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March 6, 2006

SVPLTR: #06-0017

Mr. James Caldwell
Regional Administrator, Region III
U. S. Nuclear Regulatory Commission
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Dresden Nuclear Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-19 and DPR-25
Docket Nos. 50-237 and 50-249

Subject: Response to Preliminary White Finding Regarding Inoperability of High Pressure Coolant Injection System

Reference: Letter from M. A. Satorius (NRC) to C. M. Crane (Exelon Generation Company, LLC), "Dresden Nuclear Power Station, Units 2 and 3 NRC Inspection Report 05000237/200514; 05000249/200514 Preliminary White Finding," dated February 3, 2006

In the referenced letter, the NRC identified a preliminary White finding resulting from an event at Dresden Nuclear Power Station (DNPS) Unit 3 on January 30, 2004, when the reactor water level increased during a scram recovery, resulting in water entering the High Pressure Coolant Injection (HPCI) steam line. Subsequent engineering evaluation determined that the estimated quantity of water, about 60 gallons, rendered HPCI inoperable.

The referenced letter provided Exelon Generation Company, LLC (EGC) an opportunity to present our perspectives on the facts and assumptions used by the NRC to arrive at the finding and its significance at either a Regulatory Conference or in a written response to the NRC. In a telephone call between Mr. Pedro Salas (EGC) and Mr. Mark Ring (NRC) on February 14, 2006, EGC notified the NRC of our intent to provide a written response on the finding.

EGC agrees that a performance deficency occurred in that the events of January 30, 2004, led to water entering the HPCI steam line. Immediate actions were taken to correct the feedwater level control (FWLC) logic on both DNPS units to preclude the event from reoccurring. In March 2005, the system was challenged on Unit 2, and the FWLC system operated as expected.

For the January 2004 event, DNPS performed its own risk analysis, based on plant specific information and concluded that the risk associated with the HPCI steam lines flooding is 5 E-7, which is less than that assessed by the NRC and supports a Green (very low safety significance) finding.

DNPS has provided available risk information to the Region III Senior Risk Analysts (SRAs) in support of a preliminary NRC safety significance determination. However, further review has identified four additional recommended changes to the model used for the SRA's own assessment to more accurately reflect DNPS's equipment configuration, design and procedures. These changes range from elimination of inappropriate cutsets to assumptions of operator error. These recommended changes and our basis are summarized below.

Stuck Open Safety Valve (SOSV) Initiating Event Frequency

The NRC analysis uses a frequency of 1.5E-02 per year for the SOSV initiating event. It is DNPS's understanding that industry experience was used in the calculation of this frequency. Three events were identified as SOSV initiating events. DNPS review of the three events has determined that two of the three events described failures applicable to pneumatically operated relief valves. These events are not applicable to spring operated safety valves of the type used at DNPS. The third event was caused by operator actions post scram and is not applicable to a failure at the beginning of the event when the FWLC system is being challenged.

A computer analysis was run for an initiating event with a relief valve instantaneously opening. The simulated vessel level did not seriously challenge the bottom of the HPCI turbine steam nozzle. Only in instances when DNPS spring operated safety valves are challenged would a SOSV initiating event be possible. The safety valve settings are above those of the four electromatic relief valve (ERV) settings and also above the Target Rock safety/relief valve setting. DNPS's recent history, post extended power uprate, is that the ERVs have not opened following a Group I isolation event.

In summary, the initiating events that have been used as input to the NRC calculation for the SOSV initiating event frequency are not applicable to the FWLC scenario that occurred at DNPS in January 2004. Based on industry and DNPS history, the frequency of a SOSV initiating event that could impact the FWLC system and lead to HPCI steam line flooding is likely to be several orders of magnitude less than 1.5E-02 per year. A DNPS specific assessment calculated a frequency of 2E-05 per year. To factor in uncertainties, a frequency of 1E-04 per year is recommended.

Dependent Operator Action Failure to Restart Feedwater (FW) and Automatic Depressurization System (ADS)

The NRC analysis assigned a medium dependency between the two human actions. The analysis identified the restart of FW human action as the first action followed by operator failure to depressurize. The analysis used a SPAR-H methodology of multiplying the first operator action Human Error Probability (HEP) times a dependency factor to yield the overall failure probability for the two dependent actions. The analysis utilized a HEP for the human action "Operator Fails to Restart FW after High Level Trip" of 1E-03 and a dependency factor of 0.14. The DNPS site-specific Human Reliability Assessment (HRA) calculates a HEP for the operator action "Operator Fails to Restart FW after High Level Trip" of 3.2E-04.

The DNPS values were developed using industry accepted methodology and were based on DNPS procedures and training. It is recommended that the NRC calculation be based on the DNPS specific HEP. Utilizing the SPAR-H methodology yields the overall failure probability given failure of the first event as HEP1 * 0.14 = (3.2E-04) * (0.14), or 4.5E-05. The dominant cutsets that contain the dependent operator action would be reduced by a factor of three using the DNPS specific calculations.

Operator Fails to Maintain FW Injection

Operators are trained to restart the FW pumps with FWLC in automatic following a high level trip event. This should be considered as part of the normal actions to restart FW after a high level trip. The operator actions associated with restart of FW and maintaining control require the same cognitive tasks and most importantly, once restart is completed, FW make-up to maintain reactor water level is maintained in automatic. Therefore, cutsets involved with human error in maintaining FW injection should be eliminated.

Operator Fails to Align/Start Condensate/Condensate Booster Pumps

The NRC analysis assumes the operator must restart the condensate/condensate booster (CD/CB) pumps following a reactor vessel level 8 trip. However, at DNPS, following a FW trip on level 8, the CD/CB pumps continue to run. There are only two CD/CB pump trips, motor over current and a trip of the 'D' CD/CB pump on a loss of coolant accident (LOCA) signal (i.e., high drywell pressure). The CD/CB pumps remain running on min-flow following a FW pump trip signal. Therefore, it is reasonable to assume operators will not have to restart CD/CB pumps and the operator action "Operator fails to align/start condensate" is not required.

Therefore, for fidelity to the DNPS design, cutsets involved with failure to align/start CD/CB pumps should be eliminated. Details of our recommended changes are contained within the attachment to this letter.

Conclusions

Based on review of the NRC results, if adjusted as recommended in the attachment to this letter, this performance deficiency does not rise to the level of a White finding. With these suggested changes, it is EGC's conclusion that the overall core damage probability of the event is significantly less than 1E-06. Therefore, the event should be characterized as a Green finding (i.e., very low safety significance).

Notwithstanding conclusions on safety significance, as noted in the referenced letter, DNPS took both immediate and long term corrective actions to adjust the DNPS FWLC systems on both units in February 2004 to properly account for three FW pump operation and ensure reactor vessel water level would not reach the HPCI steam line. Based on those changes and the satisfactory performance of the FWLC system since then (i.e., approximately 24 months of operation on both units), the finding is not reflective of the current performance of the HPCI systems at DNPS.

A fundamental purpose of the NRC's Reactor Oversight Process (ROP) is to apply a performance-based approach to assessment, focusing NRC and licensee attention on those issues associated with degraded performance. As discussed in NRC Inspection Manual Chapter (MC) 0305,"Operating Reactor Assessment Program," Section 06.05, the Action Matrix was developed with the philosophy that licensees address their performance issues without additional NRC engagement beyond the baseline inspection program. All actions associated with this event, as discussed above, were completed promptly and any NRC actions specified in the Regulatory Response column of the Action Matrix would provide little or no benefit. As this is a two year old issue, which was resolved with immediate corrective actions, inclusion in the Action Matrix in 2006 to be carried for four quarters is contrary to the purpose of the ROP. MC 0305, Section 06.06(f) allows the NRC to deviate from the Action Matrix, to either increase or decrease its actions.

Therefore, if the NRC's assessment of this event does not reach a conclusion of a Green finding, (i.e., very low safety significance), we encourage a determination by the NRC not to include this event in the Action Matrix, with no further actions.

If you have any questions regarding this response, please contact Mr. Pedro Salas, Regulatory Assurance Manager, at (815) 416-2800.

