	Entergy PSA Engineering Analysis	EA-PSA-SDP-D11-2-11-07	Rev. 1
		Attachment 12 – Page 1 of 26	

Attachment 12 HRA Calculator Output for Developed HEPs

This attachment contains the EPRI HRA Calculator output for the failure to trip charging pump HEP, and failure to align EY-10 to the bypass regulator, and failure to align an alternate charger, as discussed in Section 6.3.

References

- [1] EPRI HRA Calculator™, Version 4.0, Electric Power Software Center, 9625 Research Drive, Charlotte, NC 28262.

CVC-PMOA-P55-TRIP-S, OP FAILS TO STOP CHARGING PUMP OPERATION (HEP)

Cognitive Method	Date	Analyst - Reviewer
CBDTM/ASEP/THERP	12/07/11	FJY - BAB
Analysis File	File Date	File Size (Bytes)
Pal_Post_HEPs_r3 1-5-11.HRA	12/07/11	5935104

Table 1: CVC-PMOA-P55-TRIP-S SUMMARY

Analysis Method:	CBDTM/ASEP Combination (Sum)	
Analysis Database:	Pal_Post_HEPs_r3 1-5-11.HRA (12/07/11, 5935104 Bytes)	
Analysis Results:	without Recovery	with Recovery
P_{cog-CBDTM}	6.8e-03	3.1e-04
P_{cog-ASEP}	1.9e-03	1.9e-03
P_{exe}	2.0e-02	4.6e-03
Total HEP		6.8e-03
Error Factor		5

Identification and Definition
<p>This HEP is modified from the base case to replicate the conditions of the 9/25/2011 loss of dc event. As a result of the loss of dc and preferred ac power in this event an additional charging pump started on a right channel safety injection signal. Letdown was isolated when CV-2009 closed due a right channel containment high radiation signal. Consequently the event results in a charging letdown flow mismatch which results in a continuous rise in pressurizer level. This condition requires the operator action to control charging to regain control of pressurizer level prior to challenging a pressurizer safety. The timing regarding this action is provided under the time window description. This action is the same as the base case action under different conditions with the same indications and alternate timing as described in the 'Time Window' discussion.</p> <p>In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising.</p> <p>a. SOP-2A Section 7.3.9 TO RESTORE LETDOWN provides direction for restoring letdown flow. There is no stated procedural link between the ARPs and SOP-2A Section 7.3.8 ISOLATE LETDOWN AT RATED CONDITIONS. However, this section does provide direction to successfully mitigate this condition and may be referred to as the title describes the existing condition.</p> <p>b. In the event action is not taken to manually control charging flow, PZR level will continue rising and the PRESSURIZER LEVEL HI-LO, EK-0761 annunciator will alarm at 62.75% level, and then annunciator PRESSURIZER HIGH LEVEL, EK-0769 will alarm at 75% level. ARP response for these annunciators directs the operator to SHIFT level level control to the channel not in service. Additionally direction is provided that manual control may be necessary.</p> <p>On reactor trip the operators enter EOP-1.0 STANDARD POST-TRIP ACTIONS. Immediate Actions Step 5 directs the operator to manually control charging and letdown to maintain PZR level between 42% and 57%, at which time they take manual control of the charging pumps.</p> <p>1. Initial Conditions: Steady state, full power operations</p>

2. Initiating Event: Malfunction occurs spuriously isolating letdown.

3. Accident Sequence (preceding functional failures and successes):

LETDOWN HT EX TUBE OUTLET HI-LO PRESS EK-0704 annunciators alarms.

ARP-4 provides guidance that the operator may have to manually control pressure and RESTORE Charging and Letdown in a controlled manner per SOP-2A.

In this scenario, failure to trip charging pump(s) would challenge pressurizer safeties.

4. Preceding operator errors or successes in sequence: No operator errors or additional successes noted.

5. Operator action success criterion: Success is tripping charging pumps P-55B, C and/or A as necessary to restore level to the normal operating band .

6. Consequences of failure: SORV, LOCA, and potential for core damage.

Assigned Basic Events

Cues and Indications	
Initial Cue	EK-0704, LETDOWN HT EX TUBE OUTLET HI-LO PRESS
Recovery Cue	Pump breaker status indicating lights on panel EC-02. Charging flow indication FIC-0202 on panel EC-02. Pressurizer level indication LIC-0101A/B (narrow range on EC-02), LI-0103A (wide range, on EC-02) and LIA-0102A (wide range on panel EC-12).
Cue/s	In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising. In the event action is not taken to manually control charging flow, PZR level will continue rising and the PRESSURIZER LEVEL HI-LO, EK-0761 annunciator will alarm at 62.75% level, and then annunciator PRESSURIZER HIGH LEVEL, EK-0769 will alarm at 75% level. Additional indication available: LI-0103B on panel EC-33 in the Auxiliary Building 590 elevation LI-0102B on panel EC-150 in the Turbine Building 607 elevation
Degree of Clarity	Very Good

Procedures and Training	
Cognitive Procedure	ARP-4 TILE 4 (Revision: 58)
Cognitive Step Number	OPERATOR ACTION
Cognitive Instruction	CHECK Charging flow and Letdown flow matched.
Execution Procedure	ARP-4 TILE 4 (Revision: 58)
Other Procedure	SOP-2A (Revision: 69)
Job Performance Measure	PL-OPS-CVC-005J
Classroom Training	Frequency: 0.5 per year
Simulator Training	Frequency: 0.5 per year
Notes	
<p>Procedures applicable to this action</p> <p>EOP-1.0 STANDARD POST-TRIP ACTIONS REV 12 ARP-4 PRIMARY COOLANT PUMP STEAM GENERATOR AND ROD DRIVES SCHEME EK-07 (EC-12) REV 58 SOP-2A CHEMICAL AND VOLUME CONTROL SYSTEM REV 70</p> <p>In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising.</p> <p>TRAINING: Initial training and is included in 2 year training plan. JPM PL-OPS-CVC-005J, MANUALLY LOWER CHARGING AND LETDOWN FLOW includes an action to manually stop P-55B or P-55C when desired to reduce letdown flow. Stopping P-55A would be a similar action.</p>	

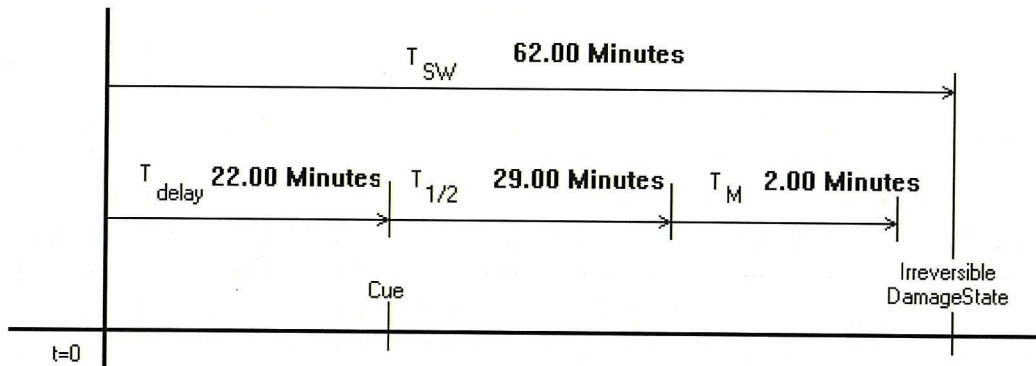
Manpower Requirements			
		Default	Actual
Operations:	Shift Manager	1	0
	Shift Supervisor	1	1
	STA	1	0
	Reactor Operators	2	1
	Plant Operators	4	0
Maintenance	Mechanics	0	0
	Electricians	0	0
	I&C Technicians	0	0
Health Physics	Technicians	1	0
Chemistry:	Technicians	1	0

