REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**418-8348**
SRP Section:	**SRP 19**
Application Section:	**19.1**
Date of RAI Issue:	**02/23/2016**

Question No. 19-47

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether,"…the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

To allow the staff to reach a reasonable assurance finding on APR1400 PRA technical adequacy, please:

a) Include in the design control document (DCD) the basis for excluding the fire-induced opening of POSRVs as an initiating event

b) If power is removed from certain valves to prevent the inadvertent opening of the POSRVs, discuss in the DCD how this configuration and relevant procedures are addressed in the PRA models and in the HRAs for the feed and bleed operation.

Response – (Rev. 1)

a) The following change is provided in DCD Tier 2, Rev.1 subsection 19.1.5.2.1.2. "Spurious opening of pressurizer Pilot Operated Safety Relief Valves (POSRVs) due to a fire is not considered, because the power to the POSRVs is removed during normal operation and can only be provided by manual operator action."

POSRV consists of main valve (RC-200/RC-201/RC-202/RC-203), two pairs of motor operated pilot valves (RC-130,131/RC-132,133/RC-134,135/RC-136,137), two pairs of

spring-loaded pilot valves (RC-300,301/RC-302,303/RC-304, 305/RC-306, 307), two pairs of motor-operated isolation valves (RC-120,121/RC-122, 123/RC-124, 125/RC-126,127) and two pairs of manual isolation valve (RC-310,311/RC-312, 313/RC-314, 315/RC-316, 317).

- Spring-loaded pilot valves (RC-300,301/RC-302,303/RC-304, 305/RC-306, 307) are operated automatically dependent on set pressure.

- Motor operated pilot valves (RC-130,131/RC-132,133/RC-134,135/RC-136,137) are normally closed and power of one of two valves for each POSRV (RC-130/RC-132/RC0134/RC-136) is racked out outside control room for preventing spurious operation during plant operation (alarm on power connected) and opened by operator for feed and bleed operation.

- Motor-operated isolation valves (RC-120,121/RC-122, 123/RC-124, 125/RC-126,127 are normally open but are manually closed by an operator to prevent discharge when spring-loaded pilot valves fail to (re)close.

- Manual isolation valves (RC-310,311/RC-312, 313/RC-314, 315/RC-316, 317) are closed in case of maintenance and set-point test of spring-loaded pilot valves.

b) The design concept of POSRV is described in DCD Section 1.5.2 and typical diagram of POSRVs is presented in DCD Figure 5.4.14-1.

- The opening of POSRVs for feed and bleed operation are needed for remote and manual operation by operators. It is described in DCD Section 1.5.2 as “The motor-operated pilot valves are normally closed, but an operator remotely and manually opens the valves to open the main valve for the rapid depressurization of the RCS.”

- When one of two motor-operated pilot valves fails to open, bleed operation for feed and bleed operation is inoperable, thus fail to open of motor operated pilot valves are considered in PRA model.

- The remotely and manually operation of POSRVs is considered in HFEs (RCOPH-S-SDSE and RCOPH-S-SDSL) for Feed and Bleed (F&B) operation in HRA as shown in the Attachment 1.

- The contents for explaining for excluding the fire-induced opening of POSRVs as an initiating event is provided in the DCD Rev.1 subsection 19.1.5.2.1.2.

- The internal flooding analysis presented in DCD sections 19.1.5.3 and 19.1.6.4 will be revised during the next update to account for the potential that operators may need to traverse flooded areas to align for feed and bleed operation.

- An evaluation of the potential for internal flooding events to affect operator actions to initiate feed and bleed cooling has been performed and determined that there would be a negligible impact. A copy of this evaluation is shown in Attachment 2.

- The at-power and low-power and shutdown internal flooding PRA models will be revised in the next update to reflect the need for operator actions outside the control room and in potentially flooded areas.

Impact on DCD

DCD Tier 2, Rev.1 section 19.1 reflects this response.

Impact on PRA

The at-power and low-power and shutdown internal flooding PRA models will be revised as stated above in the response.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

RCOPH-S-SDSE-FW, Operator Fails to Open POSRVs in Early Phase for F&B Operation

Plant	Data File	File Size	File Date	Record Date
APR1400-DC	APR1400_DC_HRA-Rev.10.hra	1806336	07/24/13	07/24/13
	Name			**Date**
Analyst	Namcheol Kim			
Reviewer	Kisu Kim			

HEP Summary				
	P_{cog}	P_{exe}	Total HEP	Error Factor
Method	CBDTM	THERP	CBDTM+THERP	
Without Recovery	2.0e-02	3.4e-02		
With Recovery	4.1e-03	5.1e-03	9.1e-03	5

Identification and Definition
1. Initial Conditions : Steady state, full power operation 2. Initiating Events: GTRN, SGTR, SLOCA, SBO, PR-SL, PLOESW, PLOCCW, LSSB-U, LSSB-D, LOOP, LOIA, LOFW, LODCA, LODCB, LOCV, GRID-LOOP, FWLB 3. Preceding operator error or success in sequence : N/A 4. Operator action success criterion : Operator should open POSRV(s) for RCS heat removal. 5. Consequence of failure : Core Damage 6. Definition : In this HFE, RCS heat removal using SG is failed and temperature of RCS cold leg rises. Thus operator opens POSRVs for RCS heat removal. The POSRVs operation is performed with FRG HR-3.

Assigned Basic Events

Cues and Indications	
Initial Cue	S/G Low Level
Recovery Cue	Step 7 of HR-3 in EOG-10
Cue Comments	
Degree of Clarity	Very Good

Procedures and Training	
Cognitive Procedure	EOG-07 (Revision: 0)
Cognitive Step Number	7
Cognitive Instruction	Entry into EOG-10, HR-03
Execution Procedure	EOG-10, HR3 (Revision: 0)
Job Performance Measure	
Classroom Training	None
Simulator Training	None
Notes	

The procedure and training information is not available in DC phase. However, APR1400 EOG is used and training is assumed for this operator action.

Crew Member	Total Available	Required for Execution	Notes
Shift Supervisor	1	0	
STA	1	0	
Reactor Operator	1	1	
Turbine Operator	1	0	
Electrical Operator	1	0	
Local Reactor Operator	2	1	
Local Turbine Operator	2	0	

Dependencies (Related Human Interactions)

Key Assumptions

Operator Interview Insights
Operator interview is not available in DC phase.