Respectfully,

Danny Bost

Danny Bost
Site Vice President
Dresden Nuclear Power Station

Attachment: Detailed Review of NRC Risk Assessment

cc: NRC Document Control Desk
NRC Senior Resident Inspector — Dresden Nuclear Power Station
Director, Division of Reactor Safety — NRC Region III

ATTACHMENT

DETAILED REVIEW OF NRC RISK ASSESSMENT

Detailed Review of NRC Risk Assessment

The Exelon Generation Company, LLC (EGC) Risk Management review of the SPAR Model cutsets identified key inputs that are not consistent with Dresden Nuclear Power Station (DNPS) operation. These inputs are identified below.

I. <u>Stuck Open Safety Valve (SOSV) Initiating Event Frequency</u>

NRC Analysis

The NRC analysis uses a frequency of 1.5E-02 for this initiating event. A DNPS specific calculation, shown below, provides a more realistic initiating event frequency of 2E-05.

The NRC calculation in support of the High Pressure Coolant Injection (HPCI) steam line significance determination process (SDP) Phase 3 evaluation used as input three industry events. These events are described below.

1. June 5, 1970, Dresden Nuclear Power Station, Unit 2

   This event is described in NUREG-0823, "Integrated Plant Safety Assessment Systematic Safety Evaluation Program (SEP)," February 1983. The initiating event was a turbine trip, and safety valves did not stick open until later in the event. A level-indicator chart pen stuck early in the event. Reacting to the erroneous chart reading, the operator increased Feedwater (FW) flow, resulting in flooding of the main steam lines. Opening of a safety valve was triggered by high reactor water level and operator actions to depressurize the reactor pressure vessel (RPV) using the relief valves. Water hammer occurred during these depressurization attempts resulting in lifting of the safety valves. The discharge nozzle jet of the initially open safety valve impinged on the manual lifting bars on nearby safety valves, bending the lifting bars and causing these other safety valves to lift and stick open. The manual lifting bars, initially required by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, have since been removed.

2. September 11, 1995, Limerick Generating Station, Unit 1

   This event is described in Licensee Event Report (LER) 252-95-008. Unit 1 was manually shutdown in response to the unexpected opening of the 'M' Main Steam safety relief valve (SRV) when the valve could not be closed within 2 minutes per Technical Specifications (TS) Section 3.4.2. The LER further states, "Inspection of the SRV revealed steam erosion attributed to pilot valve seat leakage, resulted in the failure of the pilot valve. This produced a differential pressure across the SRV main disc, thereby opening the SRV."

3. February 23, 2001, Limerick Generating Station, Unit 2

   This event is described in LER 353-01-001. On February 23, 2001, operators were performing a planned Unit 2 shutdown to repair the 2N Main Steam Relief Valve (MSRV) due to first stage pilot valve seat leakage. During power reduction the 2N MSRV inadvertently lifted and remained open. The cause was a sudden loss of material from the first stage pilot valve due to erosion and oxidation of the Stellite disc material in the area of the seating surface. A manual scram was initiated as required by Technical Specifications (TS).

Detailed Review of NRC Risk Assessment

DNPS Analysis

The above events are judged to be not applicable to the DNPS Feedwater Level Control (FWLC) system failure to control RPV water level below the HPCI steam line event that occurred on January 30, 2004. The 1970 DNPS event, although leading to a SOSV, is not applicable for the following reasons.

1. The valve did not open at the start of the initiating event. The failure mode described is not associated with the automatic FWLC system since water hammer from reactor vessel overflow would not occur at the start of the event.

2. Post initiator operator actions resulted in water hammer and subsequent safety valve challenges. Level 8 trip logic of FW was installed following this event. Overfill to the extent necessary for water hammer is not credible given the level 8 FW trip logic.

3. The manual lifting bars involved with the failure mode have since been removed.

The two Limerick events describe failure modes that also are not applicable to spring operated safety valves. The DNPS safety valves do not utilize pilot valves, and therefore are not susceptible to the failure modes described in the Limerick events.

Since no industry events have been identified that can be used to establish a historic SOSV frequency, an alternate approach to calculating this frequency is proposed.

Alternate Stuck Open Safety Valve Frequency Calculation

The DNPS design basis is such that safety valves are not challenged for Group I main steam isolation valve (MSIV) closure events. Relief valves are sized to handle this scenario. A more severe scenario is a turbine trip scram with a failure of the turbine bypass system. This scenario is discussed in the DNPS Updated Final Safety Analysis Report (UFSAR), Revision 5, dated January 2003.

> "5.2.2.2.2 Relief Valve Sizing
>
> The relief valves were sized by assuming a turbine trip with trip scram but with a failure of the turbine bypass system. The results for this transient are shown in Figure 5.2-2 and Reference 7. The sudden closure of the stop valves with no initial bypass flow effectively doubles the initial rate of increase of primary system pressure. Scram is initiated immediately from the stop valve closure. The vessel pressure would peak at 1292 psig. Peak pressure in the steam line at the safety valve location would be approximately 1253 psig and is 13 psi above the lowest safety valve setpoint of 1240 psig; ..."

The expected frequency of such an event is very low. Essentially all bypass valves would need to fail to open. NUREG/CR-5750 provides data to calculate a frequency for such an event. NUREG/CR-5750 reports that from 1988-2003, there has been one Turbine Trip without bypass event. Two other Turbine Trip with bypass events are also identified during the same period. However, these two were discounted because they occurred during the initial four months of plant operation. The period in question covered 444.61 boiling water reactor years.

Turbine Trip with loss of Bypass Flow Frequency = 2.25E-03/yr

Note this value is comparable to a frequency of 1.95E-03 used in the Browns Ferry probabilistic risk analysis (PRA).

Given a turbine trip without bypass event, the number of safety valves challenged must be determined. The DNPS UFSAR states:

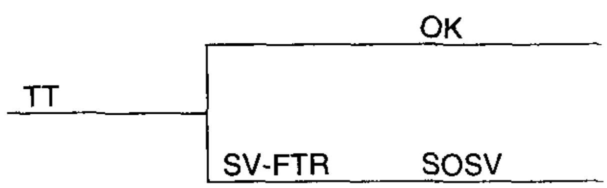
> "5.2.2.2.1 Determination of the Number of Safety Valves
>
> In determining the minimum safety valve capacity to conform to the ASME Code limits, no credit was allowed for turbine trip scram or for power-operated, pressure-relieving devices. Credit was taken for subsequent protection action such as neutron flux scram or high reactor pressure scram. Sizing was based on a full power turbine trip with bypass system failure, starting from turbine design conditions of operation. The minimum number of safety valves needed for conformance to the above criteria is three. An additional design margin was allowed in choosing eight safety valves."

The UFSAR also notes, "As stated previously, only three valves are required to meet ASME Code requirements. Eight valves provide relief of 44% of turbine design steam flow. (The Target Rock safety relief valve is not included, therefore, considering this valve results in additional conservatism.)."

Given a turbine trip without bypass event, three safety valves are assumed to be challenged. This assumption is conservative given the conservatism's noted in the UFSAR sections above. A simple event tree is used to find the SOSV initiating event frequency.

SOSV Frequency Calculation Event Tree

Turbine Trip w/o Bypass	Safety Valves Fail to Reclose	Endstate



Event Descriptions Table

Event	Description	Probability	Source
%TT	Turbine trip with trip scram but with a failure of the turbine bypass system	2.25E-03/yr	NUREG/CR-5750 input data
SV-FTR	Spring Operated Safety Valve Failure To Reclose (3E-03 failures/demand * 3 demands)	9E-03	EPRI ALWR Database (NUCLARR)

The total SOSV Frequency = 2.25E-03/yr * 9E-03

SOSV Frequency = 2E-05/yr.

To account for uncertainty, a frequency of 1E-04/yr. is recommended.

Additional Discussion/Information

It should be noted that General Electric (GE) calculations were performed in support of the DNPS extended power uprate (EPU). These calculations, using bounding assumptions, showed that relief valves were challenged during a Group I isolation (e.g., MSIV Closure and Scram at time=0) for RPV pressure control. However, the peak pressures predicted by the EPU calculations did not approach the safety valve settings.

DNPS history shows that the relief valves, even with their lower setpoints, have not been challenged following Turbine Trip events. A Group I Isolation/Scram occurred on Unit 2 on March 24, 2005. Unit 2 was operating at 100% post-EPU electrical power (i.e., 912 MWe) at the time. No electromatic relief valves were challenged during this event. During the March 24, 2005, event, plant data recorders showed that RPV pressure decreased slightly prior to the scram due to the opening of Turbine Bypass Valves in response to an initial plant transient. The increased steam flow resulted in the Group I Isolation/Scram. It is noted that the DNPS event occurred under realistic conditions and the peak RPV pressure did not approach the peak pressures predicted by the GE EPU calculations.

