

# Final ASP Program Analysis - Precursor

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research			
<b>Waterford Steam Electric Station, Unit 3</b>	Both Emergency Diesel Generators Declared Inoperable		
<b>Event Date:</b> 8/26/2015	<b>LER:</b> <a href="#">382-2015-007</a> <b>IRs:</b> <a href="#">50-382/2015-003</a> and <a href="#">50-382/2016-002</a>	$\Delta\text{CDP} = 6 \times 10^{-6}$	
<b>Plant Type:</b> Combustion Engineering 2-Loop PWR with a Large Dry Containment			
<b>Plant Operating Mode (Reactor Power Level):</b> Mode 1 (100% Reactor Power)			
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## EXECUTIVE SUMMARY

On August 26, 2015, with the reactor operating at 100% power, Waterford Unit 3 had a condition when both emergency diesel generators (EDGs) were inoperable during overlapping periods. EDG A experienced a runtime failure 15 hours into a 24-hour scheduled run to satisfy a surveillance requirement. EDG B was subsequently started, per Technical Specifications (TS) requirements, and was declared inoperable due to a room exhaust damper not opening. Operators were able to manually open the damper, returning EDG B to operable status. The period of time when both EDGs were inoperable was approximately 8 hours.

According to the risk analysis modeling assumptions used in this Accident Sequence Precursor (ASP) analysis, the most likely core damage scenarios involve a non-recoverable loss of offsite power (LOOP) and subsequent station blackout (SBO) due to the failure of the EDGs, and operators failing to recover an EDG in 1 hour or 4 hours. These accident sequences account for approximately 93% of the increase in core damage probability for the event ( $\Delta\text{CDP}$ ). The point estimate  $\Delta\text{CDP}$  for this event is  $6 \times 10^{-6}$ , which is considered a precursor in the ASP Program.

NRC inspections did not identify any licensee performance deficiencies and, therefore, no inspection findings are associated with this event. An independent ASP analysis was required because both safety-related EDGs were unavailable at the same time due to different causes.

## EVENT DETAILS

**Event Description.** On August 26, 2015, EDG A tripped and was declared inoperable during a test run. EDG A was being run for 24 hours to satisfy TS Surveillance Requirement 4.8.1.1.2.e.6. The failure point came approximately 15 hours into the 24-hour scheduled run. The EDG tripped on generator differential—this protective function indicates a phase-to-phase current imbalance. Per TS 3.8.1.1 action b.(1), with one EDG inoperable, the site must demonstrate the operability of the other EDG within 8 hours.

Subsequently, operators attempted to start EDG B, but it was declared inoperable due to the room exhaust fan not starting. The fan did not start because the exhaust intake damper did not open. The room exhaust fan and damper are part of the ventilation system designed to maintain the temperature in the diesel generator rooms at a minimum of 50°F and a maximum of 120°F whenever the EDGs are in operation.

The site entered TS 3.8.1.1.f. which required operators to restore one of the inoperable EDGs to operable status within 2 hours or be in hot standby within the following 6 hours because both EDGs were inoperable. During this time, an operations brief was conducted and preparations for a plant shutdown were completed. Prior to exceeding the allowed outage time, the EDG B room exhaust intake damper was manually opened and the room exhaust fan started. The duration that both EDGs were knowingly inoperable at the same time was 2 hours and 20 minutes. EDG A remained inoperable until August 31<sup>st</sup> when repairs were completed. See licensee event report (LER) 382-2015-007 (Ref. 1) for additional event information.