Dependencies (Related Human Interactions)
CVC-AVOB-CV-2001 OP FAILS TO CLOSE CV-2001 ON HIGH TEMP AT LETDOWN HX E-58 (HEP)
CVC-AVOA-CV-2003 OPERATOR FAILS TO CLOSE LETDOWN ORIFICE STOP VALVE CV-2003 (HEP)
CVC-AVOA-CV-2122 OP FAILS TO OPEN LETDOWN INTERMEDIATE PRESSURE CONTROL (HEP)
CVC-PMOA-P55-TRIP OP FAILS TO STOP CHARGING PUMP OPERATION (HEP)
CVC-PMOE-P-55-2 OP FAILS TO START ADDITIONAL CHARGING PUMPS FOR 2 IN SERVICE
CVC-MVOA-SUCT-SRCE OP FAILS TO TRANSITION SUCTION SOURCE TO SIRWT (HEP)

Key Assumptions

Operator Interview Insights

Timing Analysis



Timing Analysis	
T_{sw}	62.00 Minutes
T_{delay}	22.00 Minutes
$T_{1/2}$	29.00 Minutes
T_M	2.00 Minutes
Time available for recovery	9.00 Minutes
SPAR-H Available time (cognitive)	38.00 Minutes
SPAR-H Available time (execution) ratio	5.50
Minimum level of dependence for recovery	HD

Notes

Regarding Tsw : The time for Tsw is based on the 9/25/2011 loss of dc event that led to increasing pressurizer level. The rising pressurizer level was consequence the loss dc power that caused isolation of letdown flow and a right channel safety injection signal. The right channel safety injection signal resulted in the start of an additional charging pump. The excess charging flow with no letdown flow caused the rise in pressurizer level and pressure. Based on the event timeline and additional information provided in the EA-PSA-SDP-D11-2-11-07, the time to the consequential condition that pressurizer safety would be challenged without operator intervention was determined to be 62 minutes. Additional details regarding the event response are discussed in the EA.

The time to the indication of high pressurizer pressure and increasing level was 22 minutes. The median (actual) response time was 29 minutes. The response time was a result of operator action to verify boration requirements were met prior throttling injection flow.

The base version of the HEP assumed a bounding condition and was based on three charging pumps operating with nominal letdown and assumed the consequential failure occurs when 100% level is reached and ignored the volume above 100%. The base version with three charging pumps operating predicted the time to consequential failure to be 30 minutes. The base version with only two charging pumps operating predicts consequential failure at 64 minutes similar to the Tsw for 9/25/2011 event.

The execution time is unchanged as the actions in this version are the same actions used in the base case.

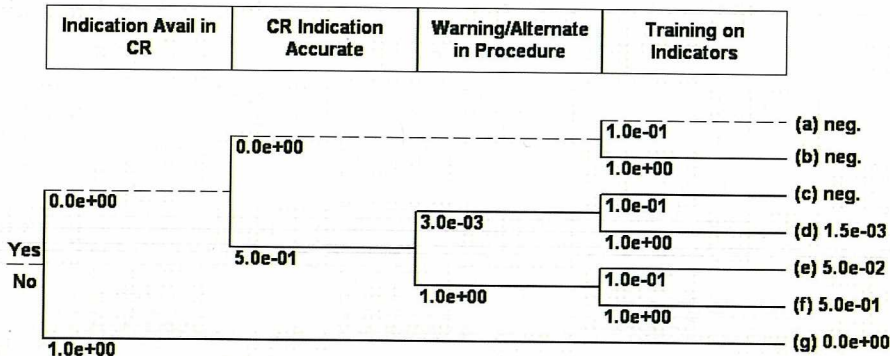
Per P-IOAQ (RMassa, 12/21/2010):

Tm: It would take ~2 minutes to complete the action once the need is identified.

NOTE: Currently, actions to open the additional letdown valves are not credited as part of this action.

Cognitive Analysis		
Pc Failure Mechanism	Branch	HEP
P _{ca} : Availability of Information	a	neg.
Notes: Indicators available, accurate. Crew trained.		
P _{cb} : Failure of Attention	l	7.5e-04
Notes: Workload expected to be high (multiple alarms). Operators monitor pressurizer conditions, using instruments located on a front panel. Indicators are alarmed.		
P _{cc} : Misread/miscommunicate data	a	neg.
Notes: The applicable indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.		
P _{cd} : Information misleading	a	neg.
Notes: Cues as stated.		
P _{ce} : Skip a step in procedure	g	6.0e-03
Notes: The steps concerning pressurizer control and leak isolation are not hidden in any way although they are not graphically distinct. The operators are in multiple procedures. The ONPs and the ARPs are Continuous Use procedures and the operators are required to mark off steps as they are completed via the circle/slash method of placekeeping.		
P _{cf} : Misinterpret Instructions	a	neg.
Notes: The procedure steps involving pressurizer control use standard wording and the operators have all the information they need to complete this action.		
P _{cg} : Misinterpret decision logic	l	neg.
Notes: There are no NOT, AND or OR statements in the decision logic for pressurizer control. The operators have practiced pressurizer control, however, the scenarios postulated for this action are do not clearly link the symptoms to the action of controlling the charging pumps.		
P _{ch} : Deliberate violation	a	neg.
Notes: The operators believe that the instructions contained in their procedures are accurate and adequate.		
Initial P _c (without recovery credited)		6.8e-03
Notes		
Cognitive Complexity		
	Complex	
Equipment Accessibility		
	Control Room (Panel C-12): Accessible	

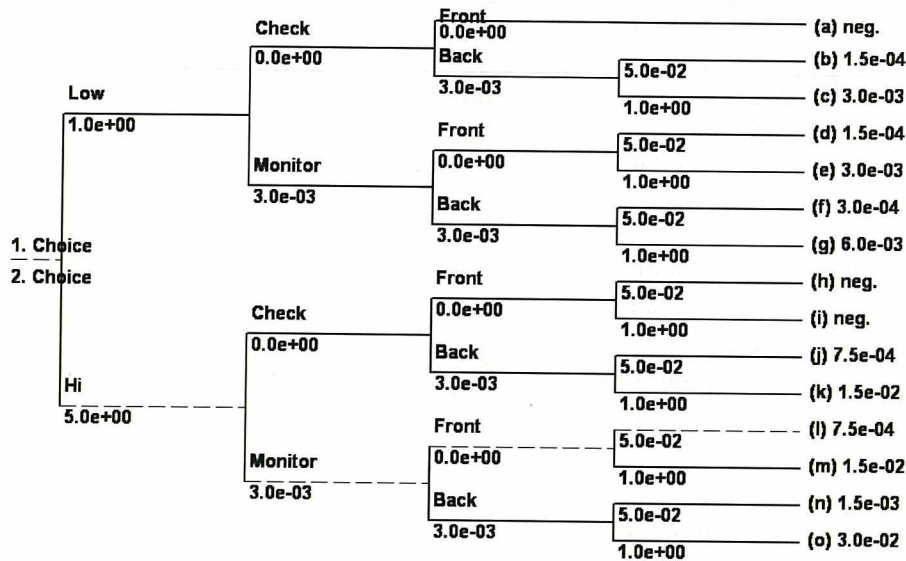
pca: Availability of information



Indicators available, accurate. Crew trained.

pcb: Failure of attention

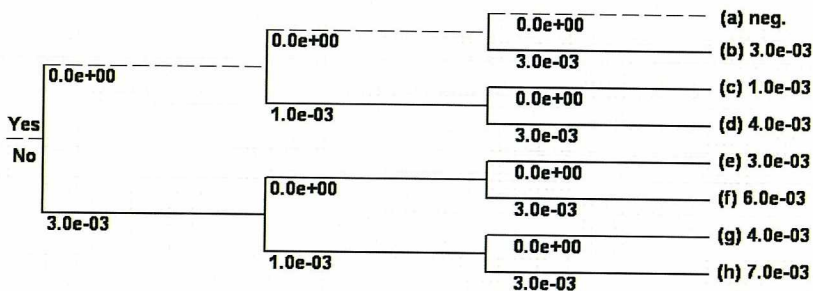
Low vs. Hi Workload	Check vs. Monitor	Front vs. Back Panel	Alarmed vs. Not Alarmed
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Workload expected to be high (multiple alarms). Operators monitor pressurizer conditions, using instruments located on a front panel. Indicators are alarmed.