Timing Analysis	
T_{sw}	60.00 Minutes
T_{delay}	0.00 Minutes
$T_{1/2}$	28.00 Minutes
T_M	15.00 Minutes
Time available for recovery	17.00 Minutes
SPAR-H Available time (cognitive)	45.00 Minutes
SPAR-H Available time (execution) ratio	2.13
Minimum level of dependence for recovery	MD

Notes

MAAP analysis shows that if F&B is succeeded within 60 min, it is possible to prevent core damage.
For LOFW Event with Early F&B, (refer to Table 5-9 1(a) ~ 1(f) of the Success Criteria Notebook)
1. Rx Trip : 0 hr (22.126 sec)
2. Core Uncovery : 0.88 hr (3171.808 sec)
3. F&B completion timing : 70 min
4. Core Damage : no occurrence within 24 hours
5. CSAS Generation : 7.2 hr (28162.430 sec)

[EOG Driven Action]
* T0 = LOFW
* Tsw = 60 min (F&B completion by MAAP Analysis)
* Td = 0 min
* T1/2 = 28 min (SPTA EOG + DA EOG + EOG-07 steps #7 + FRG HR-3 step #7, 15+7+6)
* Tm = 15 min (power recovery at local and manual opening of POSRVs)

Cognitive Analysis		
Pc Failure Mechanism	**Branch**	**HEP**
P_{ca}: Availability of Information	a	neg.
Notes: Operator can access to all information and required indication to operate a plant in the main control room.		
P_{cb}: Failure of Attention	i	neg.
Notes: In general, within 2 hours from accident initiation, work load is assumed to be high for CBDTM unless the work load relevant to a specific HFE cannot be judged appropriately. This HFE is to open POSRVs manually and thus the operator only performs and one-time check of SG level and status of related components and variables. It is not necessary to check them continuously. It's assumed that the indicator to be checked is always displayed on the front panel of the MCR because all of the controls in the modern control room are expected to be located in the front of the room. It is assumed that operators concentrate on EOG and performs EOG-driven actions after reactor trip. Thus operators can not respond to alarms until related parameter are mentioned in the EOG step.		
P_{cc}: Misread/miscommunicate data	a	neg.
Notes: It is assumed that required indicator on the control board such as layout, demarcation, labeling and others is always located easily. With the advanced digital I&C interface in the MCR, the indication is assumed to be "good" unless there are scenario specific considerations to warrant otherwise, in which case, justification for the deviation will be provided. It is assumed that formal communications will always be used when the specified value is transferred between operators.		
P_{cd}: Information misleading	b	3.0e-03
Notes: In this HFE, the related parameter values dose not satisfy the range of EOG description values and related system does not respond automatically(i.e. Failure of RCS heat removal by secondary side). Thus operators recover RCS heat removal with POSRVs. The EOG provides contingeny actions which are instructions on how to proceed if the cue states are not as stated.		
P_{ce}: Skip a step in procedure	a	1.0e-03
Notes: It's assumed that it's always transparent for operators to proceed the relevant instruction or stand-alone numbered step on the EOGs. The MCR operator is not required to use an an additional procedure in addition to the EOG, so "single" branch is selected for this HFE. Only if there are special or distinct marks are provided in the procedure, "YES" branch in the "Graphically Distinct" should be selected. For this operator action, related procedure step is hold point step and has graphically distinct. The use of placekeeping aids is always assumed to be used due to the nature of the computerized procedure system (CPS) software, i.e., the operator will be required to confirm completion of a step as the procedural items are addressed. Scenarios for which deviations from this assumption are possible, justification for the choice made will be provided.		
P_{cf}: Misinterpret Instructions	a	neg.
Notes: It is generally assumed that the wording of the procedures will be standard versus ambiguous for the Misinterpret Instruction decision tree, pcf, of the CBDTM. The step present all information required to identify the actions directed and their objects.		

P_{cg}: Misinterpret decision logic	A	1.6e-02
Notes: If diagnosis is performed just after EOG-01 completion, select sequence (a) or (b) because "NOT, AND, OR, BOTH AND and OR" are present through EOG01 and EOG02. Otherwise, "No" branch should be selected on the "NOT Statement" branch. The operators are always trained and practiced about specified scenario to perform.		
P_{ch}: Deliberate violation	a	neg.
Notes: The operators are always assumed to believe in the adequacy of instruction presented.		
Initial P_c(without recovery credited)		2.0e-02
Notes		
Equipment Accessibility	MCR: Accessible	

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	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_c	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_d	3.0e-03	-	-	X	-	-	N/A	MD	1.5e-01		4.5e-04
Pc_e	1.0e-03	-	-	-	-	-	N/A	-	1.0e+00		1.0e-03
Pc_f	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_g	1.6e-02	-	-	X	-	-	N/A	MD	1.6e-01		2.6e-03
Pc_h	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Final Pc (with recovery credited)											4.1e-03
Notes											
STA review is possible through RCS heat removal section of SFSC.											

Execution Performance Shaping Factors		
Special Requirements	Tools	Adequate
	Parts	Adequate
	Clothing	Adequate
Environment	Lighting	Normal
	Heat	Normal
	Radiation	Background
	Atmosphere	Normal
Equipment Accessibility	Local - SWGR Room	Accessible
Stress	**High**	
	Plant Response As Expected:	No
	Workload:	N/A
	Performance Shaping Factors:	N/A
Notes		
This HFE is to recover RCS heat removal after the failure of RCS heat removal with secondary side. This operator action have to be performed under limited condition to prevent undesired plant state.		
Execution Complexity	Simple	

Execution Unrecovered							
Procedure: EOG-10, HR3, Functional Recovery Guideline - Core and RCS Heat Removal Once-Through-Cooling		**Comment**				**Stress Factor**	**Over Ride**
Step No.	**Instruction/Comment**	**Error Type**	**THERP**		**HEP**		
			Table	**Item**			
EOG-10, HR-3, #2-d.1	Ensure electrical pwer is available to motor operated pilot valves.					5	
	Location: Local (Outside MCR)	EOM	20-8a	1	1.3e-03		
		EOC	20-12	8a	2.7E-4		
					Total Step HEP		7.9e-03
EOG-10, HR-3, #7-1	Confirm POSRV open status - POSRV leakage alarm and associated POSRV discharge line temperature					5	
	Location: MCR	EOM	20-7b	1	4.3e-04		
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #7-2	Manually open ALL motor operated pilot valves.					5	
	Location: MCR	EOM	20-7b	1	4.3e-04		
		EOC	20-12	4	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.					5	
	Location: MCR	EOM	20-7b	1	4.3e-04		
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #9	If pressurizer pressure is less than or equal to low pressurizer pressure SIAS setpoint, then ensure SIAS is actuated.					5	
	Location: MCR	EOM	20-7b	1	4.3e-04		
		EOC	20-12	3	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #10-b	Verify SI flow of each pump is greater than SI flow delivery curve.					5	
	Location: MCR	EOM	20-7b	1	4.3e-04		
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03

