONTROL LEVEL STOPPED TURBINE DRIVEN EFW (AFTER VERIFYING MOTOR DRIVEN PUMP WAS RUNNING) TO PREVENT WATER DAMAGE TO THE TURBINE IN THE EVENT OF OVERFILL</p>	<p>RESTORE POWER AS SOON AS POSSIBLE (OVERFEED NOT ADDRESSED IN DETAIL)</p>	<p>9. NO SS ALARMS 10. ADEQUATE SUBCOOLING 11. ADEQUATE PRIMARY TO 12. O PRIMARY TO SECONDARY HEAT TRANSFER EXCESSIVE</p>
<p>H. OPERATOR VERIFIED HPI FLOW (MAKEUP) AND SUBCOOLED MARGIN</p>		<p>GO TO SECTION III C</p>
<p>I. CLOSED EFW BLOCK VALVE. CONTROLLED EFW BLOCK VALVE BYPASS (EFW 161 AND 162) AND CONTROLLED</p>		<p>SECTION III 3C 1.0 VERIFY PRESSURIZE LEVEL OR RESTORE W/ HPI OR MAKEUP</p>

OPERATOR ACTION AND PLANT PROCEDURE COMPARISON

OPERATOR ACTION	PLANT PROCEDURES	DRAFT ATOG
<p>J. STABILIZED THE PLANT VERIFIED NATURAL CIRCULATION BY OBSERVING TC DECREASE WHEN TBV'S WERE USED TO LOWER PRESSURE AND VERIFIED OTSG</p>		<p>2.0 RB PRESSURE/TEMP INCREASE 3.0 RB PRESSURE NOT INCREASING</p> <p>GO TO SECTION 5.0</p> <p>STEP 5.0 CLOSE START UP FEED WATCH CONTROL VALVE & ATTEMPT TO GAIN CONTROL (WHEN LEVEL APPROACHES SET POINT - GO TO STEP 6.0 IF OTSG LEVEL IS INCREASING.</p> <p>STEP 6.0 SECTION III3C 6.0 CONTROL RC TEMP W/ TBV 6.1 MAINTAIN APPROPRIATE LEVEL (THIS IS STEP 7.8) 6.2 CONTROL PRESSURIZED LEVEL</p>

C. SAFETY CONSIDERATIONS

THERE WERE NO SAFETY LIMITS EXCEEDED DURING THIS TRANSIENT. AUTOMATIC ESFAS ACTUATION WAS NOT REQUIRED; HOWEVER, HIGH PRESSURE INJECTION (HPI) WAS MANUALLY INITIATED TO PREVENT LOSS OF PRESSURIZER LEVEL INDICATION IN THE INITIAL POST-TRIP OVERCOOLING PORTION OF THE TRANSIENT. TWO HPI PUMPS WERE STARTED AND HPI FLOW DIRECTED FROM THE B.WST TO THE RCS THROUGH ALL FOUR HPI NOZZLES.

BOTH MAIN FEEDWATER AND FORCED RC FLOW WERE LOST CONCURRENT WITH THE LOSS OF OFFSITE POWER AND REACTOR TRIP. THE EMERGENCY FEED PUMPS STARTED AS DESIGNED AND SUPPLIED WATER TO THE OTSG'S THROUGH THE EMERGENCY FEEDWATER NOZZLES. A SLIGHT OVERCOOLING OF THE RCS OCCURRED WHEN THE STARTUP FEEDWATER VALVES DID NOT CONTROL THE STEAM GENERATOR LEVELS AT 50% ON THE OPERATOR RANGE, AS DESIGNED, BECAUSE OF THE AIR LOCKS DUE TO LOSS OF INSTRUMENT AIR. EMERGENCY FEEDWATER FED THE OTSG'S TO 80-90% ON THE OPERATE RANGE BEFORE THE OPERATOR STOPPED THE OVERFEED BY CLOSING THE EMERGENCY BLOCK VALVES. MINIMUM STEAM PRESSURES APPEAR TO HAVE BEEN 621 PSIG IN THE A STEAM GENERATOR AND 461 PSIG IN THE B STEAM GENERATOR. THE MINIMUM RCS PRESSURE WAS ABOUT 1355 PSIG AND RCS T_{AVE} DROPPED TO APPROXIMATELY 510°F. PRESSURIZER LEVEL REMAINED ABOVE 60 INCHES INDICATED LEVEL.