pcc: Misread/miscommunicate data

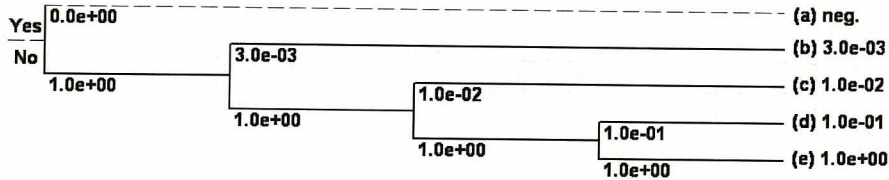
Indicators Easy to Locate	Good/Bad Indicator	Formal Communications
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The applicable indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.

pcd: Information misleading

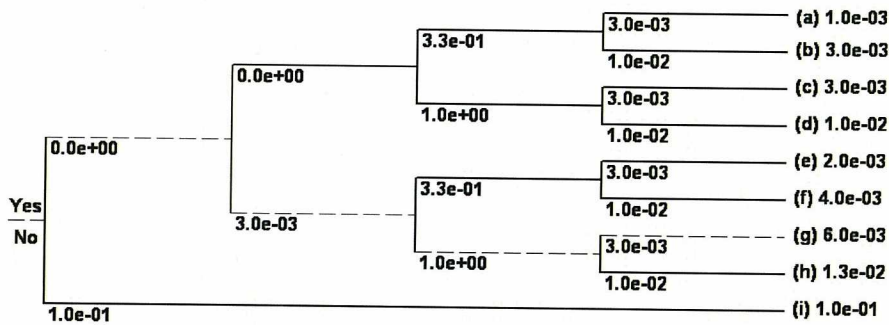
All Cues as Stated	Warning of Differences	Specific Training	General Training
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Cues as stated.

pce: Skip a step in procedure

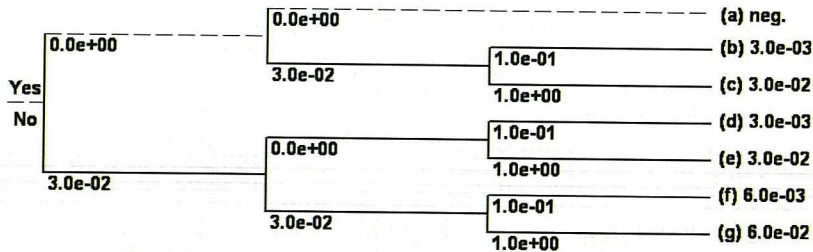
Obvious vs. Hidden	Single vs. Multiple	Graphically Distinct	Placekeeping Aids
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The steps concerning pressurizer control and leak isolation are not hidden in any way although they are not graphically distinct. The operators are in multiple procedures. The ONPs and the ARPs are Continuous Use procedures and the operators are required to mark off steps as they are completed via the circle/slash method of placekeeping.

pcf: Misinterpret instruction

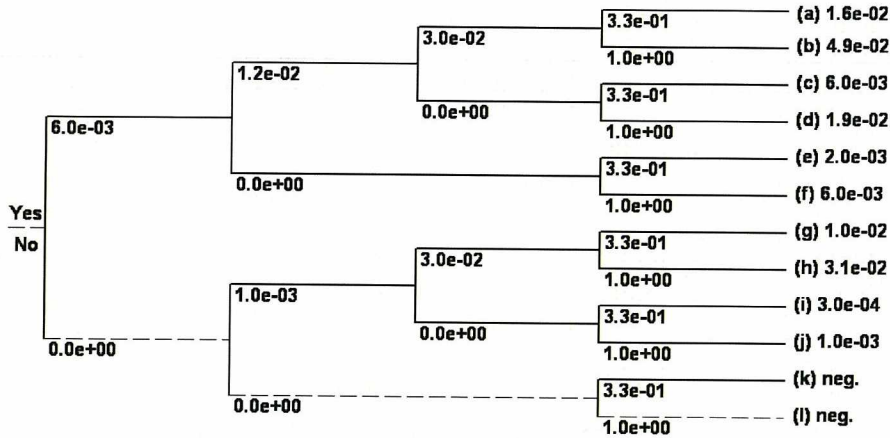
Standard or Ambiguous wording	All Required Information	Training on Step
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The procedure steps involving pressurizer control use standard wording and the operators have all the information they need to complete this action.

pcg: Misinterpret decision logic

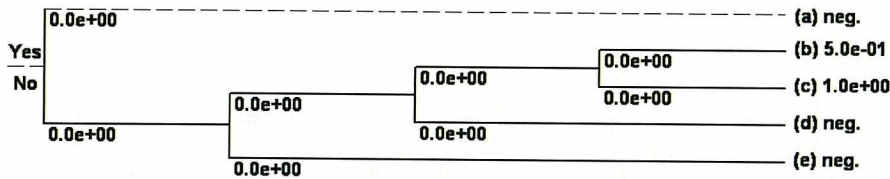
"NOT" Statement	"AND" or "OR" Statement	Both "AND" & "OR"	Practiced Scenario
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There are no NOT, AND or OR statements in the decision logic for pressurizer control. The operators have practiced pressurizer control, however, the scenarios postulated for this action are do not clearly link the symptoms to the action of controlling the charging pumps.

pch: Deliberate violation

Belief in Adequacy of Instruction	Adverse Consequence if	Reasonable Alternatives	Policy of "Verbatim"
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The operators believe that the instructions contained in their procedures are accurate and adequate.

Cognitive Recovery											
	Initial HEP	Self Review	Extra Crew	STA Review	Shift Change	ERF Review	Recovery Matrix	Dependency Level	Multiply HEP By	Override Value	Final Value
Pc _a	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc _b	7.5e-04	X	-	X	-	-	N/A	-	1.0e-02		7.5e-06
Pc _c	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc _d	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc _e	6.0e-03	X	X	-	-	-	N/A	-	5.0e-02		3.0e-04
Pc _f	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc _g	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc _h	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Final Pc (with recovery credited)											3.1e-04
Notes											
Pc uses "extra crew" as a surrogate for shift supervisor credit (Control Room Supervisor).											
Control room actions would be peer checked as they are performed by the other Reactor Operator, Shift Engineer or Control Room Supervisor.											

Pc ASEP Nominal Diagnosis Model

In order to compensate for possible non-conservative estimates produced by the cause-based method for short term actions (Time available for recovery <1 hour), the cognitive failure probability for short term actions is taken to be the sum of the cause-based and ASEP results; longer term actions do not include the ASEP component.

Use Nominal HEP because the event is not a "well-recognized classic", but it is trained on.

