Entergy

Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61
P. O. Box 220
St. Francisville, LA 70775
Tel 225 336 6225
Fax 225 635 5068

Rick J. King
Director
Nuclear Safety Assurance

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

Subject: URI 50-458/0014-04 Station Blackout Valve, SWP-AOV599
River Bend Station - Unit I
License No. NPF-47
Docket No. 50-458

File Nos.: G9.5, G15.4.1

RBG-45648

RBF1-01-0022

Ladies and Gentlemen:

Entergy Operations, Inc. (EOI) is providing additional voluntary information in Attachment 1 to this letter for consideration by NRC in the significance determination process regarding SWP-AOV599, Station Blackout Valve, Unresolved Item (URI) 50-458/0014-04. Specifically, Inspection Report 00-14 indicated that this issue would require further risk evaluation by the Regional Senior Risk Analyst (SRA) using the significance determination process and would require a panel review by NRC. EOI is providing this information regarding our risk perspective considering the mitigation capability demonstrated herein. Our conclusions show that the unresolved issue is not risk significant.

RBS had previously performed a Phase III SDP Evaluation on September 21, 2000, and provided a copy to the station's Senior Resident Inspector. This evaluation was conducted using System Notebook SWP-10, Service Water/Service Water Cooling, Calculation G13.18.12.3-104 Revision 0, and River Bend Station's Probabilistic Safety Assessment Model (PSA), Revision 2D.

On January 11, 2001, EOI began implementing a revised PSA Model. This revised model will be used for any subsequent conditions.

A001

Should you have any questions regarding the attached information, please contact Mr. Joe Leavines of my staff at (225) 381-4642.

Sincerely,

RJK/rlb
attachment

cc:

Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

NRR Project Manager,
Robert E. Moody
U.S. Nuclear Regulatory Commission
M/S O-7D1
Washington, D.C. 20555

NRC Sr. Resident Inspector
P.O. Box 1050
St. Francisville, LA 70775

Background

During NRC inspection 50-458/0014 exit on November 17, 2000, the NRC issued URI 50-458/0014-04 pending safety significance determination regarding the inability of the Station Blackout Valve (SWP-AOV599) to open automatically. The finding was characterized as a maintenance rule issue in that RBS had not captured and evaluated the failure as required by the maintenance rule.

The inability of SWP-AOV599 to automatically open is a concern because the High Pressure Core Spray Pump Diesel Generator (HPCS DG) and its related cooling water pump could be damaged if operated for an extended period of time under these conditions. If the High Pressure Core Spray Diesel Generator were to fail, the HPCS pump would not be available during the Station Black Out Event.

It should be noted, however, that a failure of SWP-AOV599 is significant only if an additional failure occurs that prevents injection from the Reactor Core Isolation Cooling System (RCIC).

EOI has evaluated this issue using PSA insights, engineering evaluations of equipment design and performance as well as reviews of expected plant and operator response to a Station Blackout Event. It was established that a minimum of approximately five minutes of margin was available to recognize and take actions before the diesel would be damaged by operation without cooling water. Furthermore, more than seven minutes of shutoff head conditions could be tolerated prior to Standby Service Water Pump damage. Finally, it has been demonstrated that core damage will not occur without an injection source for 75 minutes. Operator response to a Station Blackout Event, as required by procedure, was also evaluated. This evaluation concluded that operators were very likely to take appropriate corrective action before equipment damage occurred and much earlier than the onset of core damage.