Execution Recovered							
Critical Step No.	**Recovery Step No.**	**Action**	**HEP (Crit)**	**HEP (Rec)**	**Dep.**	**Cond. HEP (Rec)**	**Total for Step**
EOG-10, HR-3, #2-d.1		Ensure electrical pwer is available to motor operated pilot valves.	7.9e-03				1.2e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #7-1		Confirm POSRV open status - POSRV leakage alarm and associated POSRV discharge line temperature	8.7e-03				1.3e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #7-2		Manually open ALL motor operated pilot valves.	8.7e-03				1.3e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #9		If pressurizer pressure is less than or equal to low pressurizer pressure SIAS setpoint, then ensure SIAS is actuated.	8.7e-03				1.3e-03
	EOG-10, HR-3, #10-b	Verify SI flow of each pump is greater than SI flow delivery curve.		8.7e-03	MD	1.5e-01	
		Total Unrecovered:	3.4e-02			**Total Recovered:**	5.1e-03

RCOPH-S-SDSL, Operator Fails to Open POSRVs in Late Phase for F&B Operation

Plant	Data File	File Size	File Date	Record Date
APR1400-DC	APR1400_DC_HRA-Rev.10.hra	1806336	07/24/13	07/24/13
	Name			**Date**
Analyst	Namcheol Kim			
Reviewer	Kisu Kim			

HEP Summary				
	P_{cog}	P_{exe}	Total HEP	Error Factor
Method	CBDTM	THERP	CBDTM+THERP	
Without Recovery	2.0e-02	3.4e-02		
With Recovery	3.2e-03	5.1e-03	8.3e-03	5

Identification and Definition
1. Initial Conditions : Steady state, full power operation 2. Initiating Events: GTRN, SGTR, SLOCA, SBO, PR-SL, PLOESW, PLOCCW, LSSB-U, LSSB-D, LOOP, LOIA, LOFW, LODCA, LODCB, LOCV, GRID-LOOP, FWLB 3. Preceding operator error or success in sequence : N/A 4. Operator action success criterion : Operator should open POSRV(s) for RCS heat removal. 5. Consequence of failure : Core Damage 6. Definition : In this HFE, RCS heat removal using SG is failed and temperature of RCS cold leg rises. Thus operator opens POSRVs for RCS heat removal. The POSRVs operation is performed with FRG HR-3.

Assigned Basic Events	
Cues and Indications	
Initial Cue	S/G Low Level
Recovery Cue	Step 8 of HR-3 in EOG-10
Cue Comments	
Degree of Clarity	Very Good

Procedures and Training	
Cognitive Procedure	EOG-07 (Revision: 0)
Cognitive Step Number	7
Cognitive Instruction	Entry into EOG-10, HR-03
Execution Procedure	EOG-10, HR3 (Revision: 0)
Job Performance Measure	
Classroom Training	None
Simulator Training	None
Notes	
The procedure and training information is not available in DC phase. However, APR1400 EOG is used and training is assumed for this operator action.	

Crew Member	Total Available	Required for Execution	Notes
Shift Supervisor	1	0	
STA	1	0	
Reactor Operator	1	1	
Turbine Operator	1	0	
Electrical Operator	1	0	
Local Reactor Operator	2	1	
Local Turbine Operator	2	0	

Dependencies (Related Human Interactions)

Key Assumptions

Operator Interview Insights
Operator interview is not available in DC phase.

Timing Analysis	
T_{sw}	240.00 Minutes
T_{delay}	0.00 Minutes
$T_{1/2}$	31.00 Minutes
T_M	15.00 Minutes
Time available for recovery	194.00 Minutes
SPAR-H Available time (cognitive)	225.00 Minutes
SPAR-H Available time (execution) ratio	13.93
Minimum level of dependence for recovery	ZD

Notes

For LOFW Event with Late F&B, (refer to Table 5-9 2(a) ~ 2(f) of the Success Criteria Notebook)
1. Rx Trip : 0 hr (22.126 sec)
2. AFAS Generation : 0 hr (152.599 sec)
3. SHR Failure : 8.5 hr (30604.176 sec)
4. F&B completion timing : 12.5 hr
5. Core Damage : no core damage

[EOG Driven Action]
* T0 = SHR Failure
* Tsw = 240 min (F&B completion, assumption based on MAAP Analysis)
* Td = 0 min
* T1/2 = 31 min (SPTA EOG + DA EOG + SFSC + FRG HR-3 step #7, 15+10+6)
* Tm = 15 min (power recovery at local and manual opening of POSRVs)

Cognitive Analysis		
Pc Failure Mechanism	**Branch**	**HEP**
P_{ca}: Availability of Information	a	neg.
Notes: Operator can access to all information and required indication to operate a plant in the main control room.		

P_{cb}: Failure of Attention	a	neg.
Notes: In general, within 2 hours from accident initiation, work load is assumed to be high for CBDTM unless the work load relevant to a specific HFE cannot be judged appropriately. This HFE is to open POSRVs manually and thus the operator only performs and one-time check of SG level and status of related components and variables. It is not necessary to check them continuously. It's assumed that the indicator to be checked is always displayed on the front panel of the MCR because all of the controls in the modern control room are expected to be located in the front of the room.		
P_{cc}: Misread/miscommunicate data	a	neg.
Notes: It is assumed that required indicator on the control board such as layout, demarcation, labeling and others is always located easily. With the advanced digital I&C interface in the MCR, the indication is assumed to be "good" unless there are scenario specific considerations to warrant otherwise, in which case, justification for the deviation will be provided. It is assumed that formal communications will always be used when the specified value is transferred between operators.		
P_{cd}: Information misleading	b	3.0e-03
Notes: In this HFE, the related parameter values dose not satisfy the range of EOG description values and related system does not respond automatically(i.e. Failure of RCS heat removal by secondary side). Thus operators recover RCS heat removal with POSRVs. The EOG provides contingeny actions which are instructions on how to proceed if the cue states are not as stated.		
P_{ce}: Skip a step in procedure	a	1.0e-03
Notes: It's assumed that it's always transparent for operators to proceed the relevant instruction or stand-alone numbered step on the EOGs. The MCR operator is not required to use an an additional procedure in addition to the EOG, so "single" branch is selected for this HFE. Only if there are special or distinct marks are provided in the procedure, "YES" branch in the "Graphically Distinct" should be selected. For this operator action, related procedure step is hold point step and has graphically distinct.		
P_{cf}: Misinterpret Instructions	a	neg.
Notes: It is generally assumed that the wording of the procedures will be standard versus ambiguous for the Misinterpret Instruction decision tree, pcf, of the CBDTM. The step present all information required to identify the actions directed and their objects.		
P_{cg}: Misinterpret decision logic	a	1.6e-02
Notes: If diagnosis is performed just after EOG-01 completion, select sequence (a) or (b) because "NOT, AND, OR, BOTH AND and OR" are present through EOG01 and EOG02. Otherwise, "No" branch should be selected on the "NOT Statement" branch. The operators are always trained and practiced about specified scenario to perform.		
P_{ch}: Deliberate violation	a	neg.
Notes: The operators are always assumed to believe in the adequacy of instruction presented.		
Initial P_c(without recovery credited)		2.0e-02
Notes		
Equipment Accessibility	MCR: Accessible	