Actual Time	Error Factor	Median HEP	Mean	Upper Bound	Lower Bound
29.0 minutes	10	4.6e-04	1.9e-03	6.7e-03	3.1e-05

Execution Performance Shaping Factors		
Environment	Lighting	Normal
	Heat	Normal
	Radiation	Background
	Atmosphere	Normal
Equipment Accessibility	Control Room (Panel EC-02)	Accessible
Stress	Moderate	
	<i>Plant Response As Expected:</i>	Yes
	<i>Workload:</i>	High
	<i>Performance Shaping Factors:</i>	Optimal
Notes		
Following recognition of the need for the action (Pcognitive), the operator workload is assessed as high due to the number actions required as a consequence of the event. The PSFs are not negative for this action which is executed in the control room.		
Execution Complexity	Simple	

Execution Unrecovered						
Procedure: ARP-4 TILE 4, PRIMARY SYSTEM VOLUME LEVEL PRESSURE SCHEME EK-07 (C-12)		Comment			Stress Factor	Over Ride
Step No.	Instruction/Comment	Error Type	THERP			
			Table	Item		
EOP-1 Step 5.1 a	IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: a. OPERATE PZR Level Control System (PLCS).					2
	--	EOM	20-7b	2	1.3E-3	
		EOC	20-12	2	3.8E-3	
Total Step HEP						1.0e-02
EOP-1 Step 5.1 b	IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: b. MANUALLY OPERATE Charging and Letdown					2
	--	EOM	20-7b	2	1.3E-3	
		EOC	20-12	2	3.8E-3	
Total Step HEP						1.0e-02
EXEC RECOV - ICR	Execution recovery provided by independent personnel	See Section 4.3 of the HRA Notebook for further information. This execution recovery factor is applied to the individual execution steps with a dependence factor based on the time available for recovery. Note that the execution stress factors applied to the execution subtasks are not applied to the execution recovery factor. The EOM does not apply.			2	0.1
Total Step HEP						1.0e-01

Execution Recovered							
Critical Step No.	Recovery Step No.	Action	HEP (Crit)	HEP (Rec)	Dep.	Cond. HEP (Rec)	Total for Step
EOP-1 Step 5.1 a		IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: a. OPERATE PZR Level Control System (PLCS).	1.0e-02				2.3e-03
	EXEC RECOV - ICR	Execution recovery provided by independent personnel		1.0e-01	MD	2.3e-01	
EOP-1 Step 5.1 b		IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: b. MANUALLY OPERATE Charging and Letdown	1.0e-02				2.3e-03
	EXEC RECOV - ICR	Execution recovery provided by independent personnel		1.0e-01	MD	2.3e-01	
Total Unrecovered:			2.0e-02	Total Recovered:			4.6e-03

ACP-CBOB-BYREG-2, OPERATOR FAILS TO ALIGN BUS Y-01 THROUGH BYPASS REGULATOR TO SUPPLY A DE-ENERGIZED PFAC BUS (HEP)

Analyst:	FJY
Rev. Date:	12/08/11
Reviewer:	BAB
Cognitive Method:	CBDTM/THERP
Analysis Database:	Pal_Post_HEPs_r3 1-5-11.HRA (12/08/11, 5967872 Bytes)

Table 2: ACP-CBOB-BYREG-2 SUMMARY

Analysis Results:	without Recovery	with Recovery
P_{cog}	1.2e-02	6.0e-04
P_{exe}	6.5e-02	3.3e-02
Total HEP		3.3e-02
Error Factor		5

Assigned Basic Events:

Related Human Interactions:

Although Y20 is modeled in this calculation, the analysis applies equally to the alignment of any of the remaining preferred AC busses.

Initial Cue:

Loss of Preferred AC Bus Y10, Y20, Y30, or Y40

Recovery Cue:

Cue:

Multiple procedures (as listed in the "Procedures" section) direct the operators to verify that AC busses are energized. For the preferred AC busses, the contingency action directs OPS to:

- ONP-24.1, LOSS OF PREFERRED AC BUS Y10
- ONP-24.2, LOSS OF PREFERRED AC BUS Y20
- ONP-24.3, LOSS OF PREFERRED AC BUS Y30
- ONP-24.4, LOSS OF PREFERRED AC BUS Y40

Degree of Clarity of Cues & Indications:

Very Good

Procedures:

- Cognitive: ONP-24.2 (LOSS OF PREFERRED BUS Y20) Revision: 23
- Execution: SOP-30 (STATION POWER) Revision: 53
- Other: EOP-9.0 (FUNCTIONAL RECOVERY PROCEDURE) Revision: 19

Cognitive Procedure:

Step: 4.17

Instruction: IF a fault does NOT exist on Y20, THEN REFER TO SOP-30 AND PLACE Y20 on the Bypass Regulator.

Procedure Notes:

EOP-1.0, STANDARD POST-TRIP ACTIONS step 4.4.6) states: VERIFY 3 of 4 Preferred AC buses are energized.

EOP-2.0, REACTOR TRIP RECOVERY, step 4.9 directs the operators to verify that the given AC buses are energized. The contingency action for the preferred AC busses directs the operators to ONP-24.1 through ONP-24.4, LOSS OF PREFERRED AC BUS Y10 / Y20 / Y30 / Y40.

The following procedures contain this action:

EOP-2.0 REACTOR TRIP RECOVERY
 EOP-9.0 FUNCTIONAL RECOVERY PROCEDURE MV-AE-DC-1
 ONP-2.3 LOSS OF DC POWER
 ONP-24.1, 24.2, 24.3, 24.4 LOSS OF PREFERRED BUS Y-10, Y-20, Y-30, Y-40
 ARP-3 WINDOWS 34, 44, 45, 46 PREFERRED AC BUS NO. 1, 2, 3, 4 TROUBLE
 ARP-3 WINDOW 48 125V DC BUS UNDERVOLTAGE/TROUBLE
 SOP-30, STATION POWER, Section 7.6.2, To Supply a Preferred AC Bus With the Bypass Regulator

This is an Auxiliary Operator action, and the following JPMs are available:

(Licensed Operators) JPMP-OPS-EPS-001(PLACE PREFERRED AC BUS, Y-20 ON BYPASS REGULATOR)

Training:

Simulator, Frequency: 0.5 per year

JPM Procedure:

JPM ISBA-JPM-04 (PLACE PREFERRED AC BUS, Y-20 ON BYPASS REGULATOR) Revision: 6

Identification and Definition:

This action aligns power from bus Y-01 via the bypass regulator to a preferred AC power bus (Y-10, Y-20, Y-30 or Y-40) which has failed due to a failure of its power source, i.e. MCC-1 or MCC-2. As stated earlier, although Y20 is modeled here, the analysis applies to the alignment of any of the remaining preferred AC busses.

1. Initial Conditions: Steady state, full power operations
2. Initiating Event: LODC (bus ED-10)
3. Accident Sequence (preceding functional failures and successes):

Loss of DC power to DC bus ED10-R and ED10-L.
 Reactor Trip

Turbine Trip

OPS enters EOP-1.0 and performs the standard post-trip actions.

The operators would continue in EOP-1.0 and enter ONP-24.1 and ONP-24.3 For post trip actions and indications of loss of preferred ac panels EY-10 and EY-30.

ARP-3, alarm response refers the operators to ONP-24.1 and ONP-24.3 for alternatives to power the preferred AC panel loads.

EOP-1.0 event diagnostic directs the operator to EOP 9.0 if 3 of 4 preferred AC busses are not energized. Given the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0 Functional Recovery Procedure and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, 4 as applicable.

ONP-24.2 step 4.17 directs: IF a fault does NOT exist on Y20, THEN REFER TO SOP-30 AND PLACE Y20 on the Bypass Regulator.

SOP-30, STATION POWER, Section 7.6.2, To Supply a Preferred AC Bus With the Bypass Regulator.

4. Preceding operator errors or successes in sequence: No operator errors or additional successes noted.
5. Operator action success criterion: Success is restoring Y20 prior to battery depletion.
6. Consequences of failure: Loss of TD AF pump and AF valve control

Key Assumptions:

Current modeling assumes only Y-20 can be backed up by the bypass regulator. Any single preferred AC bus can be backed up.

Operator Interview Insights:

EOP-2.0, REACTOR TRIP RECOVERY, would only be entered if the scenario was an "uncomplicated" trip. If a LOOP is in progress, the operators would transition from EOP-1.0 to EOP-8.0 LOSS OF OFFSITE POWER/NATURAL CIRCULATION RECOVERY. EOP-8.0 safety function status checks require 3 of 4 preferred AC busses to be energized. So if only one is not energized, the function is met and NO corrective action is directed.

If the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0, Functional Recovery Procedure, and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, or 4 as applicable.

In summary, for loss of 1 preferred bus with any other single event in progress procedures do not direct any action being taken with exception of annunciator response procedure ARP-3.