SBO Valve Functional Description

River Bend Station is a four-hour coping plant. During the RBS Blackout Coping Study, SWP-AOV599 was not credited nor required for acceptability. The valve subsequently was added to further improve the station's risk profile. The function of SWP-AOV599, the Station Blackout Valve, is to open during a Station Blackout (SBO) Event to allow cooling water flow to the High Pressure Core Spray System (HPCS) Diesel Generator by establishing a return path for service water to the Standby Cooling Tower. Solenoid valve SWP-SOV602C works in concert with SWP-SOV602A & B to automatically provide nitrogen to operate SBO Valve SWP-AOV599 (see Figure 1). During a SBO, both Division I & II standby diesel generators are postulated as failed coincident with a Loss of

Offsite Power and the HPCS DG is started, energizing Service Water Pump SWP-P2C. However, Standby Cooling Tower return isolation valve SWP-MOV55A remains closed because Division I & II motor operated valves are not energized. SWP-AOV599 automatically opens to create a bypass around closed valve SWP-MOV55A allowing SWP-P2C to supply Division I Standby Service Water and HPCS DG loads.

The solenoids operate as follows: when Div I and II power is available SWP-SOV602A and B are positioned to block nitrogen to SWP-AOV599 and upon loss of Division I and II power SWP-SOV602A and B fail open. When Division III Service Water Pump SWP-P2C' s discharge valve, MOV40C is not fully closed, SWP-SOV 602C energizes from Division III positioning SWP-AOV599 to provide a return path to the Standby Cooling Tower. Manual initiation involves the opening of SWP-SOV601 by energizing it when the Main Control Room control switch is placed in OPEN to bypass SWP-SOV602A-C. SWP-SOV600A and B energize when the control switch is placed in the CLOSE position to close SWP-AOV599.

Indicating lights are provided in the Main Control Room providing status of SWP-AOV599 and on each local enclosure supporting SWP-SOV601and 602A through C. These lights illuminate when the respective SOV energizes.

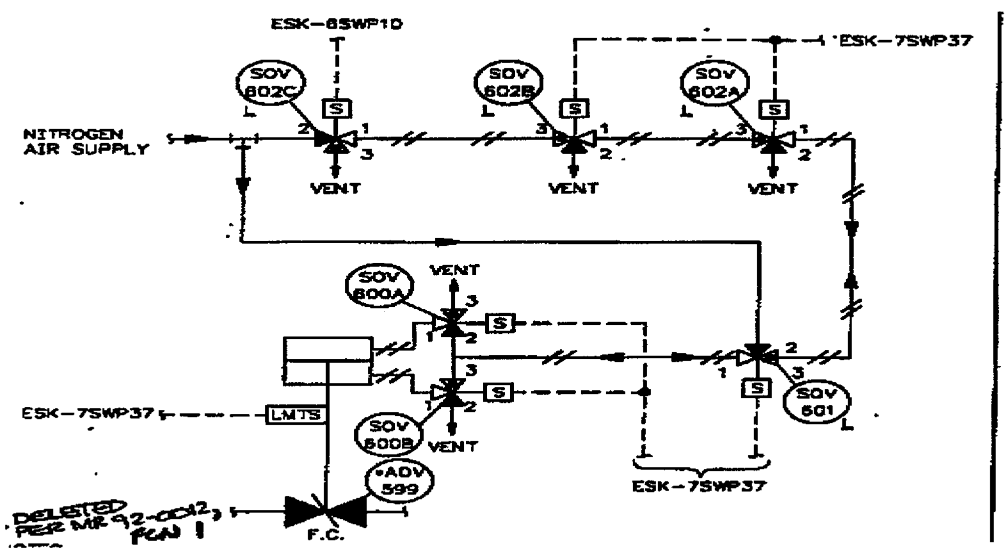

Figure 1

History

EOI installed SWP-AOV599 subsequent to RBS' Blackout Coping Study. Although not required or credited in this study, the valve was added to further improve the station's risk profile. The valve was installed and tested by a Modification Request, and was subsequently included in the IST Program in September 1992. The valve remained within the IST program until March 1995 when it was removed with the expectation that it be included in another acceptable testing process. No subsequent routine testing was established.

10CFR50.65 (a)(1) requires that for Maintenance Rule components and systems that a licensee monitor the performance or condition of structures, systems or components against established goals, to provide reasonable assurance that they are capable of fulfilling their intended function. The omission of SWP-AOV599 testing was identified in the RBS corrective action process and a new Repetitive Task was developed and implemented.