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	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_c	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_d	3.0e-03	-	-	X	-	-	N/A	MD	1.5e-01		4.5e-04
Pc_e	1.0e-03	X	-	-	-	-	N/A	MD	1.4e-01		1.4e-04
Pc_f	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_g	1.6e-02	-	-	X	-	-	N/A	MD	1.6e-01		2.6e-03
Pc_h	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Final Pc (with recovery credited)											3.2e-03
Notes											
STA review is possible through RCS heat removal section of SFSC. CPS provides the tool to prevent skip a step in the procedure. Therefore self review is available for pce.											

Execution Performance Shaping Factors		
Special Requirements	Tools	Adequate
	Parts	Adequate
	Clothing	Adequate
Environment	Lighting	Normal
	Heat	Normal
	Radiation	Background
	Atmosphere	Normal
Equipment Accessibility	Local - SWGR Room	Accessible
Stress	**High**	
	Plant Response As Expected:	No
	Workload:	N/A
	Performance Shaping Factors:	N/A
Notes		
This HFE is to recover RCS heat removal after the failure of RCS heat removal with secondary side. This operator action have to be performed under limited condition to prevent undesired plant state.		
Execution Complexity	Simple	

Execution Unrecovered							
Procedure: EOG-10, HR3, Functional Recovery Guideline - Core and RCS Heat Removal Once-Through-Cooling		**Comment**				**Stress Factor**	**Over Ride**
Step No.	**Instruction/Comment**	**Error Type**	**THERP**		**HEP**		
			Table	**Item**			
EOG-10, HR-3, #2-d.1	Ensure electrical pwer is available to motor operated pilot valves.						
	Location: Local (Outside MCR)	EOM	20-8a	1	1.3e-03	5	
		EOC	20-12	8a	2.7E-4		
					Total Step HEP		7.9e-03
EOG-10, HR-3, #7-1	Confirm POSRV open status - POSRV leakage alarm and associated POSRV discharge line temperature						
	Location: MCR	EOM	20-7b	1	4.3e-04	5	
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #7-2	Manually open ALL motor operated pilot valves.						
	Location: MCR	EOM	20-7b	1	4.3e-04	5	
		EOC	20-12	4	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.						
	Location: MCR	EOM	20-7b	1	4.3e-04	5	
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #9	If pressurizer pressure is less than or equal to low pressurizer pressure SIAS setpoint, then ensure SIAS is actuated.						
	Location: MCR	EOM	20-7b	1	4.3e-04	5	
		EOC	20-12	3	1.3E-3		
					Total Step HEP		8.7e-03
EOG-10, HR-3, #10-b	Verify SI flow of each pump is greater than SI flow delivery curve.						
	Location: MCR	EOM	20-7b	1	4.3e-04	5	
		EOC	20-9	2	1.3E-3		
					Total Step HEP		8.7e-03

Execution Recovered							
Critical Step No.	**Recovery Step No.**	**Action**	**HEP (Crit)**	**HEP (Rec)**	**Dep.**	**Cond. HEP (Rec)**	**Total for Step**
EOG-10, HR-3, #2-d.1		Ensure electrical pwer is available to motor operated pilot valves.	7.9e-03				1.2e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #7-1		Confirm POSRV open status - POSRV leakage alarm and associated POSRV discharge line temperature	8.7e-03				1.3e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #7-2		Manually open ALL motor operated pilot valves.	8.7e-03				1.3e-03
	EOG-10, HR-3, #8	Verify the motor operated pilot valves are fully opened.		8.7e-03	MD	1.5e-01	
EOG-10, HR-3, #9		If pressurizer pressure is less than or equal to low pressurizer pressure SIAS setpoint, then ensure SIAS is actuated.	8.7e-03				1.3e-03
	EOG-10, HR-3, #10-b	Verify SI flow of each pump is greater than SI flow delivery curve.		8.7e-03	MD	1.5e-01	
		Total Unrecovered:	3.4e-02			**Total Recovered:**	5.1e-03

Evaluation of Internal Flooding Effects
on Operator Action to Initiate Feed and Bleed Cooling

When implementing feed and bleed cooling, power to the pilot-operated safety relief valves (POSRV), pilot valves must be restored. Restoration of power is performed local to the power source. For internal flooding events, access to the locations where power restoration actions must occur could be impeded by the flooding event.

This paper documents the internal flooding events that could affect access to the areas where actions to restore power to the POSRV pilot valves must take place.

There are four POSRVs and each POSRV has two pilot valves in series. Both pilot valves must open in order that the POSRV to opens for feed and bleed cooling. The POSRVs, pilot valves, and associated power supplies are summarized below:

Table 1
APR1400 POSRV Summary Information

POSRV	Pilot Valves	Power Supply	Location
V200	431-V-0130	MC01A	078-A56A
	431-V-0131	MC01C	078-A05C
V201	431-V-0132	MC01A	078-A56A
	431-V-0133	MC01C	078-A05C
V202	431-V-0134	MC01B	078-A56B
	431-V-0135	MC01D	078-A05D
V203	431-V-0136	MC01B	078-A56B
	431-V-0137	MC01D	078-A05D

Because the power supplies are located on the 78-foot elevation of the auxiliary building, any internal flooding event that occurs on or propagates to the 78-foot elevation could impact the likelihood that one or more power supplies would be restored for feed and bleed cooling. Flooding events that occur below the 78-foot elevation of the auxiliary building or that occur in buildings other than the auxiliary building would not affect the operator actions to restore power.

The potential for an internal flood to affect feed and bleed cooling is to hinder or prevent operator access to the rooms where the action must occur. Although only one of the two pilot valves for each POSRV is de-energized, this analysis assumes that both valves must be re-powered. By assuming that both power supplies must be operated, more events will be considered as having an impact on the operator action. The effect of failing to re-power one or more pilot valves is to render the affected POSRV unavailable for feed and bleed cooling. POSRVs associated with unaffected pilot valves would still be available.

Listed below are internal flooding events that occur in or propagate to the auxiliary building at or above the 78-foot elevation. For each of these events, the accident sequence analysis was reviewed to determine the following information.