Manpower Requirements:

Operations:	Shift Manager	1	0
	Shift Supervisor:	1	1
	STA:	1	1
	Reactor operators:	2	1
	Plant operators:	4	2
Maintenance:	Mechanics:	0	0
	Electricians:	0	0
	I&C Technicians:	0	0
Health Physics:	Technicians:	1	0
Chemistry:	Technicians:	1	0

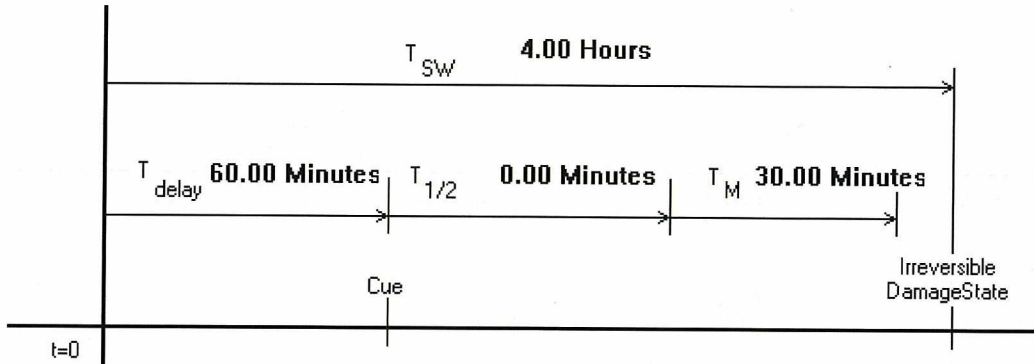
Execution Performance Shaping Factors:

Environment:	Lighting	Normal
	Heat/Humidity	Normal
	Radiation	Background
	Atmosphere	Normal
Special Requirements:		
Complexity of Response:	Cognitive	Simple
	Execution	Complex
Equipment Accessibility:	Control Room	Accessible
	Cable Spreading Room (AB 607')	Accessible
Stress:	Moderate	
	<i>Plant Response As Expected:</i>	Yes
	<i>Workload:</i>	Low
	<i>Performance Shaping Factors:</i>	Negative

Performance Shaping Factor Notes:

Because of the relatively long system window, the workload is not high. While the PSFs could be assigned as "negative" due to the emergency lighting in service for a LOOP case, operator interviews conducted in August 2009 confirmed that there is sufficient emergency lighting available for both access and execution. The PSFs are therefore not assessed as negative. Additionally, a second AO would do peer checking on a "not to delay basis." However, there is more than sufficient time to complete this action as the SPAR execution ratio is 6.

Timing:



Timing Analysis:

The system window is based on battery depletion time. As given in the EOP-3.0 basis document (rev 11) [47], the battery depletion time is 4 hours per DBD Chapter 4.01, Section 3.2.2, and FSAR Chapter 8.

According to an OPS estimate, it will take the operators 20 minutes to complete EOP-1.0. For a LOOP event, the crew will then transition to EOP-8.0 LOSS OF OFFSITE POWER/NATURAL CIRCULATION RECOVERY. EOP-8.0 safety function status checks require 3 of 4 preferred AC busses to be energized. If the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0 Functional Recovery Procedure and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, contingency action step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, 4 as applicable. Reaching this step is expected to take another 40 minutes per OPS estimates (08/26/09). Therefore, the time to reach the direction for this action is expected to take a total of 60 minutes. (Tdelay)

The manipulation time estimate for this action is 30 minutes. (OPS estimate 08/26/09)

Time available for recovery: 150.00 Minutes

SPAR-H Available time (cognitive): 150.00 Minutes

SPAR-H Available time (execution) ratio: 6.00

Minimum level of dependence for recovery: ZD

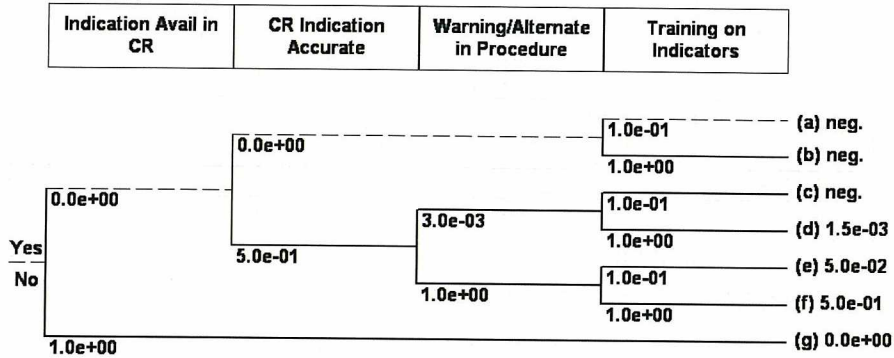
Cognitive Unrecovered

ACP-CBOB-BYREG-2

Table 3: ACP-CBOB-BYREG-2 COGNITIVE UNRECOVERED

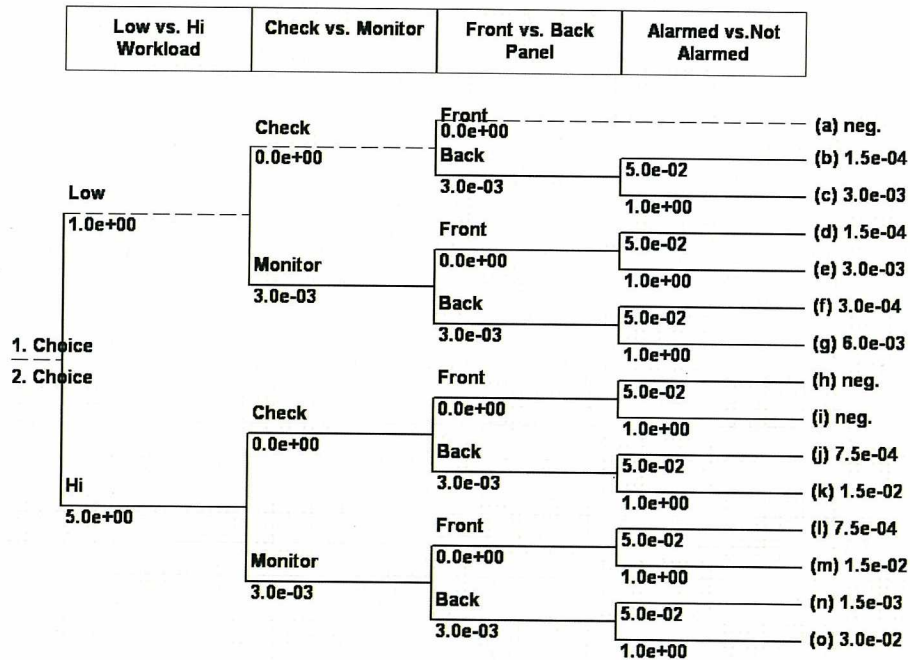
Pc Failure Mechanism	Branch	HEP
Pc _a : Availability of Information	a	neg.
Pc _b : Failure of Attention	a	neg.
Pc _c : Misread/miscommunicate data	a	neg.
Pc _d : Information misleading	a	neg.
Pc _e : Skip a step in procedure	g	6.0e-03
Pc _f : Misinterpret instruction	a	neg.
Pc _g : Misinterpret decision logic	c	6.0e-03
Pc _h : Deliberate violation	a	neg.
Sum of Pc_a through Pc_h = Initial Pc =		1.2e-02

pca: Availability of information



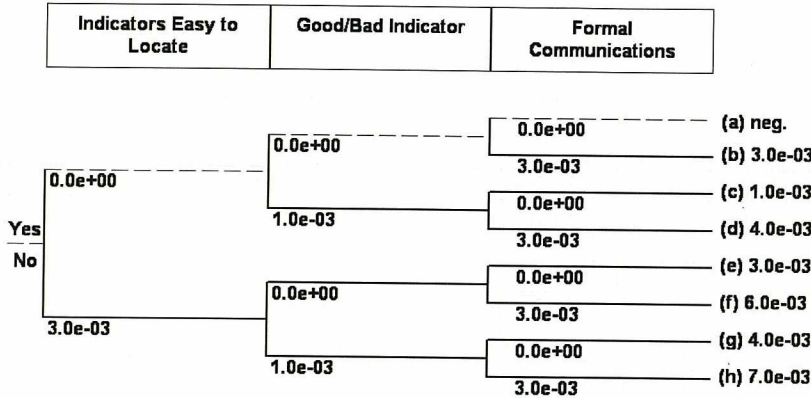
Preferred AC bus indications are available in the CR and they are accurate. The operators have been trained on all CR indications.