Dresden UFSAR
Table 5.2-1
SAFETY AND RELIEF VALVE SETPOINTS AND CAPACITY

Relief valves:
A. Capacity (total) = 2.7×10^6 lb/hr

B. Pressure settings:
Relief Valve Number and Setpoint (psig)
203-3B < 1112
203-3C < 1112
203-3D < 1135
203-3E < 1135

Safety valves:
A. Capacity (total) = 5.2×10^6 lb/hr

B. Pressure settings:
Number of Safety Valves, Setpoint (psig) and Capacity (lb/hr)
2 –1240, 644,501
2 – 1250, 649,638
4 – 1260, 654,774

Safety relief valve (Target Rock):

A. Capacity = 6.22×10^5 lb/hr at 1125 psig
B. Setpoint as relief valve = < 1135 psig
C. Setpoint as safety valve = 1135 psig

Conclusion

The likelihood of a SOSV following a transient event is very low for DNPS. Conservative calculations performed for EPU show that safety valves will only be challenged for Turbine Trip without Bypass Events. A SOSV Initiating Event Frequency of 2E-05/yr has been justified for DNPS. To account for uncertainty, a frequency of 1E-04/yr. is recommended.

Note that this calculation is not for anticipated transient without scram (ATWS) events. The frequency of mitigated ATWS events is on the order of 1E-5/yr, which is much lower than the calculated Turbine Trip with loss of Bypass Flow Frequency of 2.25E-03/yr. Therefore, the ATWS with stuck open relief valve (SORV) event is judged to be a negligible contributor.

II. Dependent Operator Action Failure to Restart Feedwater (FW) and Automatic Depressurization System (ADS)

NRC Analysis

The NRC analysis uses the following Human Error Probabilities (HEPs) as input to the Dependent Operator Action that combines failure of each Human Action.

Human Action	Human Error Probability
Operator Fails to Restart FW after High Level Trip	1E-03
Operator Fails to Depressurize	5E-04

The NRC analysis assigned a medium dependency between the two human actions and identified the restart of FW human action as the first action. SPAR-H methodology calculates the overall failure probability given failure of the first event as HEP1 * 0.14 = (1E-03) * (0.14) = 1.4E-04.

DNPS Analysis

It should be noted that the SPAR-H methodology ignores the relative HEP value of the second operator action. This could lead to a combined operator action HEP higher than the independent value of the second operator action HEP, if the first operator action is significantly more difficult than the second. The SPAR-H methodology is conservative and is not applicable in all cases. A lower dependency is more appropriate.

DNPS specific MAAP runs show that following a trip of FW on high RPV water level, the time for water level to decrease to the top of active fuel, assuming no subsequent injection, is approximately 91 minutes. Therefore, approximately 91 minutes is available for operator action to restart FW.

In addition, the operator action HEP for manual RPV depressurization during transient events for this evaluation is based on the time available starting from normal water level (i.e., transient event assuming no RPV overfill). If the additional time available for starting from the high level trip is assumed, the manual depressurization HEP could be reduced. However, this has conservatively not been incorporated into the manual depressurization HEP for this evaluation.

The DNPS site-specific human reliability assessment (HRA), provided in Appendix A-1 gives the following results.

Human Action	Human Error Probability
Operator Fails to Restart FW after hi level trip (IC unavailable)	3.2E-04
Operator Fails to Depressurize	2.4E-04

Conclusion

The EGC HEP values were developed using industry accepted methodology and are based on DNPS specific MAAP runs, plant configuration, procedures, training, and operator interviews. The NRC calculation using the SPAR-H dependency methodology should be based on the EGC site specific HEPs. The conservative SPAR-H methodology, which multiplies the dependency factor with the first HEP value, should be used with an HEP value for FW restart of 3.2E-04. The overall HEP for failing the dependent operator actions, based on the *site-specific calculation* is (3.2E-04) * (0.14) = 4.5E-05. Alternatively or in addition, a lower than "moderate" dependency should be assigned the two operator actions.

III Operator Fails to Maintain FW injection

NRC Analysis

The NRC analysis includes cutsets where an Operator Action to Control FW after restart, fails FW. The analysis does not account for the automatic control feature available to the Operator.

DNPS Analysis

For non-ATWS events, the FW pumps need to be restarted (e.g., following trip on high RPV water level). The operators are trained to start the pumps with the FWLC system in AUTO mode. Specifically, procedure DOA-0600-01, Revision 44, "Transient Level Control" provides the following note under Section C, "Immediate Operator Actions":

NOTE

> *FWLCS is designed to operate in AUTO to maintain level in a prescribed band during steady state and transient conditions. This design takes into account certain malfunctions OR failures to prevent water level control problems from getting worse.*
>
> - *Manual control (MAN) may be either Master Manual OR Individual Manual depending on the situation.*
> - *Manual control should be performed when an evaluation of feedwater system performance has determined that the controllers OR the FWRVs are NOT responding, OR responding in the wrong direction to the change in level.*

Operators have the option to place the FWLC system in manual control, but only if the AUTO FWLC system is evaluated not to be operating properly. Even when placed in the AUTO mode, the operators are trained to closely observe RPV water level to ensure that water level is maintained in a specified band.

Discussions with a plant Reactor Operator (RO), a Senior Reactor Operator (SRO), and a Licensed Trainer confirmed the operator response described above. Operator action to restart FW is a common action required during plant simulator runs for Operator requalification training (e.g., observed approximately 15-20 times per year per crew). During the simulator runs, the operators are trained to place the FWLC system in AUTO unless additional failures require them to place FW in manual control.

Multiple control room alarms and redundant EOP steps would identify the need to restart FW pumps or maintain adequate FW level control on lowering RPV water level. Therefore, based on the similarities in the two operator actions, explicit quantification of the FW manual control action is judged not required.

Conclusion

SPAR model cutsets involved with failure to maintain FW injection should be eliminated. If additional detail is desired, the automatic control function should be "ANDed" with an operator action to maintain FW injection. The "AND" logic would result in the operator action being an insignificant contributor.

Detailed Review of NRC Risk Assessment

Excepts from the DNPS HRA are included as appendices to this attachment. The HRA reviews both the operator action to restart FW (Section 3.57 of the HRA) and failure to depressurize the RPV (Section 1 of the HRA).

Detailed Review of NRC Risk Assessment

IV. Operator Fails to Align/Start Condensate/Condensate Booster Pumps

NRC Analysis

The NRC analysis assumes the operator must restart the CD/CB pumps following a high RPV water level trip.

DNPS Analysis

Following a FW trip on high RPV water level, the CD/CB pumps continue to run. Annunciator procedure DAN 902(3)-6 F-5 provides the trips associated with the CD/CB pumps. The only CD/CB pump trips are on motor over current and a trip of the 'D' CD/CB pump on a LOCA signal (i.e., high drywell pressure). These pumps remain running on min-flow following a FW pump trip signal. Therefore, it is reasonable to assume that operators will not have to restart CD/CB pumps and the operator action "Operator fails to align/start condensate" is not required. Once FW has been restarted, CD/CB flow will automatically be reestablished.

Conclusion

SPAR Model cutsets involved with failure to align/start condensate pumps should be eliminated.

Appendix A-1

Section 3.57 of

Dresden Human Reliability Assessment Handbook

3.57 OP ACT: MANUALLY RESET LEVEL 8 TRIP OR RESTART FW

3.57.1 Description of Action

Reactor level swell following a turbine trip can result in a trip of feedwater on Level 8 if feedwater is not controlled automatically or by crew intervention.

This crew action is to restart a motor driven FW pump taken in response to a Level 8 feedwater trip that occurs following a SCRAM.

There may be conditions associated with a reactor scram (turbine trip or MSIV closure) where the FW control system is not able to control the swell and rapid fill of the vessel occurs, i.e., Level 8 trips the Feedwater System. Under these conditions there is a possibility of having water intrude into the HPCI steam lines which, for Dresden, are located approximately four (4) feet below the main steam lines. This could cause HPCI to become temporarily inoperable. Potential HPCI inoperability increases the need to provide a manual action for the crew to restart FW for RPV injection.