ONCE THE OPERATORS STOPPED THE OVERFEEDING OF THE STEAM GENERATORS, THEY ALLOWED THE STEAM GENERATORS TO BOIL DOWN TO THE 50% OPERATE RANGE LEVEL DESIRED FOR NATURAL CIRCULATION COOLING. PRESSURIZER LEVEL INCREASED TO OVER 200 INCHES AND RCS PRESSURE INCREASED TO ABOUT 2450 PSIG. THE PORV WHICH IS SET AT 2450 PSIG, OPENED AND CLOSED PROPERLY 4 OR 5 TIMES TO RELIEVE PRIMARY SYSTEM PRESSURE.

FOLLOWING THE REACTOR TRIP AND LOSS OF FORCED RC FLOW, NATURAL CIRCULATION FLOW WAS ESTABLISHED QUICKLY IN THE RC AS THE FORCED FLOW COASTED DOWN. THIS PROVIDED ADEQUATE COOLING FOR THE REACTOR CORE. THE REACTOR WAS MAINTAINED IN THE NATURAL CIRCULATIONS COOLING MODE FOR ABOUT 9 HOURS BEFORE THE RC PUMPS WERE RESTARTED.

IT TOOK THE "A" EMERGENCY DIESEL GENERATOR ABOUT 17 SECONDS AFTER THE LOSS OF OFFSITE POWER TO START AND LOAD THE "A" 4160 VOLT ENGINEERED SAFEGUARDS (ES) BUS. THE "B" EMERGENCY DIESEL GENERATOR CRANKED BUT DID NOT START. IT TOOK THE OPERATORS ABOUT 4 MINUTES TO REPOWER THE "B" 4160 VOLT ES BUS BY SWITCHING POWER TO UNIT 3 4160 ES BUS "B" FROM THE UNITS 1 AND 2 STARTUP TRANSFORMER.