**Event Timeline.** The following is a sequence of key dates and times that dictate the analysis of the event.

July 28 <sup>th</sup>		Assumed last successful start/test of EDG A <sup>1</sup>
August 12 <sup>th</sup>		Assumed last successful start/test of EDG B <sup>2</sup>
August 26 <sup>th</sup>	1:15 a.m.	EDG A fails after 15 hour run and declared inoperable <sup>3</sup>
August 26 <sup>th</sup>	7:40 a.m.	EDG B declared inoperable after damper fails to open
August 26 <sup>th</sup>	9:10 a.m.	EDG B intake damper manually opened <sup>4</sup>
August 26 <sup>th</sup>	10:01 a.m.	EDG B declared operable
August 31 <sup>st</sup>		EDG A declared operable following repairs and testing

**Causes.** The direct cause for EDG A tripping on generator differential was the internal shorting of a current transformer due to insulation failure. A vendor performed a failure analysis of the failed current transformer. The report concluded that the failure was due to a manufacturing defect. Specifically, there were voids found in the insulation and the thickness of the insulation material around the fault area appeared thinner when compared to the other areas of the current transformer. It is believed that the thinner insulation in combination with voids increased the electrical stresses causing the insulation to break down. This eventually resulted in a fault.

The direct cause for the exhaust intake damper not opening was a faulted pneumatic solenoid. The solenoid was inspected on site both externally and internally and it was determined that there was mechanical wear on the inside of the solenoid and that the air inlet valve plug was bound up inside the solenoid coil. An offsite vendor concluded that rapid cycling of the solenoid valve might be the cause of the excessive wear and damage to the components.

**Additional Event Information.** After the failure of EDG B, operations personnel began to connect their temporary emergency diesel system (TEDS). The TEDS consists of two portable diesel generators and their associated support systems. The TEDS can be aligned to power one safety-related bus; however, both diesels are required. Before connecting the TEDS, operations personnel noticed that one of the temporary diesels required repair for a coolant leak and action was taken to complete this repair. The licensee successfully connected their TEDS at 1:10 p.m., which extended the maximum allowable time to restore EDG A to 10 days.

<sup>1</sup> The analyst assumed that given the required monthly surveillance for the EDG occurred 28 days prior to the scheduled 24-hour run to satisfy SR 4.8.1.1.2.e.6. There were no reports to indicate that EDG A was not tested successfully; and therefore, should be considered operable on this date.

<sup>2</sup> The analyst assumed that the site staggers testing of EDGs and, therefore, likely performed the required monthly surveillance around this timeframe. There were no reports to indicate that EDG B was not successful on this assumed date.

<sup>3</sup> The LER did not state when the EDG A was initially started. The 15-hour runtime was sourced from the Management Directive 8.3 evaluation for the event (non-publicly available).

<sup>4</sup> At this time, EDG B could be considered available to fulfil its safety function.

## MODELING

**Basis for ASP Analysis/SDP Results.** The ASP Program uses Significance Determination Process (SDP) results for degraded conditions when available and applicable. The ASP Program performs independent analyses for concurrent degraded conditions (i.e., overlapping exposure periods). This event was mentioned in Inspection Report (IR) 50-382/2015-003 (Ref. 2) and the LER was closed in IR 50-382/2016-002 (Ref. 3). In their review of the events, the inspectors did not note any performance deficiencies.

An independent ASP analysis was required because both safety-related EDGs were unavailable at the same time due to different causes. No SDP analysis was performed because no licensee performance deficiencies were identified related to the runtime failure of EDG A due to the current transformer failure or the failure to start of EDG B due to the room exhaust damper failure.

**Analysis Type.** A condition assessment was performed using the Waterford 3 Standardized Plant Analysis Risk (SPAR) model Revision 8.16, created in May 2014.

**SPAR Model Modifications.** The following modifications were required for this condition assessment:

- The 1-hour and 4-hour basic events for operators failing to recover an EDG were set to TRUE in the base model. The assumptions and data that define the underlying recovery probabilities were determined non-applicable for SBO scenarios. Therefore, basic events EPS-XHE-XL-NR01H (*Operator Fails to Recover Emergency Diesel in 1 Hour*) and EPS-XHE-XL-NR04H (*Operator Fails to Recover Emergency Diesel in 4 Hours*) were set to TRUE in the base model.