Cases to be evaluated are the following:

A. Transient without IC available
B. Transient with IC available
C. SBLOCA without IC available
D. SBLOCA with IC available
E. Medium LOCA Steam
F. Medium LOCA Water

3.57.2 Procedural Direction for Implementation

DEOP 100 provides direction on using feedwater. This is treated as an immediate skill-of-the-trade action. Procedure DOA-0600-01 provides FW system instructions for the task.

The key input to the crew is contained in a NOTE prior to the first step:

NOTE

FWLCS is designed to operate in AUTO to maintain level in a prescribed band during steady state and transient conditions. This design takes into account certain malfunctions OR failures to prevent water level control problems from getting worse.

- *Manual control (MAN) may be either Master Manual OR Individual Manual depending on the situation.*
- *Manual control should be performed when an evaluation of feedwater system performance has determined that the controllers OR the FWRVs are NOT responding, OR responding in the wrong direction to the change in level.*

If, and only if, the crew subsequently assesses the Feedwater system performance to require additional action, the following directions are provided:

1. Evaluate Feedwater System performance. If necessary, THEN perform one or more of the following:
    a. Shift REG VLV STATION(s), as applicable to MAN AND control level manually.
    b. Match Feed flow and Steam Flow to stabilize Reactor Water Level. (W-2)
    c. Start AND stop available Feedwater Pump(s) AND condensate/booster pumps as needed.
2. Subsequent Actions: IF RPV level is dropping, THEN perform one or more of the following:
    a. Manually restore RPV level to normal (+25 to +35 inches).
    b. Match Feed Flow and Steam Flow to stabilize Reactor Water Level. (W-2)
    c. Verify the applicable RFP minimum flow valves are positioned properly:

- PCV 2(3)-3201A, 2(3)A PP RECIRC VLV
- PCV 2(3)-3201B, 2(3)B PP RECIRC VLV
- PCV 2(3)-3201C, 2(3)C PP RECIRC VLV

d. Start an additional RFP (DOP 3200-03).

e. Reduce reactor power using Recirc Flow Control (DOP 0202-03).

f. Stop any blowdown through RWCU (DOP 1200-02).

Operators have the option to place the FWLCS in manual control, but only if the AUTO FWLCS is evaluated not to be operating properly. Even when placed in the AUTO mode, the operators are trained to closely observe RPV water level to ensure that water level is maintained in a specified band.

Discussions with a plant Reactor Operator (RO), a Senior Reactor Operator (SRO), and a Licensed Trainer confirmed the operator response described above. Operator action to restart FW is a common action required during plant simulator runs for Operator requalification training (e.g., observed approximately 15-20 times per year per crew). During the simulator runs, the operators are trained to place FWLCS in AUTO unless additional failures require them to place FW in manual control.

3.57.3 <u>Time Frame for Accomplishing Operator Action</u>

The action is estimated to take approximately 5 minutes to complete and is required within a short time of the initiator.

Time available for action is based on the following:

- <u>Transient</u>
  - Dresden MAAP runs for a scram with no RPV injection and the IC unavailable show that the time from an RPV water level at Level 2 to MSCWLL is 37 minutes (MAAP Case DR001). A similar case shows that the time from Level 2 to core damage is 54 minutes (MAAP Case DR004).
  - MAAP with RPV injection to Level 8 (+48") and then trip of the injection source results in approximately 54 min. between L8 (+48")

and L2 (-59") (MAAP Case DR0046). Based on the above MAAP case (DR001), it can be estimated that at least another 37 min. is available before reaching MSCWLL. The net result is that boildown from +48" (Level 8) would require more than 91 min. with no injection (and the IC not operating).

- With IC operation, the RPV level may shrink more rapidly. The time for level to drop below MSCWLL is estimated to be ½ that found above or 45 min.

- Medium LOCA

The Medium LOCA case may be divided into steam breaks and water breaks. The time for MSCWLL to be reached is estimated based upon some generic BWR calculations performed in EPRI 1009044 (BWR Large LOCA Taxonomy).

The results indicate the following:

Medium LOCA	Time to MSCWLL	Time to Core Damage
Steam		
5" dia	--	> 30 min.
20" dia	--	16 min.
Water		
5" dia	14 min.	14 min.
20" dia	--	12 min.

- Small Break LOCA (SBLOCA)

The SBLOCA evaluation is considered to be adequately treated under the transient evaluation. Slightly reduced available times are anticipated depending on whether the SBLOCA is water or steam. To provide the estimate for the limiting SBLOCA, times that are ½ of that used for transients are used.

- Summary

Case	Designation	Description	Time Available
A	2FWOP-TR-STRTH--	Transient without IC available	91 min.
B	2FWOP-TR-IC--H--	Transient with IC available	45 min.

Case	Designation	Description	Time Available
C	2FWOP-SL-STRTH--	SBLOCA without IC available	45 min.
D	2FWOP-SL-IC--H--	SBLOCA with IC available	22.5 min.
E	2FWOP-ML-STM-H--	Medium Steam LOCA	16 min.
F	2FWOP-ML-WTR-H--	Medium Water LOCA	12 min.

3.57.4 PSA Model Interface

"OP ACT: Restart FW." (Not currently modeled.)

3.57.5 Summary of Operator Interviews

Table 3.57.1-1 summarizes some of the considerations involved in the assessment of the operator's ability to successfully perform the intended action.

These have not been explicitly confirmed by crew interviews and are currently based on comparison with results for similar actions at Dresden.

Table 3.57-1

VARIABLES ASSESSED FOR FW PUMP RESTART

Influences on Performance Shape Factors	Inferred Operations Staff Consensus Information	Noteworthy Deviations from Consensus
Preconditions	Rx Scram FW Trips on Level 8	
EOP Directions (Procedures) - Unambiguous - Cautions - Obvious	Maintain RPV Level +8" to +48" - Unambiguous - clear on Front Panel For motor driven FW -- no problem in restarting. A caution to avoid multiple restarts of the large motor driven FW pumps is included in the procedure. - Obvious	
Training - Practice at Simulator - Classroom - Directions	- included in similar scenarios - second nature	
Other Considerations (Motivation & Difficulty)	Second nature to operators, as an RPV injection source.	
Instrument Readings (Indication) - Control Room - Accuracy - Front vs. Back Panel - Alarmed	Vessel Level instruments – primarily narrow range Computer points - Control Room - OK acc. - Front - Lo level alarm	
Multiple Failures	Not necessarily at this point	
Stress Level	Moderate to high stress, but the work load is well within the work load that the crew is trained to cope with during an accident response. This corresponds to the "optimum" work load performance shape factor as documented in NUREG/CR-1278, p. 17-2. As noted, these categories of "task stress" are quite broad and there are no fixed divisions between them, however, crew performance for JPMs and simulator drills indicate that the work load is well within the human capability.	
Familiarity	High	
Number of Operators	1	
Competing Tasks and *Previous Actions*	SCRAM recovery	

Table 3.57-1

VARIABLES ASSESSED FOR FW PUMP RESTART

<table>
<tr><th>Influences on Performance Shape Factors</th><th>Inferred
Operations Staff Consensus Information</th><th>Noteworthy Deviations from Consensus</th></tr>
<tr><td>Time Allowed</td><td>
<table>
<tr><th>Case</th><th>Designation</th><th>Description</th><th>Time Available</th></tr>
<tr><td>A</td><td>2FWOP-TR-STRTH--</td><td>Transient without IC available</td><td>91 min.</td></tr>
<tr><td>B</td><td>2FWOP-TR-IC--H--</td><td>Transient with IC available</td><td>45 min.</td></tr>
<tr><td>C</td><td>2FWOP-SL-STRTH--</td><td>SBLOCA without IC available</td><td>45 min.</td></tr>
<tr><td>D</td><td>2FWOP-SL-IC--H--</td><td>SBLOCA with IC available</td><td>22.5 min.</td></tr>
<tr><td>E</td><td>2FWOP-ML-STM-H--</td><td>Medium Steam LOCA</td><td>16 min.</td></tr>
<tr><td>F</td><td>2FWOP-ML-WTR-H--</td><td>Medium Water LOCA</td><td>12 min.</td></tr>
</table>
</td><td></td></tr>
<tr><td>Time Required
(estimate or observed)
- Diagnosis
- Manipulation</td><td>Restart FW, 5 min. (estimate)
- Diagnosis is based on indicator and annunciators for Level 2 and Level 1.
- Manipulation is straightforward and in CR</td><td></td></tr>
<tr><td>Summary</td><td>Second nature response of RO to FW trip on high level. Straightforward</td><td></td></tr>
</table>

CALCULATION NUMBER: 57

OPERATOR RESTARTS FEEDWATER GIVEN A LEVEL 8 TRIP

ACTION DESCRIPTION: Reactor level swell following a turbine trip can result in a trip of feedwater on Level 8 if feedwater is not controlled automatically or by crew intervention.