During the initial performance of the new Repetitive Task on March 8, 1999, SWP-SOV602C was found damaged. The test procedure had applied temporary power to the SOV and it began to smoke. At that point, the I&C technicians evaluated all associated fuses, those pulled and those still installed, and found that supply fuses F1 & F2 were blown. A faulted coil in the SOV was assumed to have occurred prior to this test (see Attachment 2, Figure 2 for clarification).

Investigation

The technicians determined during the RT performance in March 1999 that the fuses to SWP-SOV602C had blown in response to a faulted coil that occurred some time prior to their test. Since SWP-SOV602C operates in conjunction with SWP-MOV40C, a detailed review of maintenance and testing activities associated with the valve was conducted. The intent was to use the information to determine the most likely failure date. Review of quarterly stroke testing, minor inspections, corrective maintenance and ECCS testing information did not identify the failure date since the state of the solenoid valve SWP-SOV-602C was not checked during these evolutions. Motor operated valve signature testing of SWP-MOV40C was closely evaluated to discern whether or not a failure of the coil could be detected. The applicable traces indicated similar results from test to test and no definitive anomalies were detected. RBS concluded that the most probable failure date would be the first operation following the September 25, 1997, post-modification test supporting a fire protection modification. During this test, the function of SWP-SOV602C had been verified as satisfactory. Since no other credible failure could be substantiated, September 25, 1997 was used as the failure date to evaluate this issue.

Risk Evaluation

In accordance with the Significance Determination Process, a phase III PRA evaluation was performed to provide improved risk insight regarding the failure. RBS' PSA model assumes that a loss of offsite power concurrent with a failure of Division I and Division II power (Station Blackout) will result in the unavailability of Standby Service Water Pumps SWP-P2A, B & D and all associated motor operated isolation valves. Standby Service Water Pump P2C will start automatically on Division III power and supply the HPCS DG, HPCS Unit Cooler, and essential Train 'A' Standby Service Water loads. SWP-AOV599 provides a return path for service water flow to the Standby Cooling Tower; no credit is taken for manual action of this valve in the PSA model. SWP-AOV599 is assumed to fail if any one of the supporting solenoid valves (including SWP-SOV602C) fails.

The RBS Core Damage Frequency, including maintenance unavailability, is 3.16E-6 per year per revision 2D of the plant PRA. Using the methodology for temporary changes in the EPRI Probabilistic Safety Assessment Applications Guide (EPRI TR-105396), the calculated incremental risk values show that SWP-SOV602C, and the automatic function of SWP-AOV599, being assumed out of service for a one-year duration is non-risk significant. Specifically, the instantaneous risk would be 4.14E-6 per year; the incremental risk would be (4.14E-6/year – 3.16E-6/year) * (1 year) = 9.8E-7[1]. Most importantly it must be noted that if injection to the reactor is restored within approximately 75 minutes <u>no</u> core damage will result.

Engineering Evaluation

An independent engineering evaluation analyzed system response to a SBO Event in which SWP-AOV599 failed to automatically open. (See Attachment 2, Tables 1, 2, and 3 of this document for timelines.)

After SBO initiation, the Division III powered Standby Service Water Pump SWP-P2C starts and its discharge valve SWP-MOV40C starts to open. At Reactor Level 2, HPCS injection is initiated: the HPCS Pump reaches rated speed in about six seconds, at which point the HPCS DG is considered fully loaded. With SWP-AOV599 closed, service water flow is diverted to the Normal Service Water

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[1] RBS used PSA model Revision 2D to support this evaluation. On January 11, 2001, PSA Revision 3 was implemented; this Revision will be used for SDP determinations for events subsequent to that date. If this event were evaluated using the Revision 3 model the calculated core damage probability would increase with the major contributor being model changes in the probability of recovering offsite power, including updates for industry operating experience. The risk insights accounting for recovery based upon operator actions discussed in this letter would remain valid for PSA Revision 3. Calculation G13.18.12.3-104 conservatively determined that with no reactor injection, core damage does not occur for approximately 75 minutes. If SWP-AOV599 does not open operators are instructed by procedure to open it from the control room—simulator training also supports this requirement.