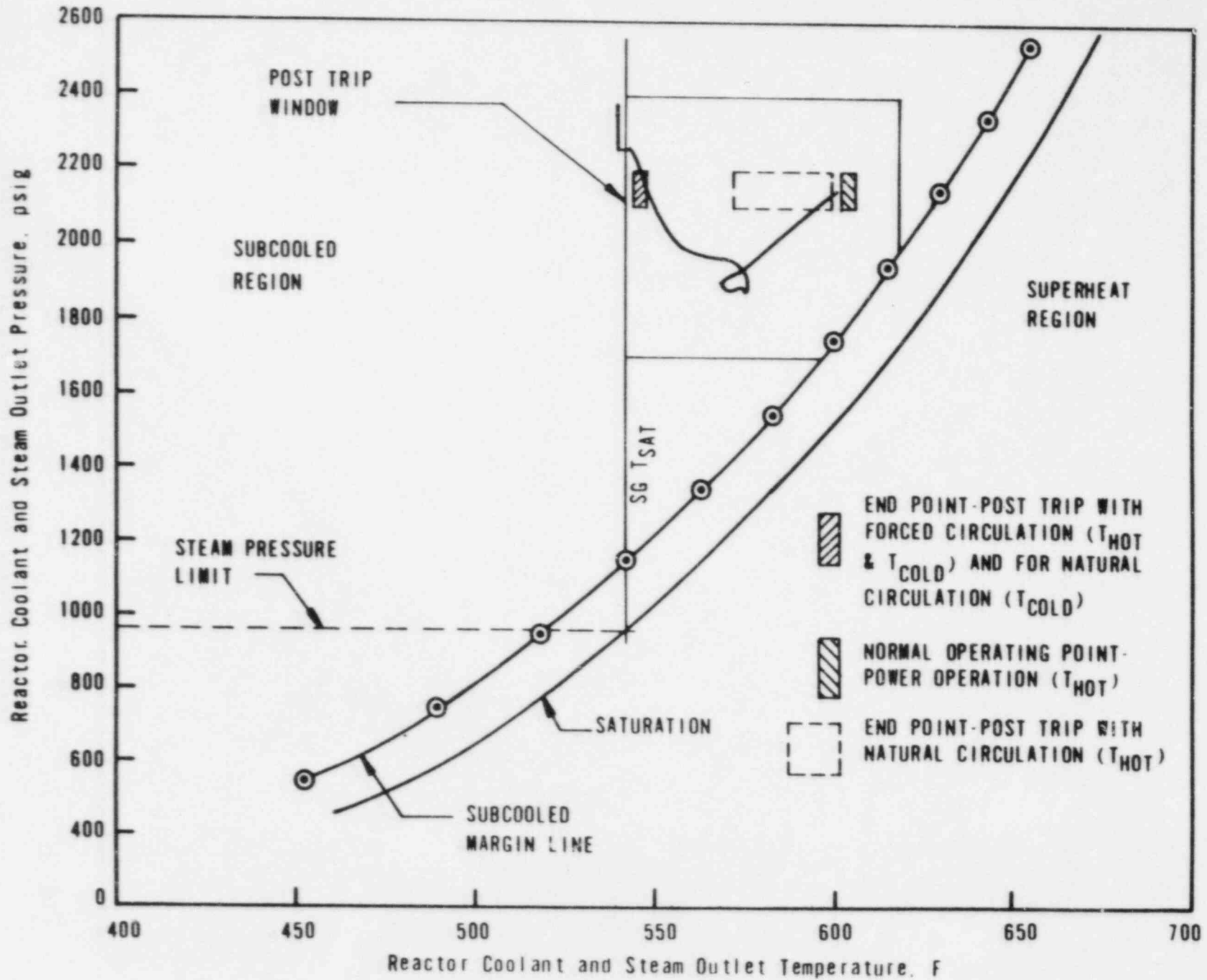
WHILE THERE WERE A NUMBER OF SECONDARY PLANT PROBLEMS WHICH REQUIRED OPERATOR ATTENTION AS A RESULT OF THE LOSS OF OFFSITE POWER, THE OPERATOR CLEARLY GAVE HIGHEST PRIORITY TO MAINTAINING ADEQUATE CORE COOLING AND PRIMARY SYSTEM INTEGRITY. ADEQUATE CORE COOLING AND SUBCOOLING MARGIN WERE MAINTAINED AT ALL TIMES DURING THE INITIAL TRANSIENT AND THE SUBSEQUENT 9 HOURS OF NATURAL CIRCULATION COOLING.

APPENDIX C
TRANSIENT ASSESSMENT PROGRAM
CORRECTIVE ACTION REPORT

PLANT: CRYSTAL RIVER III

TAP No:

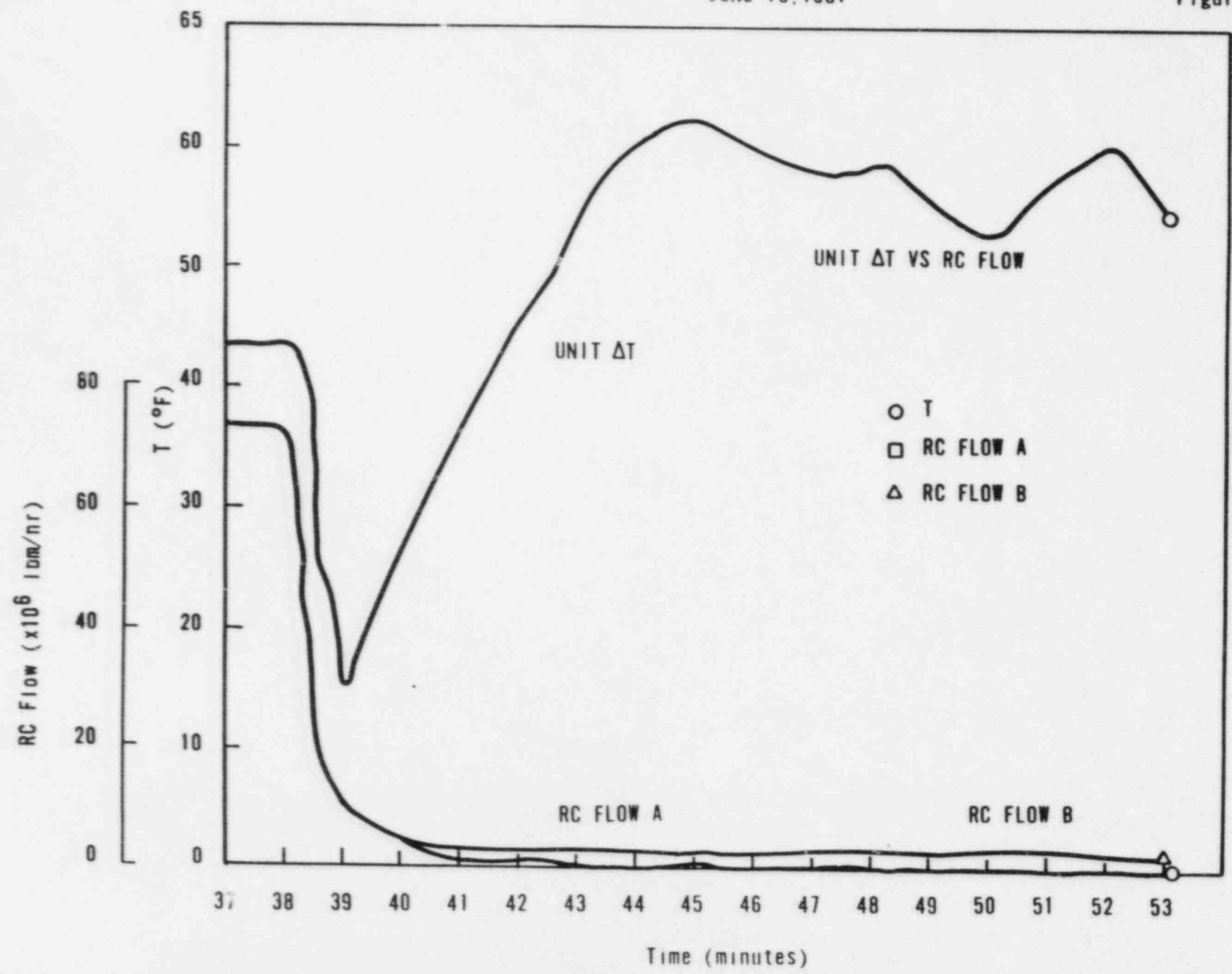
TRIP DATE: 06/16/81



LOSS OF OFFSITE POWER