This crew action is to restart a motor driven FW pump taken in response to a Level 8 feedwater trip that occurs following a SCRAM.

There may be conditions associated with a reactor scram (turbine trip or MSIV closure) where the FW control system is not able to control the swell and rapid fill of the vessel occurs, i.e., Level 8 trips the Feedwater System. Under these conditions there is a possibility of having water intrude into the HPCI steam lines which, for Dresden, are located approximately four (4) feet below the main steam lines. This could cause HPCI to become temporarily inoperable. Potential HPCI inoperability increases the need to provide a manual action for the crew to restart FW for RPV injection.

Cases to be evaluated are the following:

G. Transient without IC available

H. Transient with IC available

I. SBLOCA without IC available

J. SBLOCA with IC available

K. Medium LOCA Steam

L. Medium LOCA Water

ACTION DESIGNATOR(S):

Case	Designation	Description
A	2FWOP-TR-STRTH--	Transient without IC available
B	2FWOP-TR-IC--H--	Transient with IC available
C	2FWOP-SL-STRTH--	SBLOCA without IC available
D	2FWOP-SL-IC--H--	SBLOCA with IC available
E	2FWOP-ML-STM-H--	Medium Steam LOCA
F	2FWOP-ML-WTR-H--	Medium Water LOCA

SUB TASKS:

1. Start FW Pump

TIME REQUIRED FOR PERFORMANCE: 5 minutes (estimate)

TIME AVAILABLE:

Case	Time Available
A	91 min.
B	45 min.
C	45 min.
D	22.5 min.
E	16 min.
F	12 min.

PROCEDURES GOVERNING ACTION: DAN 902(3)-6 F-7 Rev. 16; DOA-0600-01 Transient Level Control Rev. 39.

RELEVANT CUES: Level 8 trip and subsequent loss of all RPV makeup except CRD.

DEPENDENCY ISSUES: Other HEPs may occur in cutsets with this HEP. These potentially dependent HEPs are explicitly addressed in Section 5.

QUANTIFICATION BASIS: P_C - Cause Based Method and ASEP, P_E - THERP

FAILURE PROBABILITY:

Case	Designation	Description	Failure Prob.
A	2FWOP-TR-STRTH--	Transient without IC available	3.2E-4
B	2FWOP-TR-IC--H--	Transient with IC available	3.4E-4
C	2FWOP-SL-STRTH--	SBLOCA without IC available	3.4E-4
D	2FWOP-SL-IC--H--	SBLOCA with IC available	2.3E-3
E	2FWOP-ML-STM-H--	Medium Steam LOCA	1.1E-2
F	2FWOP-ML-WTR-H--	Medium Water LOCA	2.3E-2

Execution Error

The execution failure probability, P_E, is determined using THERP.

NOTES: Failure of either subtask will fail this action.

FAILURE MODES IDENTIFIED:

- Select wrong control
- Turn selector to wrong position

QUANTIFICATION OF FAILURE MODES (based on NUREG/CR-1278 [1]):

SELECT WRONG CONTROL: Control selection failure is applicable to each of the sub-tasks identified for this action. Control selection failure probabilities are assigned to each sub-task:

1) Start FW pump, 1E-3 (Table 20-12(3)) [1].

TURN SELECTOR TO WRONG POSITION: This failure mode is applicable to each of the subtasks identified as follows:

1) Start Feedwater pump, 5E-4 per pump (Table 20-12(5)) [1].

$P_E = P_{E(\text{control select})} + P_{E(\text{wrong position})}$

$P_E = 1E\text{-}3 + 5E\text{-}4 = 1.5E\text{-}3$[1]

[1] This value is used as the initial execution failure probability. Recovery is applied as documented in Table 57.

Non-Response Probability

The non-response probability, P_C, is the sum of the non-response probabilities determined by the Cause Based Method and ASEP:

$$P_C = P_{C(\text{Cause Based})} + P_{C(\text{ASEP})}$$

The Cause Based Methodology applies recovery to each "failure mechanism" individually as documented in Table 57. The ASEP non-response probability is used directly, without recovery. The relevant values for this action are provided below:

Case A

$P_{C(\text{Cause Based})}$ = 1.63E-04 (Table 57a, Time Frame B)

$P_{C(\text{ASEP})}$ = 3.0E-6

Lower bound curve is chosen in the $P_{C(\text{ASEP})}$ evaluation to reflect the optimum level of work load and stress.

Case B and C

$P_{C(\text{Cause Based})}$ = 1.63E-04
$P_{C(\text{ASEP})}$ = 3.0E-5

Case D

$P_{C(\text{Cause Based})}$ = 1.63E-04
$P_{C(\text{ASEP})}$ = 2.0E-3

Case E

$P_{C(\text{Cause Based})}$ = 1.4E-2
$P_{C(\text{ASEP})}$ = 8.0E-3

Case F

$P_{C(\text{Cause Based})}$ = 1.4E-2
$P_{C(\text{ASEP})}$ = 2.0E-02

Final HEP

The final HEP is the sum of the P_C and P_E contributions (after applying the recovery values for the appropriate time frame).

Case A

The time available for this action is 86 minutes, which corresponds to Time Period B in Table 57. The final HEP, P_f, for this action is therefore:

$$P_f = P_{C(\text{Cause Based})} + P_{C(\text{ASEP})} + P_E$$

$$P_f = 1.63E\text{-}4 + 3.0E\text{-}6 + 1.5E\text{-}4 = 3.16E\text{-}4$$

Case B and C

$$P_f = 1.63E\text{-}4 + 3.0E\text{-}5 + 1.5E\text{-}4 = 3.43E\text{-}4$$

Case D

$$P_f = 1.63E\text{-}4 + 2.0E\text{-}3 + 1.5E\text{-}4 = 2.31E\text{-}3$$

Case E

$$P_f = 1.2E\text{-}3 + 8.0E\text{-}3 + 1.5E\text{-}3 = 1.1E\text{-}2$$

Case F

$$P_f = 1.2E\text{-}3 + 2.0E\text{-}2 + 1.5E\text{-}3 = 2.3E\text{-}2$$

Table 57a

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE A: TRANSIENT WITHOUT IC AVAILABLE (TIME ALLOWED = 86 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed:	high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscom-municate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57a

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE A: TRANSIENT WITHOUT IC AVAILABLE (TIME ALLOWED = 86 MIN)

P_c *Failure* Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous *Wording:* All Required Info: *Training on Step:*	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: Deliberate Violation	Belief in Adequacy of Instruction: Adverse Conseq if Comply: Reasonable Alternative: *Policy of "Verbatim" Compliance:*	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$									1.63E-04		
$P_{c\ (ASEP)}$	T=86 min., Lower Bound		3.0E-06	--	--	--	--		3.0E-06		
$P_{e\ (Execution)}$			1.5E-03	1.0E+00	1.0E-01	5.0E-02	2.5E-02		1.5E-04		
$P_c + P_e =$									3.16E-04		

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57b

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE B: TRANSIENT WITH IC AVAILABLE (TIME ALLOWED = 40 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	*Time Dependent Non Recovery Probability**				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed:	high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscommunicate Data	*Ind. Easy to Locate:* Good/Bad Indicator: *Formal Comms.:*	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: *Information* Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57b

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE B: TRANSIENT WITH IC AVAILABLE (TIME ALLOWED = 40 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": *Practiced Scenario:*	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: *Deliberate* Violation	Belief in Adequacy of Instruction: *Adverse Conseq if Comply:* Reasonable Alternative: Policy of "Verbatim" Compliance:	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$								1.4E-02	1.63E-04		
$P_{c\ (ASEP)}$	T=40 min., Lower Bound		3.0E-05	--	--	--	--		3.0E-05		
$P_{e\ (Execution)}$			1.5E-3	1.0E+00	1.0E-01	5.0E-02	2.5E-02		1.5E-04		
$P_c + P_e =$									3.43E-04		

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57c

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE C: SBLOCA WITHOUT IC AVAILABLE (TIME ALLOWED = 40 MIN)