(NSW) Surge Tank SWP-TK3, effectively providing a cooling water flow path to the HPCS DG.

Approximately three minutes following the start of SWP-P2C, the Normal Service Water Surge Tank has completely filled. Under the most conservative assumptions, SWP-P2C discharge flow during this transient would vary from an initial 6338 gpm to a final 5011 gpm, with the associated flow through the HPCS DG Jacket Water Cooler varying between 779.9 to 615.8 gpm. EOI Engineering calculation G13.18.14.2*07-0 demonstrates that acceptable cooling of the HPCS DG Jacket Water Cooler is provided throughout this transient.

When the Normal Service Water Surge Tank reaches a high level of approximately 21.5-ft, prior to completely filling, the "SWC-General Area Trouble" annunciator is received in the Main Control Room. The Main Control Room annunciator and SWP-AOV599's valve position indication (green light indicating closed) would provide an indication of a line-up problem. Although not as readily apparent, Normal Service Water Surge Tank level could also be verified locally by an outside operator.

Once service water flow through the HPCS DG Jacket Water Cooler drops to 700 gpm during the fill of the Normal Service Water Surge Tank, the "Standby Diesel Generator Service Water Low Flow" annunciator is activated. Using available control room indications, the alarm response procedure prompts checking service water pressure and ensuring that a service water pump is running. These alarm response procedures also provide additional actions to check local panel annunciators to determine the specific cause of the alarm.

When the HPCS DG Jacket Water Cooler Service Water Outlet Temperature, reaches the setpoint of approximately 130 degrees F, the "D/G 1A, 1B, and 1C Service Water Return High Temperature" annunciator is received in the Main Control Room. This alarm is indicative of low service water flow or an incorrect valve lineup.

After the Normal Service Water Surge Tank has filled, the associated tank relief valve would lift and remain open until a return path to the Standby Cooling Tower is established (opening of SWP-AOV599 or SWP-MOV55A). The SWP-P2C head at shutoff is greater than the head required to (219.9-ft) ensure lifting of the relief valve. The lifting of the surge tank relief valve permits a flow of approximately 215 gpm. Although this flow rate is below the pump minimum flow requirement of SWP-P2C, it prevents a shutoff head condition. Still, this flow would be insufficient to ensure proper cooling of the HPCS DG Jacket Water Cooler so at the point that the Normal Service Water Surge Tank has filled, the HPCS DG Jacket Water Cooler is assumed starved of cooling. Based on engineering judgement and consultation with vendors and industry experts, it is expected that the Standby Service Water Pump can operate under these conditions for a period of greater than seven minutes without component damage.

Potential damage to the HPCS DG is assumed to begin upon receipt of the "HPCS DG Jacket Water High Temperature" annunciator. A site calculation indicates that coolant flow to the HPCS DG Jacket Water Cooler is needed within 68.7 seconds following the fill of Normal Service Water Surge Tank. This calculation conservatively assumes no service water flow through the DG Jacket Water Cooler, no radiant heat loss from the engine, and no heat transfer inside the jacket water cooler to service water.

However, General Electric BWR and RBS specific design documents 21A9236 and 21A9236-AU indicate that the HPCS DG engine would be capable of running at full load for at least two minutes without any raw cooling water from a standby condition.

This engineering evaluation conservatively concludes that the service water system is capable of supporting transient flow conditions for periods as long as seven minutes without damage. Moreover, the HPCS DG is capable of supplying loads uninterrupted for a period of approximately five minutes during this same transient flow scenario (see Table 1 Attachment 2). Considering these system performance capabilities, reasonable delays in the recognition of flow anomalies regarding service water cooling to the DG can be tolerated without equipment damage.