pcb: Failure of attention



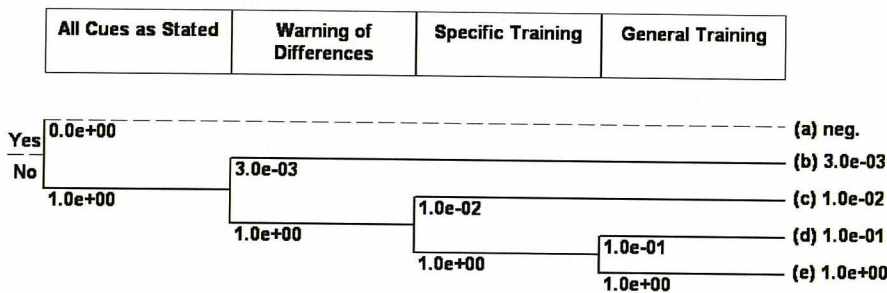
The operator workload would not be high in view of the long system window. The operator would only need to check preferred AC bus status, located on a front panel, to recognize the need for this action.

pcc: Misread/miscommunicate data



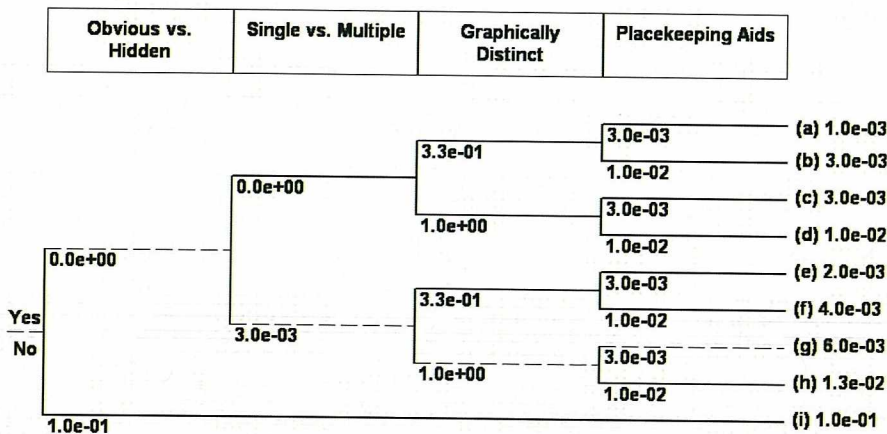
The AC bus indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.

pcc: Information misleading



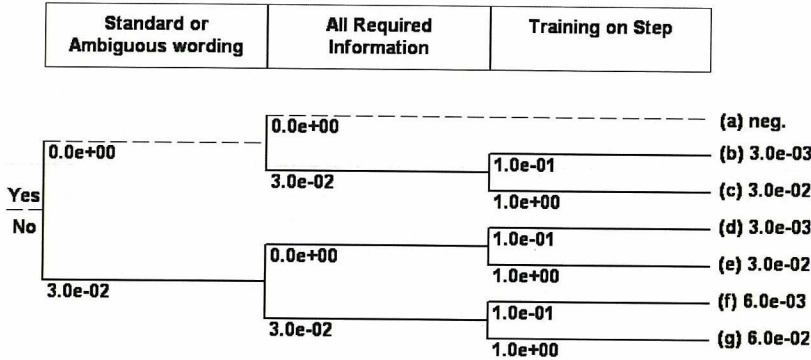
All cues are as stated.

pce: Skip a step in procedure



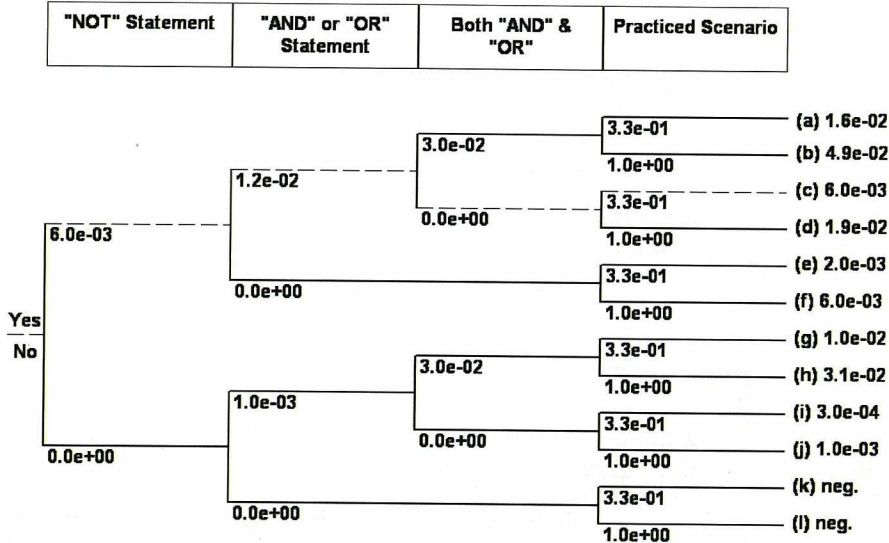
The applicable procedure steps are not hidden in any way although they are not graphically distinct. The operators are potentially in multiple procedures. The EOPs have placekeeping aids and the Palisades operators use the circle/slash method of placekeeping for the SOPs.

pcf: Misinterpret instruction



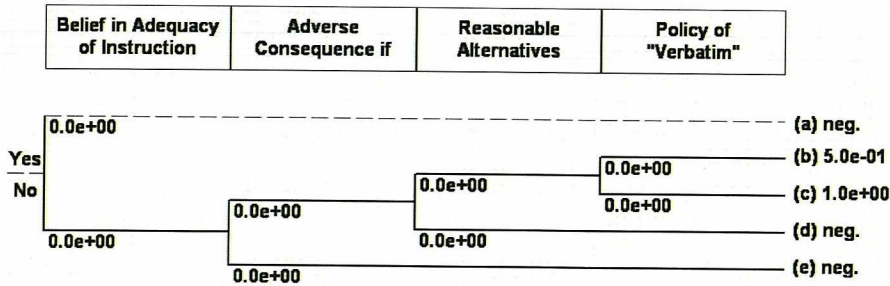
The applicable procedure steps use standard wording and the operators have all the information they need to complete this action.

pcg: Misinterpret decision logic



There are implied NOT and AND statements in the decision logic for this action. There are no OR statements. The operators have practiced loss of preferred AC bus restoration actions in the simulator.

pch: Deliberate violation



The Palisades operators believe in the adequacy of their instruction.

Cognitive Recovery

ACP-CBOB-BYREG-2

Table 4: ACP-CBOB-BYREG-2 COGNITIVE RECOVERY

	Initial HEP	Self-Review	Extra Crew	STA Review	Shift Change	ERF Review	DF	Multiply HEP By	Override Value	Final Value
P _{Ca} :	neg.	-	-	-	-	-	-	1.0e+00		
P _{Cb} :	neg.	-	-	-	-	-	-	1.0e+00		
P _{Cc} :	neg.	-	-	-	-	-	-	1.0e+00		
P _{Cd} :	neg.	-	-	-	-	-	-	1.0e+00		
P _{Ce} :	6.0e-03	X	X	-	-	-	-	5.0e-02		3.0e-04
P _{Cf} :	neg.	-	-	-	-	-	-	1.0e+00		
P _{Cg} :	6.0e-03	-	X	X	-	-	-	5.0e-02		3.0e-04
P _{Ch} :	neg.	-	-	-	-	-	-	1.0e+00		
Sum of P _{Ca} through P _{Ch} = Initial P _c =										6.0e-04

Notes:

"Extra crew" is used as a surrogate for "Shift Supervisor" (Control Room Supervisor) credit.