1. Would fluid propagate out of the room in which the flood originated?

2. Would the areas that provide immediate access to the rooms shown in Table 1 be wetted? If so, then the rooms are listed.
3. Could the flood propagate from the quadrant in which the flood is initiated to any adjoining quadrant? If so, then the quadrant to which the flood could propagate is identified.
4. Would the flood cause failure of the POSRV pilot valve power supplies directly? If so, then the affected pilot valves are identified.

This information is listed in Table 2 and is used to determine if the internal flood could impact the operator actions to re-energize the POSRV pilot valves needed to initiate feed and bleed cooling. The following criteria were used to determine if the operator actions could be impacted.

1. If the flood fails the pilot valves (by causing failure of the associated power supplies) and the flood does not propagate outside the quadrant in which the power supplies are located, then there is no effect on the operator action.
2. If the flood would cause water to flow across or accumulate on the floor of any room through which an operator must pass to access one of the power supplies listed in Table 1, then it is assumed that the actions to re-power that supply is failed. Note however, that inter-quadrant access is available on the 78-foot elevation. Therefore, fluid propagating down a stairwell or accumulating in an area not affecting direct access would have no appreciable impact on the actions.
3. Flood events that would not propagate outside the room in which the flood is initiated would affect the actions only if the room affected was needed for access to the power supplies.

The results of these evaluations are summarized in Table 2. Of the flooding events that could occur on or above the 78-foot elevation of the auxiliary building, three events, IE-078-03C-WO-S, “Flood from WO piping in 078-A03C,” IE-078-03D-WI-S, “Flood from WI piping in 078-A03D,” and IE-078-03D-WO-S, “Flood from WO piping in 078-A03D,” could have an effect on the operator action to re-power the POSRV pilot valves for feed and bleed cooling.

Event IE-078-03C-WO-S has an initiating event frequency of 7.46E-05 per year and would affect only the access to MC01C. The inability to re-power pilot valves from MC01C could affect operation of POSRVs V200 and V201. The remaining two POSRVs would be available for feed and bleed cooling. Because only one pilot valve is de-energized for each POSRV, it is likely that only one of the valves would be affected. This flooding event is from a closed-loop system with a maximum volume of about 4,300 gallons. It is unlikely that this entire volume could be released. Even if the entire volume was released, the water would drain away through floor drains and it is likely that access through the area would be unaffected when the action to re-power the pilot valves is needed. Based on these considerations, a WO system flood in room 078-A03C would have a negligible impact on the overall human error probability to initiate feed and bleed cooling.

Event IE-078-03D-WI-S has an initiating event frequency of 8.28E-06 per year and would affect only the access to MC01D. The inability to re-power pilot valves from MC01D could affect operation of POSRVs V202 and V203. The remaining two POSRVs would be available for feed and bleed cooling. Because only one pilot valve is de-energized for each POSRV, it is likely that only one of the valves would be affected. This flooding event is from a closed-loop system with a maximum volume of about 24,700 gallons. It is unlikely that this entire volume could be

released. Even if the entire volume was released, the water would drain away through floor drains and it is likely that access through the area would be unaffected when the action to re-power the pilot valves is needed. Based on these considerations, a WI system flood in room 078-A03D would have a negligible impact on the overall human error probability to initiate feed and bleed cooling.

Event IE-078-03D-WO-S has an initiating event frequency of 7.35E-05 per year and would affect only the access to MC01D. The inability to re-power pilot valves from MC01D could affect operation of POSRVs V202 and V203. The remaining two POSRVs would be available for feed and bleed cooling. Because only one pilot valve is de-energized for each POSRV, it is likely that only one of the valves would be affected. This flooding event is from a closed-loop system with a maximum volume of about 4,300 gallons. It is unlikely that this entire volume could be released. Even if the entire volume was released, the water would drain away through floor drains and it is likely that access through the area would be unaffected when the action to re-power the pilot valves is needed. Based on these considerations, a WO system flood in room 078-A03D would have a negligible impact on the overall human error probability to initiate feed and bleed cooling.

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation							
Initiating Event ID	**Description**	**Room(s) Originating**	**Propagate out of Room?**	**Wet Access to DC Supply?**	**Propagation to Adjoining Quadrant(s)**	**Pilot Valves failed by Flood**	**Feed and Bleed Affected by Event?**
IE-055-03C-FP-M	Moderate break of FP in room 055-A03C, 055-A04C, 055-A05C, or 195-A01C. Flow between 3,000 gpm and 4,000 gpm.	195-A01C	Yes	No	No	No	No
IE-055-03D-FP-M	Moderate break of FP in room 055-A03D, 055-A04D, 055-A05D, or 195-A01D. Flow between 3,000 gpm and 4,000 gpm.	195-A01D	Yes	No	No	No	No
IE-055-05C-FP-X	Major break of FP in room 055-A05C, 055-A05D, 195-A01C, or 195-A01D. Flow greater than 4,000 gpm.	195-A01D	Yes	No	Yes C	No	No
IE-055-19A-FP-M	Moderate break of FP piping in room 055-A19A, 055-A35A, 055-A36A, 078-A57C, or 137-A16A. Flow greater than 2,500 gpm.	078-A57C 137-A16A	Yes	No	No	No	No
IE-055-50B-FP-M	Moderate break of FP piping in room 055-A50B or 078-A43B with flow greater than 1,100 gpm or in 078-A44B, 078-A49B, 100-A30B, 100-A35B, 100-A36B, 100-A37B, 120-A29B, or 120-A31B with flow between 1,100 gpm and 1,690 gpm.	078-A43B 078-A44B 078-A49B 100-A30B 100-A35B 100-A36B 100-A37B 120-A29B 120-A31B	Yes	No	No	No	No
IE-078-01D-FP-M	Flood from FP piping with a flow rate greater than 2,180 gpm in room 078-A01D, in room 078-A10D with a flow rate between 2,180 gpm and 3,700 gpm, or in 120-A07D with a flow rate greater than 5,100 gpm	078-A01D 078-A10D 120-A07D	Yes	Yes 078-A05D	No	431-V-0135 431-V-0137	No
IE-078-01D-FP-X	Flood from FP piping in room 078-A01D, in room 078-A10D with a flow rate greater than 3,700 gpm.	078-A10D	Yes	Yes 078-A05D 078-A05C	Yes C	431-V-0135 431-V-0137 431-V-0131 431-V-0133	No
IE-078-02C-WO-S	Flood from WO piping in 078-02C	078-02C	No	No	No	No	No
IE-078-02D-WI-S	Flood from WI piping in 078-A02D	078-02D	No	No	No	No	No
IE-078-02D-WO-S	Flood from WO piping in 078-A02D	078-02D	No	No	No	No	No
IE-078-03C-WO-S	Flood from WO piping in 078-A03C	078-03C	No	Yes 078-A05C	No	No	Yes
IE-078-03D-WI-S	Flood from WI piping in 078-A03D	078-03D	No	Yes 078-A05D	No	No	Yes
IE-078-03D-WO-S	Flood from WO piping in 078-A03D	078-03D	No	Yes 078-A05D	No	No	Yes