Expected Response to SWP-AOV599 Failure to Auto Open

Station operators are trained, tested and evaluated on Station Blackout Events. EOI's operator training program contained appropriate knowledge requirements regarding SBO valve function in the existing training materials. The theoretical and operational knowledge of SBO valve function and interrelationships are well understood. RBS operating crews were trained on SBO in simulator scenarios. However, in the past simulator training on the inability of SWP-AOV599 to open automatically was not specifically used to evaluate the crew response.

The procedure AOP-0050, "Station Blackout", contained the step to verify SWP-AOV-599 open. If during the verification process unexpected conditions arise, operations department policy would dictate that if SWP-AOV599 had failed to open automatically, the main control room switch (located in the immediate vicinity of the position indication) would have been taken to OPEN for manual initiation. Since the stroke time for SWP-AOV599 is about eight seconds, its failure to automatically open could be recognized before the Standby Service Water Pump Discharge Valve SWP-MOV40C (stroke time approximately 30 seconds) was fully open.

Revisions of AOP-0050 in effect from 9/25/97 to 3/10/00 included the following sections:

- Immediate Operator Actions: manual initiation of RCIC
- Subsequent actions:
    1. Dispatch an operator to attempt an emergency start of the diesel generators,
    2. Verify that SWP-P2C is running,
    3. Verify the discharge isolation valve SWP-MOV40C is open,
    4. Verify SWP-AOV599 is open,
    5. Within four hours verify sufficient inventory exists within the standby cooling tower

Additionally, AOP-0050 contained a caution that stated "prolonged operation of a DG without cooling water can lead to permanent damage to the DG, do not allow a DG to run for more than one minute without cooling water."

A decision on the part of an on-shift Reactor Operator to shutdown the HPCS DG during a station blackout event would be expected to involve consultation and concurrence by the Control Room Supervisor, as well as a determination that a low/no flow condition existed.

It is apparent that after providing an injection source, the focus of operators will be on ensuring DG cooling and maintaining adequate Standby Service Water inventory. In addition to the HPCS DG, operators will be restarting Division I and II DGs as available (the shortest path approach will be followed).

CONCLUSIONS

Considering an incremental risk of 9.8E-7, the demonstrated system performance margins, operator knowledge and experience regarding SBO valve function, and procedural guidance, the loss of the automatic function of SWP-AOV599 was not risk significant.

The plant response and procedures provide multiple opportunities to detect flow path anomalies. The Attachment 2, Tables 1, 2, and 3 in this document illustrate a high probability that operators will recognize the failure of SWP-AOV599 in time to mitigate the consequences and maintain the Division III DG operating. Even in the unlikely event that they would secure the running DG, an indication of low flow would have proceeded the securing of the DG and this knowledge would shorten the recovery time substantially—approximately sixteen minutes.

EOI evaluated the failure of SWP-AOV-599 to automatically open as follows:

- Engineering performed a Phase III SDP Evaluation to quantify risk. An incremental risk of 9.8E-7 was calculated.

- Engineering performed an evaluation of system and component capabilities, which concluded that significant margin exists before equipment damage results from operation without cooling flow.

- Operations determined expected plant and operator response to a SBO event.

The revision of procedure AOP-0050, "Station Blackout", that was effective at discovery of this failure contained an immediate action to ensure Reactor Core Isolation Cooling Pump function and supplemental actions to ensure cooling water to the DG. The focus on maintaining injection to the reactor vessel first and subsequently restoring electrical power and supporting service water is appropriate.