P_c Failure Mechanism	Failure Mechanism *Parameters*		Initial *Probability*	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: *Warn/Alt in Proc.:* Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High *Workload:* Check vs. Monitor: Front vs. Back *Panel:* Alarmed vs. Not Alarmed:	*high* monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscom-municate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57c
DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE C: SBLOCA WITHOUT IC AVAILABLE (TIME ALLOWED = 40 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: Deliberate Violation	Belief in Adequacy of Instruction: Adverse Conseq if Comply: Reasonable Alternative: *Policy of "Verbatim"* Compliance:	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\,(Cause\ Based)}$									1.63E-04		
$P_{c\,(ASEP)}$	T=40 min., Lower Bound		3.0E-05	--	--	--	--		3.0E-05		
$P_{e\,(Execution)}$			1.5E-03	1.0E+00	1.0E-01	5.0E-02	2.5E-02		1.5E-04		
$P_c + P_e =$									3.43E-04		

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57d

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE D: SBLOCA WITH IC AVAILABLE (TIME ALLOWED = 17.5 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability* A	B	C	D	Time Dependent Final Probability* A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed:	high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscommunicate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57d
DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE D: SBLOCA WITH IC AVAILABLE (TIME ALLOWED = 17.5 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: Deliberate Violation	*Belief in Adequacy of Instruction:* Adverse Conseq if Comply: Reasonable Alternative: Policy of "Verbatim" *Compliance:*	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$									1.63E-04		
$P_{c\ (ASEP)}$	*T=17.5 min., Lower Bound*		2.0E-03	--	--	--	--		2.0E-03		
$P_{e\ (Execution)}$			1.5E-03	1.0E+00	1.0E-01	5.0E-02	2.5E-02		1.5E-04		
$P_c + P_e =$									2.31E-03		

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57e

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE E: MED. STEAM LOCA (TIME ALLOWED = 11 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed	high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscom-municate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57e
DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE E: MED. STEAM LOCA (TIME ALLOWED = 11 MIN)

P_c Failure Mechanism	*Failure Mechanism Parameters*		Initial Probability	Time Dependent Non Recovery Probability* A	B	C	D	Time Dependent Final Probability* A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: Deliberate Violation	Belief in Adequacy of Instruction: *Adverse Conseq if* Comply: Reasonable Alternative: Policy of "Verbatim" Compliance:	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$								1.2E-03			
$P_{c\ (ASEP)}$	*T=11 min.*, Lower Bound		8.0E-03	--	--	--	--	8.0E-03			
$P_{e\ (Execution)}$			1.5E-03	1.0E+00	1.0E-01	5.0E-02	2.5E-02	1.5E-03			
$P_c + P_e =$								1.1E-02			

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57f

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE F: MED. WATER LOCA (TIME ALLOWED = 7 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability* A	B	C	D	Time Dependent Final Probability* A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed	high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscom-municate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.25E-05	1.63E-05	8.1E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 57f
DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP
DRESDEN: OPERATOR FAILS TO RESTORE FEEDWATER AFTER LEVEL 8 TRIP
CASE F: MED. WATER LOCA (TIME ALLOWED = 7 MIN)

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no yes no yes	1.0E-05	1.0E+00	5.0E-02	2.5E-02	1.3E-02	1.0E-05	5.0E-07	2.5E-07	1.3E-07
P_ch: Deliberate Violation	Belief in Adequacy of Instruction: Adverse Conseq if Comply: Reasonable Alternative: Policy of "Verbatim" Compliance:	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$								1.2E-03	7.8E-04	4.0E-04	2.0E-04
$P_{c\ (ASEP)}$	T=7 min., Lower Bound		2.0E-02	--	--	--	--	2.0E-02			
$P_{e\ (Execution)}$			1.5E-03	1.0E+00	1.0E-01	5.0E-02	2.5E-02	1.5E-03			
$P_c + P_e =$								2.3E-02			

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Appendix A-2

Section 1 of

Dresden Human Reliability Assessment Handbook

1 FAILURE TO DEPRESSURIZE THE RPV (ADS) (NON-ATWS) (2ADOP-ACT-ADSH--)

1.1 Description of Action

RPV depressurization is performed to allow low pressure injection to the vessel given failure of high pressure injection systems. It is also specified under certain degraded containment conditions. Also, the same HEP is utilized for depressurization of RPV to allow low pressure injection and/or initiation of shut down cooling following successful operation of HPCI.

RPV Emergency Depressurization is an action clearly delineated in the EOPs to reduce RPV pressure.

This action is taken when water level drops below -143" and before -164" if an injection system is lined-up and running(1). This action is also directed for primary and secondary containment parameters such as violation of the HCTL curve, low torus level, high drywell temperature, and high torus pressure.

Two cases are investigated:

- Transient – Case A
- SBO – Case B

1.2 Procedural Direction for Implementation

DEOP 100 provides direction to control RPV Level between 8" and 48". If this cannot be maintained, and RPV level drops, actions such as steam cooling and blowdown are directed. While this specific situation (i.e., decreasing RPV water level), is the focus of this HEP, blowdown is directed based on a number of plant parameters. DEOP 200-1 provides direction to control containment parameters within specified limits. If these cannot be maintained, actions such as drywell spray and blowdown are directed. DEOP 300-1 are treated similarly for secondary containment and radioactive release control.

In each case where blowdown is directed the operator is referred to DEOP 400-2, "Emergency Depressurization" for specific direction. This procedure directs the use of the isolation condenser and specifies SRV use based on torus level. The remainder of this subsection will discuss the specific cases where blowdown is directed by EOPs.

(1) Assumes fuel zone instruments are operable. Without operable fuel zone instruments, depressurization is demanded when level becomes unknown (i.e., sometime after dropping below -70").

DEOP 100 "RPV Control"

- If water level drops below –143" (TAF) and an injection system is lined-up and running, operators are directed to blowdown prior to –164". If an injection system is not lined-up and running, operators are directed to DEOP 400-3 "Steam Cooling."

DEOP 400-3 "Steam Cooling"

- When water level is below –185" operators are directed to blowdown.

DEOP 400-5 "Failure to SCRAM"

- For failure to SCRAM scenarios, operators are directed to blowdown if RPV level cannot be restored and maintained above –164" using preferred ATWS systems (i.e., Cond/Feed, CRD, HPCI, LPCI).

DEOP 200-1 "Primary Containment Control"

- If unable to stay within the pressure suppression pressure (Torus Pressure/level) noted as Figure L, operators are directed to blowdown.
- If unable to hold drywell temperature below 281°F, operators are directed to blowdown.
- If unable to stay within the Heat Capacity Temperature Limit (Torus Temp/RPV Pressure) noted as Figure M, operators are directed to blowdown.
- If unable to hold torus level above 11', operators are directed to blowdown.

DEOP 300-1 "Secondary Containment Control"

- If two or more reactor building areas are above their maximum safe temperature (Table 300-1-A) and a primary system is discharging into the reactor building, operators are directed to blowdown.
- If two or more reactor building areas are above their maximum safe radiation levels (Table 300-1-B) and a primary system is discharging into the reactor building, operators are directed to blowdown.
- If two or more reactor building areas are above their maximum safe water levels (Table 300-1-C) and a primary system is discharging into the reactor building, operators are directed to blowdown.

DEOP 300-2 "Radioactive Release Control"

- If offsite radioactivity release rate approaches or exceeds General Emergency level and a primary system is discharging into the reactor building, operators are directed to blowdown.

DEOP 400-1 "RPV Flooding"

- While not directed to blowdown using DEOP 400-2, RPV Flooding directs operators to open 5 ADSVs if torus level is above 6'. RPV flooding is directed from DEOP 100, 400-3, and 400-5 when RPV water level is unknown.

1.3 Time Frame for Accomplishing Operator Action

There are a large number of variables in the assessment of adequate RPV depressurization to support adequate core cooling. These variables include:

- EOP direction on when to depressurize
- The number of ERVs/SRV able to be open (i.e., success criteria)
- The instrumentation accuracy
- The number and type of system trains used to inject following depressurization.
  - Condensate
  - LPCI
  - CS
  - DFP

Each of these will be discussed in turn:

EOP Directions

The EOPs direct that the RPV be emergency depressurized if the RPV water level cannot be maintained above -164", i.e., before -164" and after TAF cannot be maintained if any pump (Injection Subsystems or Alternate Injection Systems) are lined-up, e.g., SLC.