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation							
Initiating Event ID	**Description**	**Room(s) Originating**	**Propagate out of Room?**	**Wet Access to DC Supply?**	**Propagation to Adjoining Quadrant(s)**	**Pilot Valves failed by Flood**	**Feed and Bleed Affected by Event?**
IE-78-05C-WO-S	Flood from WO piping in 078-A05C	078-05C	No	Yes 078-A05C	No	431-V-0131 431-V-0133	No
IE-78-05D-WO-S	Flood from WO piping in 078-A05D	078-05C	No	Yes 078-A05D	No	431-V-0135 431-V-0137	No
IE-78-07C-WD-S	Flood from WD piping in 078-A07C	078-A07C	No	No	No	No	No
IE-78-07D-WD-S	Flood from WD piping in 078-A07C	078-A07C	No	No	No	No	No
IE-078-10C-FP-M	Moderate break of FP piping in room 078-A10C, 100-A06C, or 120-A07C. Flow between 2,180 gpm and 3,700 gpm in 078-A10C. Flow greater than 4,300 gpm in 100-A06C. Flow greater than 5,100 gpm in 120-A07C.	078-A10C 100-A06C 120-A07C	Yes	Yes 078-A10C	No	431-V-0131 431-V-0133	No
IE-078-10C-FP-X	Major break of FP piping in room 078-A10C. Flow greater than 3,700 gpm in 078-A10C	078-A10C	Yes	Yes 078-A10C	Yes A	431-V-0131 431-V-0133 431-V-0130 431-V-0132	No
IE-078-15C-AF-M	Moderate break of AF piping in room 078-A15C. Flow between 2,180 gpm and 3,700 gpm	078-A15C	Yes	Yes 078-A10C	No	431-V-0131 431-V-0133	No
IE-078-15C-AF-X	Major break of AF piping in room 078-A15C. Flow greater than 3,700 gpm.	078-A15C	Yes	Yes 078-A10C	Yes A	431-V-0131 431-V-0133 431-V-0130 431-V-0132	No
IE-078-15C-MS-S	Break of steam supply to TDAFP in room 078 A15C or 078-A17C.	078-A15C 078-A17C	No	No	No	No	No
IE-078-15D-AF-M	Moderate break of AF piping in room 078-A15D. Flow between 1,900 gpm and 3,200 gpm	078-A15D	Yes	Yes 078-A10D	No	431-V-0135 431-V-0137	No
IE-078-15D-AF-X	Major break of AF piping in room 078-A15D. Flow greater than 3,200 gpm.	078-A15D	Yes	Yes 078-A10D	Yes B	431-V-0135 431-V-0137 431-V-0134 431-V-0136	No
IE-078-15D-MS-S	Break of steam supply to TDAFP in room 078 A15D or 078-A17D.	078-A15D 078-A17D	No	No	No	No	No

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation

Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-078-19A-FP-M	Moderate break of FP piping in room 078-A19A, 120-A11A, 120-P22, 120-P25, 120-P27, or 120-P32. Flow between 1,200 gpm and 2,000 gpm in 078-A19A, or 120-A11A. Flow between 1,700 gpm and 2,500 gpm in 120-P22, 120-P25, 120-P27, or 120-P32.	078-A19A 120-A11A 120-P22 120-P25 120-P27 120-P32	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-078-19A-FP-X	Maor break of FP piping in room 078-A19A, 120-P22, 120-P25, 120-P27, or 120-P32. Flow greater than 2,000 gpm in 078-A19A. Flow greater than 2,500 gpm in 120-P22, 120-P25, 120-P27, or 120-P32.	078-A19A 120-P22 120-P25 120-P27 120-P32	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No
IE-078-19B-FP-M	Moderate break of FP piping in room 078-A19B, 078-A20B, 100-A10B, 120-A11B, or 120-A13B. Flow between 400 gpm and 690 gpm in 078-A19B or 078-A20B. Flow between 645 gpm and 935 gpm in 100-A10B. Flow between 890 gpm and 1,180 gpm in 120-A11B or 120 A13B.	078-A19B 078-A20B 100-A10B 120-A11B 120-A13B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-078-19B-FP-X	Major break of FP piping in room 078-A19B, 078-A20B, or 100-A10B. Flow greater than 690 gpm in 078-A19B or 078-A20B. Flow between 935 gpm and 1,445 gpm in 100-A10B.	078-A19B 078-A20B 100-A10B	Yes	Yes 078-A19B	Yes D	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-078-19B-WM-M	Moderate break of WM piping in room 078-19B or 100-A10B. Flow greater than 400 gpm in 078-A19B. Flow between 645 gpm and 935 gpm in 100-A10B.	078-A19B 100-A10B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-078-20A-AF-M	Moderate break of AF or AX piping in room 078-A20A. Flow between 1,200 gpm and 2,000 gpm.	078-A20A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-078-20A-AF-X	Major break of AF or AX piping in room 078-A20A. Flow greater than 2,000 gpm.	078-A20A	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation

Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-078-20B-AF-M	Moderate break of AF or AX room 078-A20B. Flow between 400 gpm and 690 gpm.	078-A20B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-078-20B-AF-X	Major break of AF or AX piping in room 078-A20A. Flow greater than 690 gpm	078-A20B	Yes	Yes 078-A19B	Yes D	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-078-21A-SI-M	Moderate break of SI piping in room 078-A21A. Flow between 245 gpm and 2,000 gpm.	078-A21A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-078-21A-SI-X	Major break of SI piping in room 078-A21A. Flow greater than 2,000 gpm.	078-A21A	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No
IE-078-21B-SI-M	Moderate break of SI piping in room 078-A21B. Flow between 1,400 gpm and 2,400 gpm.	078-A21B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-078-21B-SI-X	Major break of SI piping in room 078-A21B. Flow greater than 2,400gpm.	078-A21B	Yes	Yes 078-A19B	Yes D	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-078-25A-WO-S	Flood from WO piping in 078-A25A	078-A24A	No	No	No	No	No
IE-078-25B-WO-S	Flood from WO piping in 078-A25B	078-A24B	No	No	No	No	No
IE-078-29B-CC-M	Moderate break of CC piping in room 078-A29B. Flow between 400 gpm and 690 gpm.	078-A29B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-078-29B-CC-X	Major break of CC piping in room 078-A29B. Flow greater than 690 gpm.	078-A29B	Yes	Yes 078-A19B	Yes D	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-078-29C-CC-M	Moderate break of CC piping in room 078-A29C. Flow between 2,180 gpm and 3,700 gpm.	078-A29C	Yes	Yes 078-A10C	No	431-V-0131 431-V-0133	No
IE-078-29C-CC-X	Major break of CC piping in room 078-A29C. Flow greater than 3,700 gpm.	078-A29C	Yes	Yes 078-A10C	Yes A	431-V-0131 431-V-0133 431-V-0130 431-V-0132	No