**Exposure Periods.** In order to model this event, the analyst identified four distinct exposure periods, referred to as EP-1 through EP-4.<sup>5</sup>

- EP-1 consists of the 14-day period from July 28<sup>th</sup> through August 12<sup>th</sup> when EDG A was degraded.<sup>6</sup>
- EP-2 consists of the 14-day period from August 12<sup>th</sup> to August 26<sup>th</sup> when both EDG A and EDG B were degraded.
- EP-3 consists of the 8-hour period on August 26<sup>th</sup> when both EDG A and EDG B were unavailable. The analyst assumed that EDG B would fail on initial demand without room cooling available.

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<sup>5</sup> For the purposes of this analysis, the analyst selected the exposure time as equal to the total time from the last successful operation to the unsuccessful operation, which is potentially conservative. However, no information was available to modify this assumption (i.e., a detailed root cause evaluation showing that failure mechanism occurred after the last successful operation). This determination is consistent with Section 2 of the RASP Handbook for Internal Events (Ref. 6).

<sup>6</sup> The PRA mission time for EDGs is 24-hours. The analyst assumed that the previous surveillance tests for EDG A were successful; however, there is some potential that EDG A could have failed prior to July 28<sup>th</sup> within the mission time (i.e., the exposure period could be greater than 14 days). However, the potential risk during this period is expected to be negligible since it is expected that EDG A would have run for greater than 15 hours (and for potentially greater than the 24 hour mission time).

- EP-4 consists of the 5-day period from August 26<sup>th</sup> to August 31<sup>st</sup> when EDG A was in repair and not available.<sup>7</sup>

**Key Modeling Assumptions.** The following assumptions were determined to be significant to the modeling of this event:<sup>8</sup>

For EP-1:

- The failure of EDG A is modeled by setting basic event EPS-DGN-FR-DG3A (*Diesel Generator 3A-S Fails to Run*) to TRUE. Since EDG A could have run for at 15 hours during a LOOP initiating event, the risk increase during this exposure period is assumed to be limited to postulated late SBO and non-SBO scenarios.<sup>9</sup>
- Since it is assumed that EDG A would have successfully run for 15 hours during this exposure period, additional time would have been available to operators to recover offsite power (prior to either core uncover or battery depletion) for postulated SBO scenarios. Credit for the 15-hour runtime of EDG A is given to appropriately reduce the risk contribution of applicable SBO sequences. This is accomplished by setting the probability of basic events OEP-XHE-XL-NR01H (*Operator Fails to Recover Offsite Power in 1 Hour*) to  $3.535 \times 10^{-2}$  and OEP-XHE-XL-NR04H (*Operator Fails to Recover Offsite Power in 4 Hours*) to  $2.939 \times 10^{-2}$ . These are equivalent to the 16-hour and 19-hour offsite power non-recovery probabilities, respectively.<sup>10</sup>
- Since the offsite power non-recovery probabilities were manually adjusted to account for the 15-hour runtime for EDG A, the convolution factors need to be removed from applicable SBO cut sets to prevent double counting credit for successful runtime. Therefore, the following factors were set to TRUE:
  - OEP-XHE-XX-NR01H0 (*Convolution Factor for CCF-OPR [1HR Available]*)
  - OEP-XHE-XX-NR01H1 (*Convolution Factor for 1FTR-OPR [1HR Available]*)
  - OEP-XHE-XX-NR04H0 (*Convolution Factor for CCF-OPR [4HR Available]*)
  - OEP-XHE-XX-NR04H1 (*Convolution Factor for 1FTR-OPR [4HR Available]*)

<sup>7</sup> The multiple degraded components in this scenario necessitated modeling repair time (for EDG A, in this case) as a separate exposure period.