A Reactor Operator tasked with performing verification steps can reasonably be expected to note the failure of SWP-AOV599 to automatically open and initiate appropriate action to open the valve; in any event, he would not proceed to shutdown the HPCS DG without consultation with the Control Room Supervisor (CRS). Furthermore, determination that cooling water flow is lost to the HPCS DG would be made using operational knowledge, plant parameters and judgement—it is not expected that an operator would secure the HPCS DG without indications that point to a loss or lack of cooling. Indicators of low flow or loss of cooling to the HPCS DG would become apparent prior to HPCS DG damage. Possible triggers would be SWP-AOV599 valve position indication in the Main Control Room, "HPCS DG Jacket Water Cooler Service Water Return High Temperature", annunciator; "HPCS DG Jacket Water Cooler Service Water Low Flow", annunciator and eventually "HPCS DG Jacket Water High Temperature", annunciator. These precursors would provide sufficient input to achieve a timely manual actuation of SWP-AOV599 (See Attachment 2).

The station evaluated the possibility of operators securing the HPCS DG after failing to initially recognize that SWP-AOV599 had failed to open (see Table 3, Attachment 2). It is recognized that operators may not have been able act within exactly one minute, but the action point is "loss of flow" not simply 60 seconds elapsed time. Operators would have approximately 5 minutes prior to HPCS DG damage to recognize flow anomalies and restore flow. However, if the HPCS DG was secured during this time it could be restored in approximately 16 minutes or less.

The time to restore the cooling water flow path and restart the DG would not be expected to exceed 75 minutes and result in core damage.

Corrective Actions Taken

RBS has completed the following actions:

- Instituted routine testing of SBO Valve SWP-AOV599 and its supporting solenoids such that each of these three valves, as well as SWP-SOV601 (shared between the automatic and manual initiation pathways), is tested both individually and as a unit.

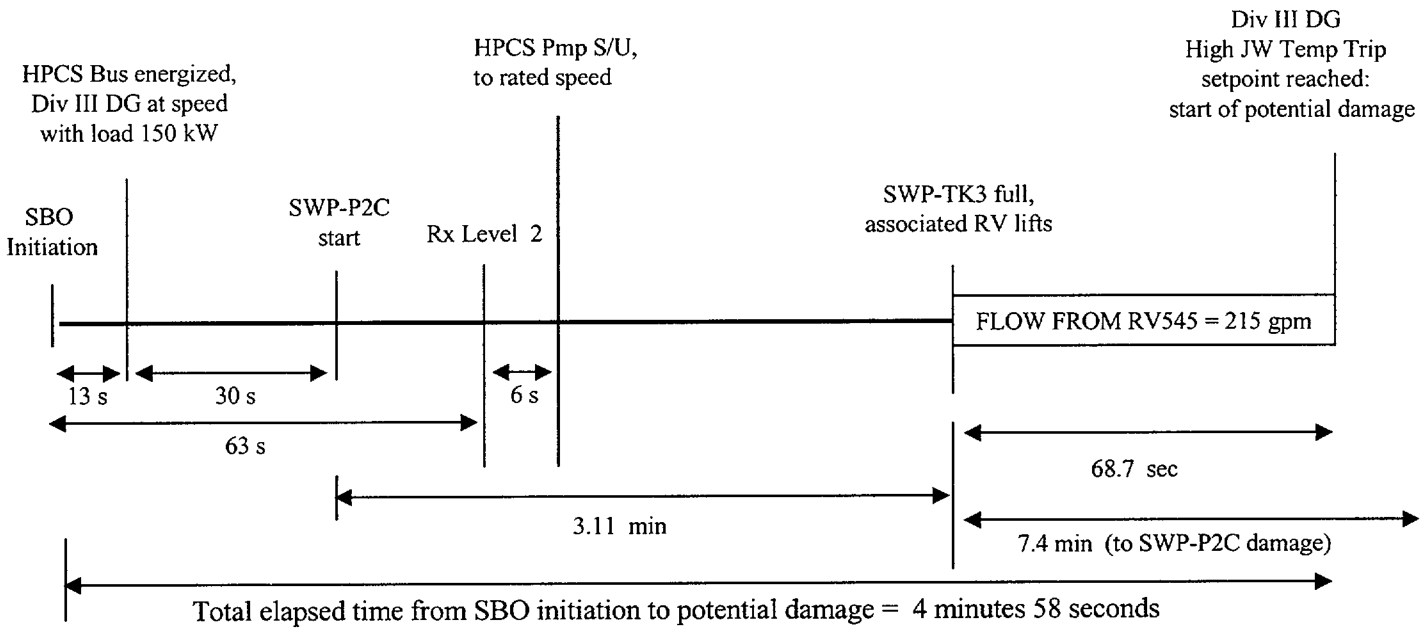
- Revised AOP-0050 to include Immediate Actions to ensure a return path to the Standby Cooling Tower during a Station Blackout event, versus the previous Subsequent Actions.