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation							
Initiating Event ID	**Description**	**Room(s) Originating**	**Propagate out of Room?**	**Wet Access to DC Supply?**	**Propagation to Adjoining Quadrant(s)**	**Pilot Valves failed by Flood**	**Feed and Bleed Affected by Event?**
IE-078-31A-FP-M	Moderate break of FP piping in room 078-A31A. Flow between 2,250 gpm and 3,900 gpm.	078-A31A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-078-31A-FP-X	Major break of FP piping in room 078-A31A. Flow greater than 3,900 gpm.	078-A31A	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No
IE-078-44B-FP-X	Major break of FP piping in room 078-A44B or 078-A49B with flow greater than 1,690 gpm or in 100-A30B, 100-A35B, 100-A36B, 100-A37B, 120-A29B, or 120-A31B with a flow rate between 1,690 gpm and 2,500 gpm.	078-A44B 078-A49B 100-A30B 100-A35B 100-A36B 100-A37B 120-A29B 120-A31B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-078-57D-CT-M	Moderate break of CT piping in room 078-A57D. Flow greater than 1,000 gpm.	078-A57D	Yes	No	No	No	No
IE-100-02C-DG-S	Break of DG piping in room 100-A02C.	100-A02C	No	No	No	No	No
IE-100-02D-DG-S	Break of DG piping in room 100-A02D.	100-A02C	No	No	No	No	No
IE-100-05C-WI-S	Break of WI piping in room 100-A05C.	100-A05C	No	No	No	No	No
IE-100-05D-WI-S	Break of WI piping in room 100-A05D.	100-A05D	No	No	No	No	No
IE-100-08C-WI-S	Break of WI piping in room 100-A08C	100-A08C	No	No	No	No	No
IE-100-08C-WO-S	Break of WO piping in room 100-A08C	100-A08C	No	No	No	No	No
IE-100-08D-WI-S	Break of WI piping in room 100-A08D	100-A08D	No	No	No	No	No
IE-100-08D-WO-S	Break of WO piping in room 100-A08D	100-A08D	No	No	No	No	No
IE-100-10B-FP-X	Major break of FP piping in room 100-A10B. Flow greater 1,445 gpm	100-A10B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-100-10B-WM-M	Moderate break of WM piping in room 100-A10B. Flow between than 635 gpm and 1,445 gpm.	100-A10B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation

Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-100-10B-WM-X	Major break of WM piping in room 100-A10B. Flow greater 1,445 gpm.	100-A10B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-100-11B-WD-S	Break of WD piping in room 100-A11B.	100-A11B	No	No	No	No	No
IE-100-20A-FP-M	Moderate break of FP piping in room 100-A20A, 100-A23A 100-P06, 100-P07, 100-P08, 100-P14, 100 P19, 100-P20, 100-P21, 100-P22, 100-P23, 100-P24, 100-P25, 100-P27, 100-P28, 100-P31, 100-P33, 100-P34, 100-P35, 100-P43, 100-P45, 100-P46, 100-P47, 100-P50, 100-P51, 100-P52, 100-P53, 100-P54, 100-P55, 100-P56, or 120-P15. Flow between 1,200 gpm and 2,000 gpm in 100-A20A or 100-A23A. Flow between 1,700 gpm and 2,500gpm in other areas	100-A20A, 100-A23A 100-P06 100-P07 100-P08 100-P14 100 P19 100-P20 100-P21 100-P22 100-P23 100-P24 100-P25 100-P27 100-P28 100-P31 100-P33 100-P34 100-P35 100-P43 100-P45 100-P46 100-P47 100-P50 100-P51 100-P52 100-P53 100-P54 100-P55 100-P56 120-P15	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No

Table 2 – Summary of Internal Flooding Effects on POSRV Pilot Valve Operation

Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-100-20A-FP-X	Major break of FP piping in room 100-A20A, 100-A23A, A23A 100-P06, 100-P07, 100-P08, 100-P14, 100 P19, 100-P20, 100-P21, 100-P22, 100-P23, 100-P24, 100-P25, 100-P27, 100-P28, 100-P31, 100-P33, 100-P34, 100-P35, 100-P43, 100-P45, 100-P46, 100-P47, 100-P50, 100-P51, 100-P52, 100-P53, 100-P54, 100-P55, or 100-P56. Flow greater than 2,000 gpm in 100-A20A or 100-A23A. Flow greater than 2,500 gpm in other areas.	100-A20A 100-A23A 100-A23A 100-P06 100-P07 100-P08 100-P14 100 P19 100-P20 100-P21 100-P22 100-P23 100-P24 100-P25 100-P27 100-P28 100-P31 100-P33 100-P34 100-P35 100-P43 100-P45 100-P46 100-P47 100-P50 100-P51 100-P52 100-P53 100-P54 100-P55 100-P56	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No
IE-100-20A-WM-M	Moderate break of WM piping in room 100-A20A. Flow greater than 1,200 gpm.	100-A20A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-100-22A-FP-S	Small break of FP piping in room 100-A22A, 100-A24A, 100-A38A, 120-A20A, or 120-A24A. Flow between 2,250 gpm and 2,500 gpm in room 100-A22A, 100-A24A or 100-A38A. Flow between 3,270 gpm and 3,600 gpm in 120-A20A or 120-A24A.	100-A22A 100-A24A 100-A38A 120-A20A 120-A24A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-100-22A-FP-M	Moderate break of FP piping in room 100-A22A, 100-A24A, 100-A38A, 120-A20A, or 120-A24A. Flow between 2,500 gpm and 4,500 gpm in room 100-A22A, 100-A24A, or 100-A38A. Flow greater than 3,600 gpm in 120-A20A or 120-A24A.	100-A22A 100-A24A 100-A38A 120-A20A 120-A24A	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No
IE-100-22A-FP-X	Major break of FP piping in room 100-A22A. Flow greater than 4,500 gpm.	100-A22A	Yes	Yes 078-A19A	Yes C	431-V-0130 431-V-0132 431-V-0131 431-V-0133	No