<sup>8</sup> For EP-1 and EP-4, the Single Pass with Cut Set Update solve method in SAPHIRE was used to eliminate invalid cut sets with failures of same train/division systems. This issue was entered into the SAPHIRE/SPAR change request log. EP-2 and EP-3 were solved with the Multiple Pass method.

<sup>9</sup> The key offsite power recovery times for Waterford are 1 hour and 4 hours during a postulated LOOP event with subsequent station blackout (SBO). The 1-hour time is associated with postulated SBO sequences in which either have a failure of turbine-driven emergency feedwater (EFW) pump or result in a consequential loss-of-coolant accident (e.g., stuck-open primary relief valve or failure of reactor coolant pump seals). Since the failure of the current transformer on EDG A occurred 15 hours into a 24-hour run, there is no expected risk increase (over baseline) during EP-1 and EP-2 for early (postulated) SBO scenarios.

<sup>10</sup> The analyst assumed the offsite power recovery times given a late SBO (initial postulated failure of EDG B and the actual failure of EDG A) would be the normal sequence time (either 1 or 4 hours based on time to core uncover or the battery depletion time) plus an additional 15 hours (time when EDG A fails).

- SAPHIRE produced duplicate cut sets involving some of the convolution factors.<sup>11</sup> The following factors were set to FALSE in order to eliminate these invalid cut sets:
  - OEP-XHE-XX-NR01H2 (*Convolution Factor for 2FTR-OPR [1HR Available]*)
  - OEP-XHE-XX-NR04H2 (*Convolution Factor for 2FTR-OPR [4HR Available]*)

For EP-2:

- The failure of EDG A is modeled by setting basic event EPS-DGN-FR-DG3A to TRUE.
- The failure of the room exhaust intake damper to open is modeled by setting basic event EPS-FAN-FS-3BSB (*DG-3B Room Fan 3B-SB Fails to Start*) to TRUE.
- The failure of the room exhaust fan to start is not an interlock that would prevent the diesel generating from automatically starting during a demand. However, room cooling would need to be established to allow the EDG to perform its safety function. During the event, operators were able to reopen the room damper in approximately 1.5 hours, reestablishing room cooling.<sup>12</sup> The basic event EPS-XHE-XL-NR04H (*Operator Fails to Recover Emergency Diesel in 4 Hours*) was used to model this recovery for SBO scenarios.<sup>13</sup> This human failure event (HFE) was evaluated using SPAR-H (Ref. 4 and Ref. 5). [Table 1](#) and [Table 2](#) provide the key qualitative information for this HFE and the performance shaping factor (PSF) adjustments required for the quantification of the HEP using SPAR-H.

**Table 1. Qualitative Evaluation of HFE for Recovery of EDG in Four Hours**

<b>Definition</b>	The definition for this HFE is the operators failing open a room exhaust damper in an EDG room given a LOOP/SBO.
<b>Description and Event Context</b>	Given a LOOP/SBO, operators will be relying on emergency onsite power, in this case EDGs, to provide AC power and charging source for DC power to safety-related loads. EDG room cooling is essential to protect the diesel engine and/or generator from catastrophic damage. Operators will cease EDG operation in order to preserve the EDG for later use. Room cooling consists of fans, ductwork, dampers, and a control system capable of exchanging air from the room with the outside environment.
<b>Operator Action Success Criteria</b>	Recover the EDG to operable status within four hours. Specifically, this scenario requires operators to manually open a damper in the EDG room cooling system.
<b>Nominal Cues</b>	The room exhaust fan not running, the room temperature rapidly increasing, and a visual of the damper in the closed position are all cues to the operators in this scenario.
<b>Procedural Guidance</b>	No specific procedures exist for operators to use to recover room cooling. Generic EDG maintenance and troubleshooting procedures exists, which is likely what operators will use. Skill-of-the-craft and obvious cues will indicate to operators that there is a problem.
<b>Diagnosis/Action</b>	This HFE contains sufficient diagnosis and action components.

<sup>11</sup> This issue was entered into the SAPHIRE/SPAR change request log.