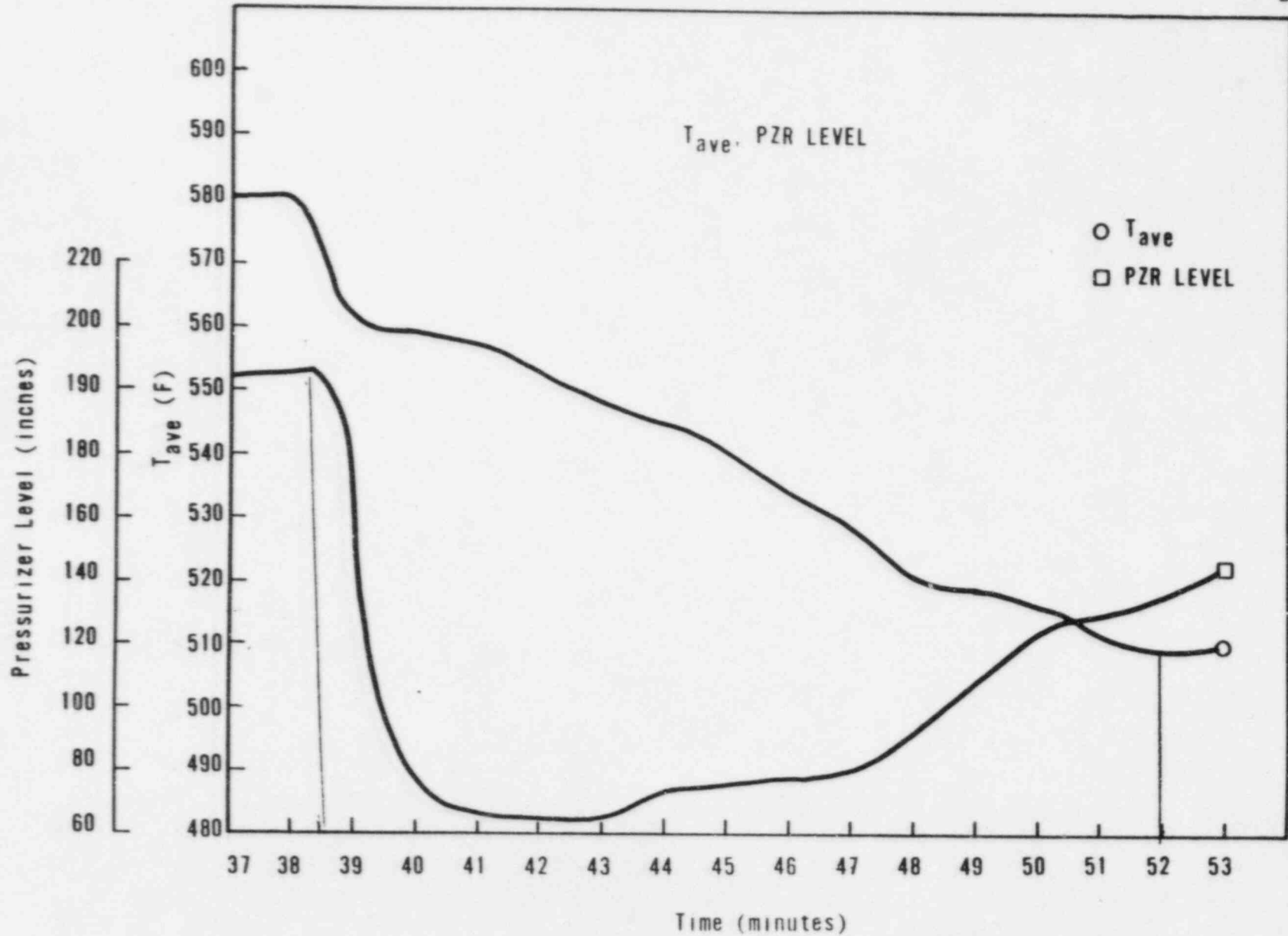
JUNE 16, 1981

Figure 2



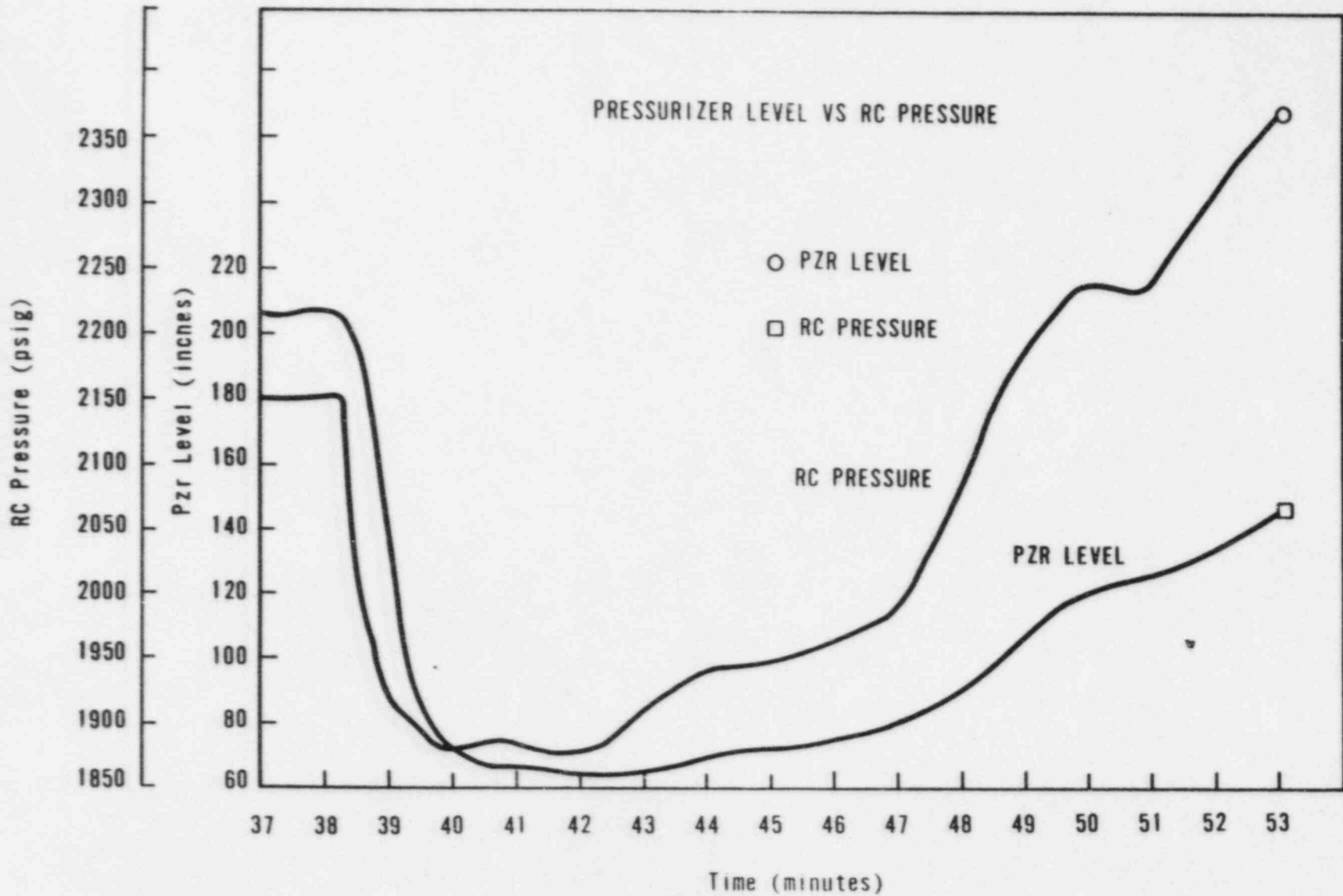
LOSS OF OFFSITE POWER