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Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-100-32B-WM-M	Moderate break of WM piping in room 100-A32B, 100-A35B, 100-A37B, or 120-A29B with flow greater than 1,100 gpm.	100-A32B 100-A35B 100-A37B 120-A29B	Yes	No	No	No	No
IE-100-37B-FP-X	Moderate break of FP piping in room 100-A30B, 100-A35B, 100-A37B, 120-A29B, or 120-A31B flow greater than 2,500 gpm.	100-A30B 100-A35B 100-A37B 120-A29B 120-A31B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-120-06C-CC-M	Moderate break of CC system piping in room 120-A06C. Flow greater than 250 gpm.	120-A06C	No	No	No	No	No
IE-120-06D-FP-M	Moderate break of FP system piping in room 120-A06D. Flow greater than 1,000 gpm.	120-A06C	Yes	No	No	No	No
IE-120-11A-WM-M	Moderate break of WM piping in room 120-A11A. Flow greater than 1,200 gpm.	120-A11A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE-120-11B-FP-X	Major break of FP piping in room 120-A11B or 120-A13B. Flow greater than 1,180 gpm.	120-A11B 120-A13B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-120-15B-WO-S	Break of WO piping in room 120-A15B.	120-A15B	No	No	No	No	No
IE-137-02C-WD-M	Moderate break of WD piping in room 137-A02C. Flow greater than 1,760 gpm.	137-A02C	Yes	Yes 078-A10C	No	431-V-0131 431-V-0133	No
IE-137-09C-FP-M	Moderate break of FP piping in room 137-A09C. Flow between 1,935 gpm and 3,060 gpm in 137-A09C.	137-A09C	Yes	Yes 078-A10C	No	431-V-0131 431-V-0133	No
IE-137-09C-FP-X	Major break of FP piping in room 137-A09C. Flow greater than 3,060 gpm in 137-A09C.	137-A09C	Yes	Yes 078-A10C	Yes A	431-V-0131 431-V-0133 431-V-0130 431-V-0132	No
IE-137-09D-FP-M	Moderate break of FP piping in room 137-A09D or 137-A11D. Flow between 1,935 gpm and 3,060 gpm in 137-A09D. Flow between 1,690 gpm and 2,675 gpm in 137-A11D.	137-A09D 137-A11D	Yes	Yes 078-A10D	No	431-V-0135 431-V-0137	No
IE-137-09D-FP-X	Major break of FP piping in room 137-A09D or 137-A11D. Flow greater than 3,060 gpm in 137-A09D. Flow greater than 2,675 gpm in 137-A11D.	137-A09D 137-A11D	Yes	Yes 078-A10D	Yes B	431-V-0135 431-V-0137 431-V-0134 431-V-0136	No

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Initiating Event ID	Description	Room(s) Originating	Propagate out of Room?	Wet Access to DC Supply?	Propagation to Adjoining Quadrant(s)	Pilot Valves failed by Flood	Feed and Bleed Affected by Event?
IE-137-10C-WO-S	Break of WO piping in room 137-A10C.	137-A10C	No	No	No	No	No
IE--137-10D-WO-S	Break of WO piping in room 137-A10D.	137-A10D	No	No	No	No	No
IE-137-13B-FP-M	Moderate break of FP piping in room 137-A13B, 137-A17B, or 137-A18B. Flow between 490 gpm and 1,180 gpm.	137-A13B 137-A17B 137-A18B	Yes	Yes 078-A19B	No	431-V-0134 431-V-0136	No
IE-137-13B-FP-X	Major break of FP piping in room 137-A13B 137-A17B, or 137-A18B. Flow greater than 1,180 gpm.	137-A13B 137-A17B 137-A18B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-137-15A-WO-S	Break of WO piping in room 137-A15A.	137-A15A	No	No	No	No	No
IE-137-15B-WO-S	Break of WO piping in room 137-A15B.	137-A15B	No	No	No	No	No
IE-137-20A-FP-M	Moderate break of FP piping in room 137-A20A. Flow greater than 6,300 gpm in 137-A20A.	137-A20A	Yes	Yes 078-A19A	No	431-V-0130 431-V-0132	No
IE--137-23A-WO-S	Break of WO piping in room 137-A23A.	137-A23A	No	No	No	No	No
IE-137-29B-FP-M	Moderate break of FP piping in room 137-A29B. Flow between 1,690 gpm and 2,500 gpm.	137-A29B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-137-29B-FP-X	Major break of FP piping in room 137-A29B. Flow greater than 2,500 gpm.	137-A29B	Yes	Yes 078-A19B	Yes A	431-V-0134 431-V-0136 431-V-0135 431-V-0137	No
IE-157-01D-CC-S	Small break of CC system piping in room 157-A01D. Flow less than 250 gpm.	157-A01D	Yes	No	No	No	No
IE-157-01D-CC-M	Moderate break of CC system piping in room 157-A01D. Flow greater than 250 gpm.	157-A01D	Yes	No	No	No	No
IE-157-01D-WM-S	Small break of WM system piping in room 157-A01D. Flow less than 130 gpm.	157-A01D	Yes	No	No	No	No
IE-157-01D-WM-M	Moderate break of WM system piping in room 157-A01D. Flow between 130 gpm and 200 gpm.	157-A01D	Yes	No	No	No	No
IE-157-01D-WM-X	Major break of WM system piping in room 157-A01D. Flow greater than 200 gpm.	157-A01D	Yes	No	No	No	No

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Initiating Event ID	**Description**	**Room(s) Originating**	**Propagate out of Room?**	**Wet Access to DC Supply?**	**Propagation to Adjoining Quadrant(s)**	**Pilot Valves failed by Flood**	**Feed and Bleed Affected by Event?**
IE-157-01D-WO-S	Break of WO system piping in room 157-A01D.	157-A01D	No	No	No	No	No
IE-157-13C-FP-M	Moderate break of FP system piping in room 157-A13C. Flow greater than 750 gpm.	157-A13C	Yes	No	No	No	No
IE-157-16C-WM-M	Moderate break of WM system piping in room 157-A16C. Flow greater than 750 gpm.	157-A16C	Yes	No	No	No	No
IE-157-16D-WL-M	Moderate break of WL system piping in room 157-A16D. Flow greater than 750 gpm.	157-A16D	Yes	No	No	No	No
IE-157-19C-WO-S	Break of WO system piping in room 157-A19C.	157-A19C	No	No	No	No	No
IE-157-19D-WO-S	Break of WO system piping in room 157-A19D.	157-A19D	No	No	No	No	No
IE-157-25C-WIM-S	Break of WI or WM system piping in room 157-A25C	157-A25C	No	No	No	No	No