The cue to begin to consider this action is the initial drop in RPV water level at the time of the scram. The second cue occurs when the lo-lo RPV water level is reached and automatic systems are unsuccessful in maintaining the RPV water level. Finally, when TAF is reached or determined that level cannot be maintained above TAF, the crew is directed to emergency depressurize if one (1) subsystem is lined up. This can generally be construed to be the case (i.e., it is not precluded in the model).

MAAP calculations have indicated that substantial delays in the initiation of emergency depressurization can be tolerated if all SRV/ERVs are opened successfully. However, if only a single SRV/ERV is available, then the depressurization is desired at the specified EOP levels.

(See the discussion of fuel zone level indication for additional insight into the timing success.)

Number of ERVs/SRVs

The number of ERVs/SRVs specified for use is 5. The success criterion for the Base PSA uses two ERV/SRVs as success. This is adequate for the Base PSA after EPU when depressurization occurs as specified in the EOPs.

Instrument Accuracy

The RPV water level instrument accuracy for the fuel zone instruments can be quite large for the postulated conditions because of the calibration conditions for the fuel zone instruments. The TSGs include a correction to the fuel zone reactor water level measurement. Without this correction, this creates the situation where the +40" to 60" error in the fuel zone instruments at 1000 psig forces operator action well before it is required by the EPG Bases.

The operating crew is well aware of the RPV water level instrumentation overlap between the wide range level instruments and the fuel zone instruments. The crew will use the wide range instruments following an accident initiated from power until the level drops below the wide range indicated level. At that point, the fuel zone RPV water level instruments would be used. This affects emergency depressurization decisions.

Currently, the fuel zone correction is not in Control Room procedures. Therefore, this HRA assumes that actions are directed without correcting for the fuel zone error.

The procedures (DEOP 100) specify that on low RPV level TAF (-143 in.) and before –164 in. that blowdown (DEOP-04) would be implemented even if all that was available was SBLC from the boron tank. because this is considered nearly always available (i.e., cannot be precluded in the model) due to fuel zone calibration, blowdown will occur substantially before –164 in. actual (or in the worst case if the wide range is used; all actions will be taken before –70 in. (bottom of W.R.) i.e., steam cooling contingency is a moot point.

Number and Type of Systems for Injection

The ability to restore RPV water level and adequate core cooling following RPV depressurization is also strongly dependent on the system lined up for injection.

- Feedwater/Condensate has the highest injection head and could recover the level the quickest
- CS is the next best pump train
- LPCI is the lowest priority system and is the most restrictive in terms of success criteria and timing of depressurization
- DFP is not considered a successful injection source.
- SBCS use is included as a potential water source but its success probability is a strong function fo the accident sequence and the ability to assure that the pathway does not clog (i.e., the stacked disk FW Regulatory Valve does not become clogged)

Conclusion

The *timing* for crew response varies with the accident sequence and initiating event. The following times available for crew response are provided based on deterministic thermal hydraulic calculations.

The MAAP timing for the Base PSA indicates the following critical times for a boildown accident with no available injection:

	No Level Error (DR05014)	Include Level Error Without Correction (DR05014A)
Initial Cue	t = 0	t = 0
2nd Cue (lo-lo)	10 min	10 min
3rd Cue (Perceived TAF)	26 min	22 min
Point of Recovery (Perceived MSCWLL)	35 min [DR05015]	31 min

(MAAP Cases DR05014 and DR05015.)

The distinctions between the two calculations are as follows:

(a) The "No Level Error" case shows the required times for actions based on best estimate deterministic calculation

(b) The Case, which has "Include Level Error Without Correction", reflects the perceived cues that the crew would observe.

The conclusion is that the cues for action will occur much more quickly because of the fuel zone instrument error. Therefore, the time for direction to perform an action will be well before it is actually required. This means more emergency blowdowns. This may be an issue for continued plant operability if too many EBs occur, but should have minimal negative impact on the assessed risk.

Therefore, the time available from the second cue to the point of no recovery (using two SRVs as the depressurization success criteria) is 25 minutes. This is considered to be the time available for operator action when using the restrictive success criteria of 2 SRVs.

This HEP is used in transients and small steam LOCA, scenarios and the time frame available for diagnosis and action is 35 minutes[(1)].

If the scenario involves a Station Blackout without AC power available, then the fuel zone water level instruments are not available and the decision regarding RPV blowdown must be made at the bottom of the Wide Range Water level instruments (-70").

	No Level Error (DR05014)	No Fuel Zone Available	
		120 gpm Leak (DR05011C)	12.5 gpm Leak (DR05011D)
Initial Cue	t=0	t=0	t=0
2nd Cue (lo-lo)	10 min.	10 min.	11 min.
3rd Cue (Perceived TAF)	26 min.	Blowdown at -70"	Blowdown at -70"
Point of Recovery (Perceived MSCWLL)	35 min.[(3)]	--[(1)]	--[(2)]
Core Damage	40 min.	27 min.	28 min.

(1) Estimated to be 22 min.
(2) Esimated to be 23 min.
(3) 31 min. for uncorrected fuel zone level indication

The time required to manipulate the SRVs to initiate depressurization is quite short. This is estimated to be less than 30 sec. to 1 min. However, the JPM allows 2 min. for this action. (See JPM S-0218-01).

1.4 PSA Model Interface

Modeled as
2ADOP-ACT-ADSH-- FAILURE TO DEPRESS RPV (ADS) (NON-ATWS)

It has been found to have relatively high importance when occurring in combination with initiation of the Isolation Condenser, and is relatively important by itself (i.e., high RAW).

1.5 Summary of Operator Interviews

(1) MAAP reference [D-91-006] allows 35 min. time frame for the Pre-EPU configuration. For EPU, use

Table 1-1 summarizes some of the considerations involved in the assessment of the operator's ability to successfully perform the intended action.

MAAP DR050500 and MAAP DR05014 and DR05014B.

Table 1-1

VARIABLES ASSESSED IN THE OPERATING STAFF INTERVIEWS FOR EMERGENCY DEPRESSURIZATION (Non-ATWS, NON-LOCA)

Influences on Performance Shape Factors	Operations Staff Consensus Information	Noteworthy Deviations from Consensus
Preconditions	Rx Scram HPI unavail.	
EOP Directions (Procedures) - Unambiguous - Cautions - Obvious	DEOP 100 RPV Control - Unambiguous - Injection system variability in capability recognized in training but not in EOPs - Obvious	
Training - Practice at Simulator - Classroom - Directions	- Part of simulator exercise, also JPM S-0218-01 - Yes - Clear	
Other Considerations (Motivation & Difficulty)	High motivation but blowdown is significant Containment challenge and HPI recovery would be highly preferred ADS would be inhibited by procedure Issues with fuel zone level indication; The fuel zone instruments read consistently low when the recirc. pumps are tripped and the RPV is at elevated temperature and pressure. This means that the direction to depressurize will occur much more quickly than actually required. This, in turn, means that there is additional time from the cue of RPV depressurization to the latest time required.	
Instrument Readings (Indication) - Control Room - Accuracy - Front vs. Back Panel - Alarmed	RPV Level Inst & Computer points - Control Room - OK acc. - Front - Alarms at Lo and LoLo Levels	
Multiple Failures	Yes	
Stress Level	High	
Familiarity	Good Familiarity; Simulator Practice	
Number of Operators	1	
Competing Tasks and Previous Actions	- HPCI, CRD recovery, IC initiation - FW Restoration / Manipulation - Alignment of a low pressure injection system	
Time Allowed	Case A – 35 min.(1), (2) Case B – 35 min.(1), (2)	
Time Required (estimate or observed) - Diagnosis - Manipulation	2 minutes (JPM S-0218-01) - Diagnosis is based on RPV water level indication on Fuel Zone instruments(3) - Manipulation is straightforward and in CR	

Table 1-1

VARIABLES ASSESSED IN THE OPERATING STAFF INTERVIEWS FOR EMERGENCY DEPRESSURIZATION (Non-ATWS, NON-LOCA)

Influences on Performance Shape Factors	Operations Staff Consensus Information	Noteworthy Deviations from Consensus
Summary	Stressful but simple.	

(1) Note that for offsite AC recovery the premature depressurization that results at -70" would limit the allowed AC recovery probability. This is addressed in the AC recovery assessments, not in the RPV depressurization.

(2) These times are maximum times allowed for crew action.

(3) Fuel Zone calibration results in conservatively low level indication if the instrument correction is not applied. (See TSGs Attachment I.)