JUNE 16, 1981

Figure 3



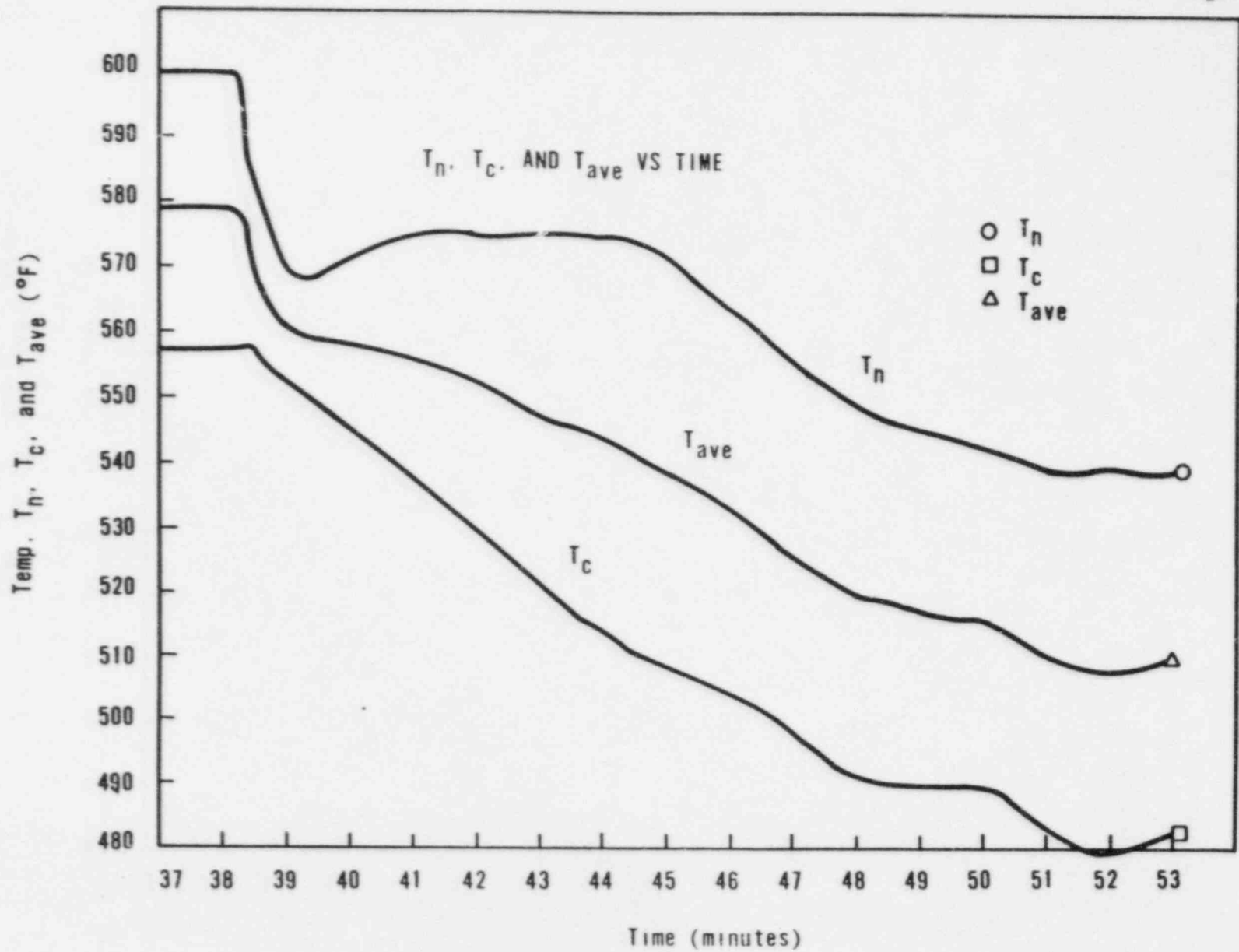
LOSS OF OFFSITE POWER