- Created and fully implemented simulator training scenarios that directly model the failure of the SBO valve to open.

EOI chartered an independent assessment team to conduct a review of RBS's efforts in the evaluation of SWP-AOV-599's failure to provide additional assurance that the evaluation was thorough and appropriate corrective actions were taken. No significant additional insight was gained; however, the assessment's findings were incorporated into the station's failure evaluation and corrective actions.

Table 1

SEQUENCE OF EVENTS
Estimated Time for Operator Action to Open SWP-AOV599



Initial Conditions: 100% power, RCIC failed, SWP-SOV602C failed

***NOTE: This timeline is representative of reasonable operator actions.**

Table 2

Path A: HPCS DG Not Secured & SWP-AOV-599 Manually Opened

Event ID	Time (sec)	Description of Event
T0	0	Loss of Offsite Power occurs
T1	5	Enter EOP-0001
T2	8	RCIC initiated
T3	10	Div I & II DGs fail to respond
T4	13	HPCS bus energized, Div III DG at speed
T5	15	Enter AOP-0050
T6	43	SWP-P2C started, MOV40C starts to open
T7	63	Rx Level 2
T8	69	HPCS Pump started, to rated speed
T9	73	SWP-MOV40C fully open
T10	78	Unit Operator performs AOP-0050 verifications
T11	88	Unit Operator manually opens AOV599
T12	96	AOV599 indicates full open, flow verified *(end of event)
T13* (timeline allowed to run to establish time to fail)	230	NORMAL SERVICE WATER SURGE TANK (SWP-TK3) filled, RV lifts (3 min, 7 sec)
T14	299	Div III DG Jacket Water High Temp (4 min, 58 sec)