Execution Unrecovered

ACP-CBOB-BYREG-2

Table 5: ACP-CBOB-BYREG-2 EXECUTION UNRECOVERED

Step No.	Procedure: SOP-30, STATION POWER Instruction/Comment	Error Type	Comment			HEP	Stress Factor	Over Ride
			THERP					
			Table	Item				
ONP-24.2 NOTE	CHECK for fault per Note located prior to step 4.17 in ONP-24.2		NOTE located prior to step 4.17 in ONP-24.2: NOTE: If the loss of the preferred AC bus is due to the Inverter DC input breaker opening and the Inverter AC output breaker did NOT trip, it is unlikely that there is a fault on the preferred AC bus itself.				2	
	--	EOM	20-7b	2	1.3E-3			
		EOC	20-9	2	1.3E-3			
		EOC	20-11	7	neg.			
Total Step HEP							5.2e-03	
SOP-30 - 7.6.2.c	IF the Preferred AC Bus is to be restored on the Bypass Regulator following an Inverter failure, THEN PLACE the Manual Bypass Switch in the BYPASS SOURCE position.						2	
	--	EOM	20-7b	2	1.3E-3			
		EOC	20-12	4	1.3E-3			
		EOC	20-12	8a	2.7E-4			
Total Step HEP							5.8e-03	
SOP-30 - 7.6.2.d	CLOSE (ON) Breaker 41 on Instrument AC Bus Y01						2	
	--	EOM	20-7b	2	1.3E-3			
		EOC	20-12	12	3.8E-3			
		EOC	20-12	8a	2.7E-4			
Total Step HEP							1.1e-02	
SOP-30 - 7.6.2.e	PLACE the Kirk interlock key (SS key #234) into the breaker lock for Preferred AC Bus to be transferred. (Located in Bypass Regulator)		selection error is negligible				2	
	--	EOM	20-7b	2	1.3E-3			
	used as a surrogate	EOC	20-12	8a	2.7E-4			
Total Step HEP							3.1e-03	
SOP 30 - 7.6.2.f	PLACE the breaker lock to OPEN position (this allows permissive closing of associated breaker).						2	
	--	EOM	20-7b	2	1.3E-3			
		EOC	20-12	3	1.3E-3			
		EOC	20-12	8a	2.7E-4			
Total Step HEP							5.8e-03	


SOP 30 - 7.6.2.g	CLOSE (ON) the Bypass Regulator Breaker to the Inverter to be spared.					2	5.8e-03
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	4	1.3E-3		
		EOC	20-12	8a	2.7E-4		
Total Step HEP							
SOP 30 - 7.6.2.h.	PERFORM the following to transfer loads from the Inverter to the Bypass Regulator					2	5.8e-03
	--	EOM	20-7b	2	1.3E-3		
	selection error - CLOSE Bypass Source AC Input Breaker.	EOC	20-12	4	1.3E-3		
	manipulation error - CLOSE Bypass Source AC Input Breaker.	EOC	20-12	8a	2.7E-4		
	VERIFY In Sync light is ON.	EOC	20-9	1	neg.		
	VERIFY In Sync light is ON.	EOC	20-11	7	neg.		
	PUSH "Bypass Source To Load" pushbutton.	EOC	20-12	4	1.3E-3		
	PUSH "Bypass Source To Load" pushbutton.	EOC	20-12	8a	2.7E-4		
	VERIFY "Bypass Source Supplying Load" light is ON.	EOC	20-9	2	1.3E-3		
	VERIFY "Bypass Source Supplying Load" light is ON.	EOC	20-11	7	neg.		
	ENSURE Manual Bypass Switch in BYPASS SOURCE position.	EOC	20-9	2	1.3E-3		
	ENSURE Manual Bypass Switch in BYPASS SOURCE position. Used as a surrogate.	EOC	20-11	7	neg.		
	OPEN Inverter Output breaker.	EOC	20-12	4	1.3E-3		
	OPEN Inverter Output breaker.	EOC	20-12	8a	2.7E-4		
	OPEN Bypass Source AC Input breaker.	EOC	20-12	4	1.3E-3		
	OPEN Bypass Source AC Input breaker.	EOC	20-12	8a	2.7E-4		
DEPRESS ALARM RESET to clear Inverter alarms.	EOC	20-12	3	1.3E-3			
DEPRESS ALARM RESET to clear Inverter alarms.	EOC	20-12	8a	2.7E-4			
Total Step HEP							
SOP 30 - 7.6.2.6	OPEN Inverter Output breaker.	SHOULD I ADD THE STEPS OMITTED? If not - change to short list				2	2.3e-02
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	4	1.3E-3		
		EOC	20-12	8a	2.7E-4		
Total Step HEP							
EXEC RECOV - OCR	Execution recovery provided by independent personnel	See Section 4.3 of the HRA Notebook for further information. This execution recovery factor is applied to the individual execution steps with a dependence factor based on the time available for recovery. Note that the execution stress factors applied to the execution subtasks are not applied to the execution recovery factor. The EOM does not apply. Although the execution occurs in both the control room and in the cable spreading room, the "outside control room" execution recovery factor is applied.				2	0.5
	Total Step HEP						

Execution Recovery

ACP-CBOB-BYREG-2

Table 6: ACP-CBOB-BYREG-2 EXECUTION RECOVERY

Critical Step No.	Recovery Step No.	Action	HEP (Crit)	HEP (Rec)	Dep.	Cond. HEP (Rec)	Total for Step
ONP-24.2 NOTE		CHECK for fault per Note located prior to step 4.17 in ONP-24.2	5.2e-03				2.6e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.c		IF the Preferred AC Bus is to be restored on the Bypass Regulator following an Inverter failure, THEN PLACE the Manual Bypass Switch in the BYPASS SOURCE position.	5.8e-03				2.9e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.d		CLOSE (ON) Breaker 41 on Instrument AC Bus Y01	1.1e-02				5.5e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.e		PLACE the Kirk interlock key (SS key #234) into the breaker lock for Preferred AC Bus to be transferred. (Located in Bypass Regulator)	3.1e-03				1.6e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.f		PLACE the breaker lock to OPEN position (this allows permissive closing of associated breaker).	5.8e-03				2.9e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.g		CLOSE (ON) the Bypass Regulator Breaker to the Inverter to be spared.	5.8e-03				2.9e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.h.		PERFORM the following to transfer loads from the Inverter to the Bypass Regulator	2.3e-02				1.2e-02
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.6		OPEN Inverter Output breaker.	5.8e-03				2.9e-03
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
Total Unrecovered:			6.5e-02	Total Recovered:			3.3e-02

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Attachment 13 Procedure Use Evaluation for DC Panel ED-11-2 Fault Event

This attachment contains the following:

- Event procedure use in narrative format
- Event procedure use in flow chart format (Figure A13-1)

Note: the narrative and flow chart provide an overview of procedure usage during the ED-11-2 event. They are not all inclusive, i.e. they do not include all procedures referenced/used during the event.

Procedure Use Narrative


I. Procedure Use Expectations

During the ED-11-2 event multiple procedures were concurrently in use, including Emergency Operating Procedures (EOPs), Off Normal Procedures (ONPs), Annunciator Response Procedures (ARPs), General Operating Procedures (GOPs) and System Operating Procedures (SOPs). EOP and ONP procedure steps are written in the order the writer expects the plant to respond. Since the plant may not respond exactly as predicted, performance of steps out of sequence may be necessary. To avoid masking event symptoms and complicating diagnosis, additional actions to those stated in the EOP-1.0 Immediate Actions are not permitted until EOP-1.0 event diagnosis completion, except as directed as an immediate action of an applicable ONP, or are otherwise immediately essential for personnel safety, plant safety, equipment protection or safety of the public.