JUNE 16, 1981

Figure 4



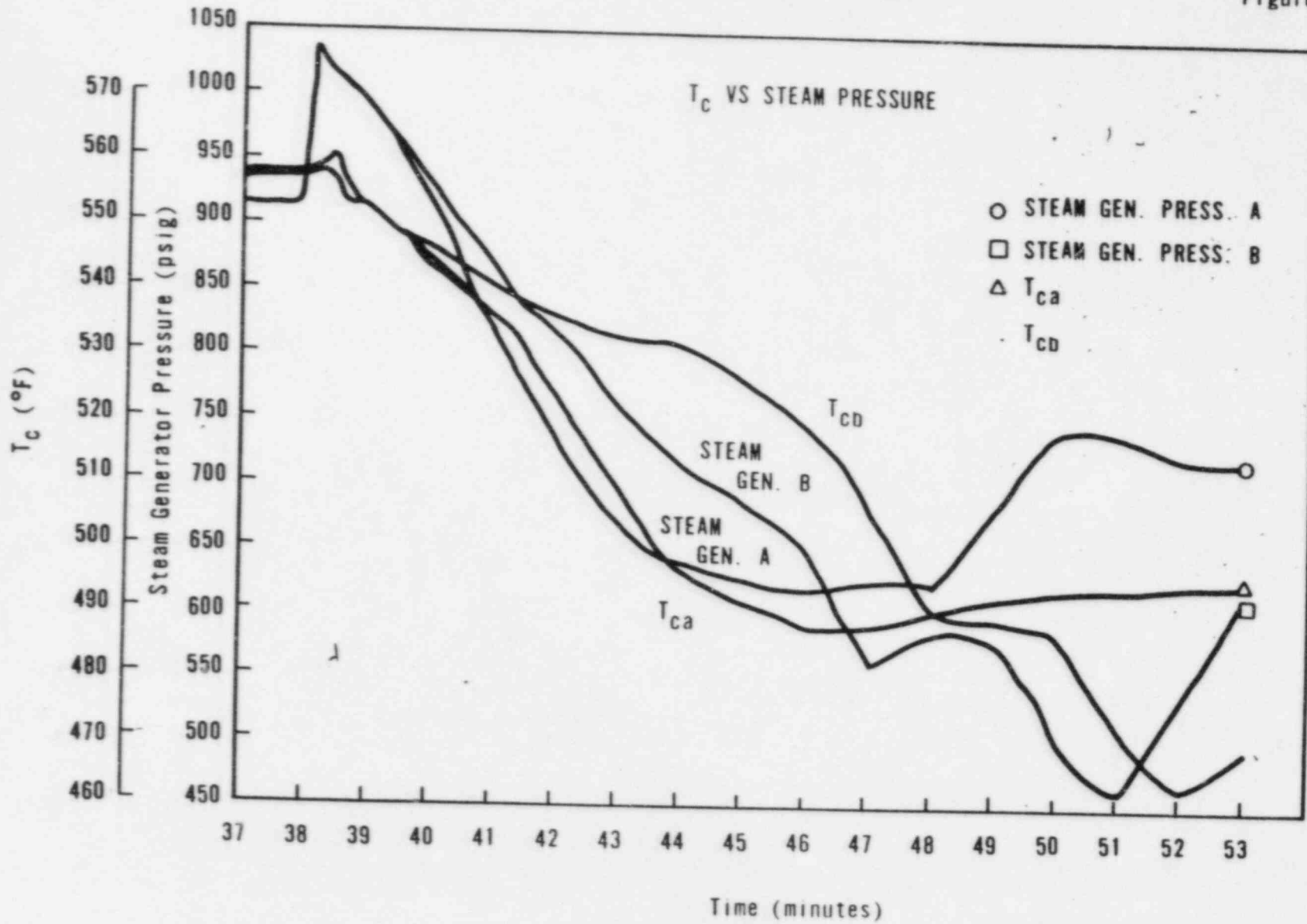
LOSS OF OFFSITE POWER
JUNE 19, 1981

Figure 5



LOSS OF OFFSITE POWER
JUNE 16, 1981

Figure 6



LOSS OF OFFSITE POWER
JUNE 16, 1981

Figure 7