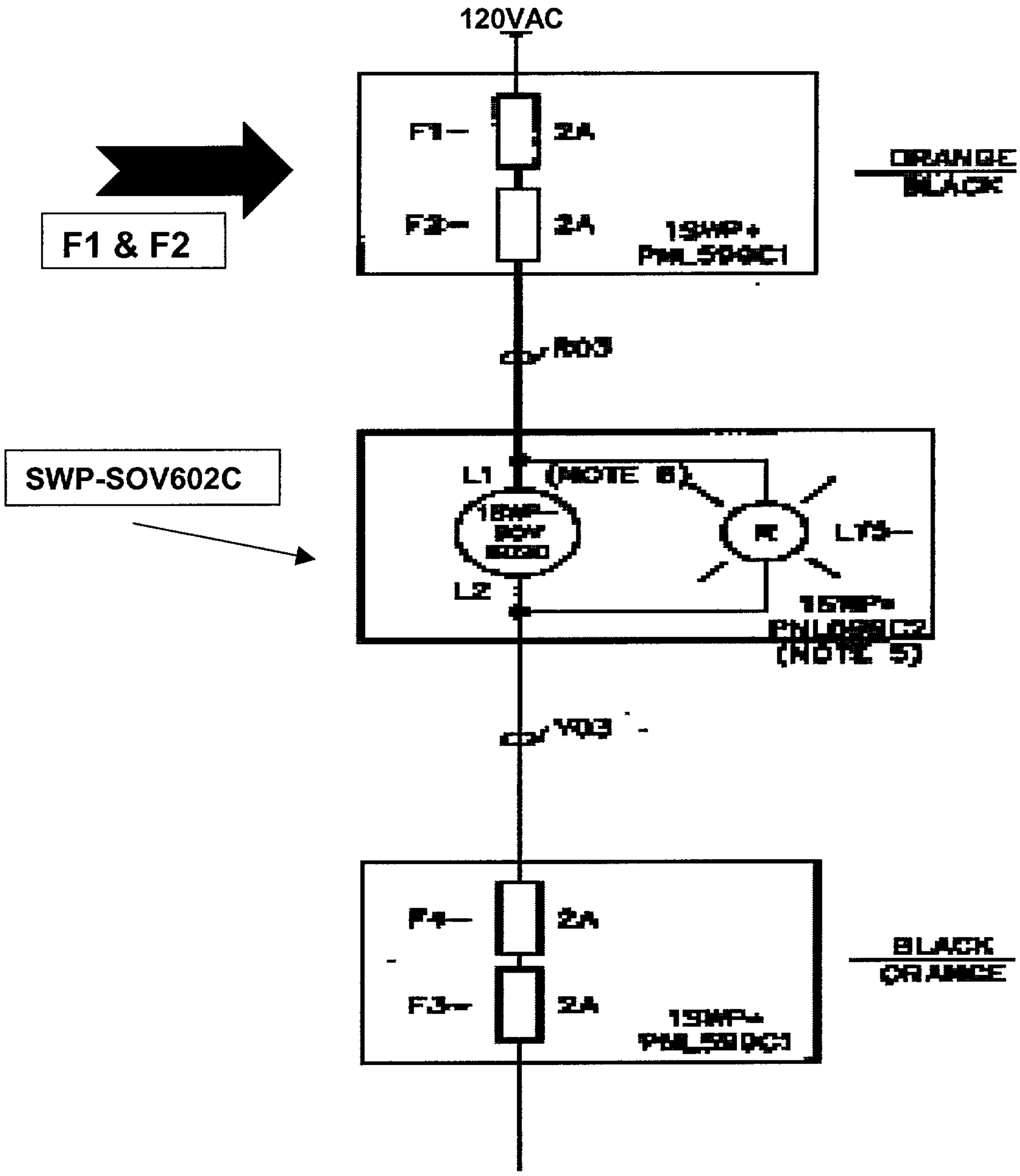
Table 3

Path B: HPCS DG Secured & Manual Opening of SWP-AOV599 Fails

Event ID	Time (sec)	Description of Event
T11	88	Unit Operator attempts to manually open AOV599, attempt fails
T12	98	Unit Operator trips Div III DG due to lack of cooling water
T13	121	Operator dispatched to manually open SWP-MOV55A
T14	131	Operator is dispatched to rack out HPCS pump breaker
T15	135	Control Building operator arrives at the DG control panel (approx. 2 min transit time) and begins troubleshooting Div I & II DG
T16	361	Operator arrives at SWP-MOV55A (approx. 4 min transit time) and starts to manually open valve
T17	731	Operator reports HPCS pump breaker racked out
T18	961	Operator reports SWP-MOV55A full open (approx. 10 min to open valve)
T19	1270	Unit Operator restarts Div III DG (approx. 5 min for MCR crew to decide it is OK to restart and identify procedure)
T20	1290	SWP-P2C starts, SWP-MOV40C open
T21	1307	Unit Operator checks SWP-P2C running with pressure/flow indicated.

***NOTE: These timelines are representative of reasonable operator actions. Response times are based on qualitative evaluation of simulator scenarios and plant walk downs.**

Figure 2


120VAC
F1 & F2
SWP-SOV602C
F1
F2
2A
2A
ORANGE
BLACK
L1
L2
(NOTE 5)
F4
F3
2A
2A
BLACK
ORANGE