II. EOP-1.0 Standard Post-Trip Actions

Operators enter EOP-1.0 Standard Post-Trip Actions and perform Immediate and Operator Actions. The loss of dc and preferred ac buses precluded verification of some required conditions. For example, main generator breaker, atmospheric steam dump valve, and auxiliary feedwater pump P-8B and associated flow control valve indications were not available. Operators performed contingency action 2.b.1 to open the main generator breakers after verifying their status with International Transmission Control (ITC). The loss of dc panels ED-11-1 and ED-11-2 and preferred ac buses EY-10 and EY-30 were identified.

EOP-1.0 Operator Actions include performing GOP-10 Balance of Plant Actions Following A Reactor Trip and event diagnosis using the diagnostic flow chart. Due to not having at least 3 preferred ac buses energized, the operators were directed to EOP-9.0 Functional Recovery Procedure. GOP-10 checklist GCL-10.1 Post Trip Checklist Inside Control Room directs review of control panel annunciators and referencing associated ARPs. The unavailability of ED-11-1 and ED-11-2 noted previously and annunciator EK-0548 125V DC UNDERVOLTAGE ARP-3 Electrical Auxiliaries and Diesel Generator Scheme EK-05 (EC-11) direction provided cues for ONP-2.3 Loss of DC Power entry. Operators entered both EOP-9.0 and ONP-2.3.

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III. EOP-9.0 Functional Recovery Procedure

Operators enter EOP-9.0 and perform Operator Actions including referring to Site Emergency Plan (SEP) EI-1, verifying emergency boration in progress and identifying in use safety function success paths. It was determined that SEP implementation was not required.

The following safety function success paths were selected based on EOP-9.0 Resource Assessment Tree 'conditions' criteria:

1. Reactivity Control: RC-3 Boration Using SIS (due to SIAS activated)
2. Maintenance of Vital Auxiliaries Electric DC: MVAE-DC-1 Battery Chargers/Station Batteries
3. Maintenance of Vital Auxiliaries Electric AC: MVAE-AC-1 Offsite Power
4. Inventory Control: IC-2 Safety Injection (due to SIAS activated)
5. Pressure Control: PC-3 Saturated Pressure Control (due to SIAS activated)
6. Heat Removal: HR-2 S/G with SI Operating (due to SIAS activated)
7. Containment Integrity: CI-1 Automatic/Manual Isolation
8. Containment Atmosphere Control: CA-1 Containment Air coolers (Normal Mode*)
9. Maintenance of Vital Auxiliaries Water: MVAW-1 Service Water and CCW
10. Maintenance of Vital Auxiliaries Air: MVAA-1 Instrument Air Compressors


*Note: Although containment air coolers were operating in the Emergency Mode, CA-1 was selected based on meeting plant conditions criteria, i.e. containment temperature < 125oF and containment pressure < 0.85 psig.

Operators identified MVAE-DC-1 as the only jeopardized safety function and proceeded completing appropriate actions while monitoring other safety functions by performing periodic safety function status checks (SFSCs).

The MVAE-DC-1 instruction column Step 6 condition requiring at least 3 preferred ac buses energized was not met. This required operators to perform the contingency action ('ENERGIZE ALL available Preferred AC Buses'), referring to applicable ONPs (ONP-24.1 Loss of Preferred AC Bus Y-10 and ONP-24.3 Loss of Preferred AC Bus Y-30). After verification of bus EY-30 being fault-free, operators energized EY-30 from the bypass regulator per ONP-24.3 and SOP-30 Station Power Section 7.6.2.

Pressurizer (PZR) pressure and level controllers and the heater select switch were placed in channel B during performance of ONP-24.3. This action enabled the PZR spray valves (lowered PCS pressure), reduced P-55A charging pump speed from 53 gpm to 33 gpm and opened the letdown orifice isolation valves. Opening the orifice valves resulted in RV-2006 lifting and annunciator EK-0702 RELIEF VALVE 2006 RELIEF VALVE DISCH HI TEMP alarming. Operators isolated flow to RV-2006 by placing the orifice valve handswitches to close per ARP-4 Primary System Volume Level Pressure Scheme EK-07 (C-12).

Due to observed high PZR level, in use success paths Inventory Control IC-2 and Heat Removal HR-2 were referenced for direction to stop PCS inventory addition. Emergency boration requirements were verified per HR-2 Step 6 and safety injection throttling criteria verified per IC-2 Step 10. Operators then throttled safety injection, including stopping both operating charging pumps.

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IV. ONP-2.3 Loss of DC Power

Due to observed steam generator E-50A high level, operators identified the need to stop AFW pump P-8B. ONP-2.3 Step 2.b directs stopping P-8B by closing steam supply valve CV-0522B per SOP-12 Feedwater System Section 7.2.3 and Attachment 9. Operators dispatched a plant operator to close CV-0522B using EOP Supplement 19 Alternate Auxiliary Feedwater Methods Section 4 Steps 2.a and 2.b, which is equivalent to SOP-12 for the necessary actions.

After verifying dc buses ED-10L and ED-10R fault free, operators energized them from station battery ED-01 per ONP-2.3 Step 11 and placed #3 battery charger ED-17 in service per SOP-30 Step 7.8.2. After verifying bus EY-10 fault-free, and due to its normal power supply (inverter ED-06) not being available (dc input breaker tripped open), operators energized EY-30 from its normal power supply (inverter ED-08) per SOP-30 Step 7.6.3 and energized EY-10 from the bypass regulator per SOP-30 Step 7.6.2.


Reenergizing panel ED-11-1 resulted in instrument air compressor C-2A tripping and annunciator EK-1104 AIR COMPRESSORS C2A, C2B, C2C TRIP alarming. Per ARP-7 Auxiliary Systems Scheme EK-11 (C-13) operators manually started C-2B and C-2C and referred to ONP-7.1 Loss of Instrument Air. (Compressors C-2B and C-2C did not automatically start due to breaker 72-119 not being available.)

Procedure Use Flow Chart



Procedure Use Flow
Chart

Figure A13-1: Procedure Use Flow Chart

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References

- [1] Admin 4.06, Revision 20, Emergency Operating Procedure Development and Implementation
- [2] Admin 4.16, Revision 3, Off Normal Procedure Development and Implementation
- [3] ARP-3, Revision 70, Electrical Auxiliaries and Diesel Generator Scheme EK-05 (EC-11)
- [4] ARP-4, Revision 58, Primary System Volume Level Pressure Scheme EK-07 (C-12)
- [5] ARP-7, Revision 79, Auxiliary Systems Scheme EK-11 (C-13)
- [6] EI-1, Revision 54, Emergency Classification and Actions
- [7] EOP Supplement 19, Revision 10, Alternate Auxiliary Feedwater Methods
- [8] EOP-1.0, Revision 13, Standard Post-Trip Actions
- [9] EOP-9.0, Revision 21, Functional Recovery Procedure
- [10] EOP-9.0 HR-2, Revision 22, Heat Removal-2
- [11] EOP-9.0 IC-2, Revision 22, Inventory Control-2
- [12] EOP-9.0 MVAE-DC-1, Revision 20, Maintenance of Vital Auxiliaries Electric-DC-1
- [13] GOP-10, Revision 21, Balance of Plant Actions Following A Reactor Trip
- [14] ONP-2.3, Revision 16, Loss of DC Power
- [15] ONP-7.1, Revision 13, Loss of Instrument Air
- [16] ONP-24.1, Revision 24, Loss of Preferred AC Bus Y10
- [17] ONP-24.3, Revision 24, Loss of Preferred AC Bus Y30
- [18] SOP-12, Revision 60, Feedwater System
- [19] SOP-30, Revision 63, Station Power

Figure A13-1: Procedure Use Flow Chart