1.6 Calculation: Cases A and B

SUB TASKS:

1) Open at least 2 of 5 ADS valves

TIME REQUIRED FOR PERFORMANCE: 1 minute (estimates from other BWR operator interviews)
2 minutes based on JPM S-0218-01

TIME AVAILABLE: 35 minutes (MAAP DR05014, DR05016), 35 minutes is used based on discussion above (successful operation of HPCI provides additional minutes).

PROCEDURES GOVERNING ACTION: DEOP 100, DEOP 400-2

RELEVANT CUES: SCRAM, Low RPV water level (lo-lo alarm and indication)

DEPENDENCY ISSUES: Other HEPs may occur in cutsets with this HEP. These potentially dependent HEPs are explicitly addressed in Section 5.

QUANTIFICATION BASIS: P_C - Cause Based Method and ASEP, P_E - THERP

FAILURE PROBABILITY: 2.4E-4 (Table 1-2)

NOTES: Evaluated for Transient cases.

Execution Error

The execution failure probability, P_E, is determined using THERP.

NOTES: Two of five ADS valves is required for success. Failure requires an execution failure on each ADS valve; high dependence is assumed.

FAILURE MODES IDENTIFIED:

- *Select wrong control*
- Turn selector to wrong position

QUANTIFICATION OF FAILURE MODES:

SELECT WRONG CONTROL: ADS valve controls are functionally grouped; 1E-3 is assigned for this item (Table 20-12(3)) [1]

TURN SELECTOR TO WRONG POSITION: 5E-4 is assigned for this item (Table 20-12(5)) [1]
$P_{E(1\ ADS\ value)}$ = (Select wrong control) + (Turn selector to wrong position)
$P_{E(1\ ADS\ value)}$ = 1E-3 + 5E-4 = 1.5E-3

$P_{E(5\ ADS\ valves)}$ = (1.5 E-3) *6.3E-1 * 5.5E-1 * 5.3E-1 * 5.1E-1 = 1.4E-4(1)
(conditional failure probabilities are taken from Table 20-18 (1-4) for high dependence).

(1) This value is used as the initial execution failure probability. Recovery is applied as documented in Table 1.

Non-Response Probability

The non-response probability, P_C, is the sum of the non-response probabilities determined by the Cause Based Method and ASEP:

$P_C = P_{C(\text{Cause Based})} + P_{C(\text{ASEP})}$

The Cause Based Methodology applies recovery to each "failure mechanism" individually as documented in Table 1-2. The ASEP non-response probability is used directly, without recovery. The relevant values for this action are provided below:

$P_{C(\text{Cause Based})}$ = 1.6 E-4 (Table 1-2, Time Frame B)

Time Reliability Correlation (ASEP)
The time available for diagnosis is the total time window from a recognized cue (approximately 35 min.) minus the manipulation time of 2 min. or a time of 33 min. for the diagnosis. The ASEP TRC yields the following result (see Figure 4.2-1).

$P_{C(\text{ASEP})}$ = 7E-5 (lower bound curve)[1]

---

[1] The following excerpt from NUREG/CR-4772 provides the basis for using the Lower Bound Curve:

Use lower bound curve if:

(a) the event is a well recognized classic (e.g., TMI-2 incident), and the operators have practiced the event in the simulator requalification exercises, and

(b) the talk through and interviews indicate that all the operators have a good verbal recognition of the relevant stimulus patterns and know what to do or which written procedures to follow.

Final HEP

The final HEP is the sum of the P_C and P_E contributions (after applying the recovery values for the appropriate time frame).

The time available for this action is 35 minutes, which corresponds to Time Period B in Table 1-2. The final HEP, P_f, for this action is therefore:

$$P_f = P_{C(\text{Cause Based})} + P_{C(\text{ASEP})} + P_E$$

$$P_f = 1.6E\text{-}4 + 7.0E\text{-}5 + 1.4E\text{-}5 = 2.4E\text{-}4$$

Table 1-2

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability* A	B	C	D	Time Dependent Final Probability* A	B	C	D
P_ca: Availability of Information	Ind. Avail in CR: CR Idn. Accurate: Warn/Alt in Proc.: Training on Ind:	yes yes n/a yes	Negligible	1.0E+00	1.0E-01	5.0E-02	2.5E-02	Neg.	Neg.	Neg.	Neg.
P_cb: Failure of Attention	Low vs. High Workload: Check vs. Monitor: Front vs. Back Panel: Alarmed vs. Not Alarmed	 high monitor front alarmed	Negligible	5.0E-01	2.5E-02	1.3E-02	6.5E-03	Neg.	Neg.	Neg.	Neg.
P_cc: Misread/Miscommunicate Data	Ind. Easy to Locate: Good/Bad Indicator: Formal Comms.:	yes good yes	5.0E-04	1.0E+00	2.5E-01	1.3E-01	6.5E-02	5.0E-04	1.3E-04	6.5E-05	3.3E-05
P_cd: Information Misleading	All Cues As Stated: Warning of Differences: Specific Training: General Training:	yes n/a n/a n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ce: Skip a Step in Procedure	Obvious vs. Hidden: Single vs. Multiple: Graphically Distinct: Place Keeping Aids:	obvious multiple yes no	1.3E-03	5.0E-01	2.5E-02	1.3E-02	6.5E-03	6.5E-04	3.3E-05	1.7E-05	8.5E-06

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

Table 1-2

DETERMINATION OF PC USING EPRI'S CAUSE-BASED APPROACH AND TOTAL HEP

P_c Failure Mechanism	Failure Mechanism Parameters		Initial Probability	Time Dependent Non Recovery Probability*				Time Dependent Final Probability*			
				A	B	C	D	A	B	C	D
P_cf: Misinterpret Instruction	Standard Unambiguous Wording: All Required Info: Training on Step:	yes yes n/a	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_cg: Misinterpret Decision Logic	"NOT" Statement: "AND" or "OR" Statement: Both "AND" and "OR": Practiced Scenario:	no no n/a yes	Negligible	1.0E+00	5.0E-02	2.5E-02	1.3E-02	Neg.	Neg.	Neg.	Neg.
P_ch: Deliberate Violation	Belief in Adequacy of Instruction: Adverse Conseq if Comply: Reasonable Alternative: Policy of "Verbatim" Compliance:	yes n/a n/a n/a	Negligible	1.0E+00	2.5E-01	1.3E-01	6.5E-02	Neg.	Neg.	Neg.	Neg.
$P_{c\ (Cause\ Based)}$								1.2E-03	1.6E-04	8.2E-05	4.1E-05
$P_{c\ (ASEP)}$			7.0E-05	--	--	--	--	--	7.0E-05	--	--
$P_{e\ (Execution)}$			1.4E-04	1.0E+00	1.0E-01	5.0E-02	2.5E-02	1.4E-04	1.4E-05	7.0E-06	3.5E-06
$P_c + P_e =$								--	2.4E-04		

* A: 0 - 15 minutes B: 15 minutes - 6 hours C: 6 hours - 14 hours D: 14 hours - 24 hours

NOTES TO TABLE 1-2:

These notes provide the bases for each response to the cause - based questions, i.e., bullet by bullet.

P_Ca:

- RPV pressure, water level, and injection system status indicators are available in the control room.
- The instrumentation is accurate.
- N/A
- The operators have been trained on all control room instrumentation.

P_Cb:

- The operator workload is High.
- The operator needs to monitor the pressure instrumentation to determine when RPV pressure is sufficiently low.
- The RPV pressure and level indicators are located on a front panel.
- Reactor SCRAM and low water level are alarmed in the control room.

P_Cc:

- The RPV pressure and water level indicators are easy to locate.
- The indicators are "Good".
- Formal communications are implemented in the Control Room.

P_Cd:

- All cues are as stated.
- N/A
- N/A
- N/A

P_Ce:

- The steps governing depressurization are not hidden in any way.
- The operator will be following multiple procedures or paths in procedures at the time this action is carried out.
- The step governing this action is graphically distinct.
- There are no placekeeping aids in the DEOPs.

P_Cf:

- The procedures are written with standard unambiguous wording.
- All of the required information is provided for the operator.
- N/A

P_Cg:

- There are no "NOT" statements in the decision logic.
- There are no "AND" or "OR" statements in the decision logic.
- N/A.
- The operators have practiced depressurizing the RPV.

P_Ch:

- The operators believe in the adequacy of their procedures.
- N/A
- N/A
- N/A