<sup>12</sup> No credit is given for opening of the EDG B damper within 1 hour for (postulated) SBO sequences.

<sup>13</sup> No credit was given for EDG recovery for non-SBO scenarios, which is potentially conservative. However, note that only SBO scenarios are significant contributors to risk for this exposure period.

Table 2. SPAR-H Evaluation of HFE for Recovery of EDG in Four Hours

PSF	Diagnosis/ Action Multiplier	Notes
Time Available	0.01 / 1	The operators would need approximately 10 minutes to perform the action component of opening the damper manually. The time for diagnosis is approximately 80 minutes. Therefore, available time (i.e., 230 minutes) for the diagnosis component for this operator action is assigned as <i>Expansive Time</i> (i.e., $\times 0.01$ ). Since sufficient time was available for the diagnosis component, the available time for the action component for this operator action is evaluated as <i>Nominal</i> (i.e., $\times 1$ ). See Reference 5 for guidance on apportioning time between the diagnosis and action components of an HFE.
Stress	2 / 2	The PSF for diagnosis and action stress is assigned a value of <i>High Stress</i> (i.e., $\times 2$ ) due to the postulated LOOP/SBO and failures of other systems.
Complexity	2 / 2	The PSF for diagnosis complexity is assigned a value of <i>Moderately Complex</i> (i.e., $\times 2$ ) because operators would have to contend with multiple equipment unavailabilities and the concurrent actions/multiple procedures during a postulated SBO. The PSF for action complexity is also assigned a value of <i>Moderately Complex</i> (i.e., $\times 2$ ) because actions outside the control room are required.
Procedures Experience/Training Ergonomics/HMI Fitness-for-Duty Work Processes	1 / 1	No event information is available to warrant a change in these PSFs (for diagnosis and action) from <i>Nominal</i> for these HFEs.

An HEP evaluated using SPAR-H is calculated using the following formula:

$$\text{Calculated HEP} = (\text{Product of Diagnosis PSFs} \times 0.01) + (\text{Product of Action PSFs} \times 0.001)$$

Therefore, the probability of basic event EPS-XHE-XL-NR04H was set to  $4 \times 10^{-3}$ .

- The probability of basic events OEP-XHE-XL-NR01H and OEP-XHE-XL-NR04H were set to  $3.535 \times 10^{-2}$  and  $2.939 \times 10^{-2}$ , respectively, based on the same assumptions related to the 15-hour successful runtime of EDG A in EP-1.<sup>14</sup>

For EP-3:

- The failure of EDG A is modeled by setting basic event EPS-DGN-FR-DG3A to TRUE.
- The failure of the room exhaust intake damper to open is modeled by setting basic event EPS-FAN-FS-3BSB to TRUE.

<sup>14</sup> Manual adjustments to the convolution factors (as was performed in the analysis for EP-1) were not required during this exposure period because the convolution factors were not present in the cut sets (due to both EDGs modeled as failed).

- Similar to EP-2, operators were able to open the exhaust damper to reestablish room cooling. Therefore, recovery is applicable during this exposure period. Basic event EPS-XHE-XL-NR04H was set to  $4 \times 10^{-3}$ .
- Maintenance activities on critical equipment would have been restricted during the testing of EDG A. Therefore, basic event EFW-TDP-TM-AB (*EFW TDP A/B Unavailable Due to Test and Maintenance*) was set to FALSE.

For EP-4:

- The time required to repair EDG A is modeled by setting basic event EPS-DGN-TM-DG3A (*DG 3A-S Unavailable Due to Test and Maintenance*) to TRUE.<sup>15</sup>
- Operators would restrict planned maintenance on many systems and components when EDG A is unavailable for an extended time. Therefore, the following basic events were set to FALSE:
  - EFW-MDP-TM-B (*EFW MDP B Unavailable Due to Test and Maintenance*)
  - EFW-TDP-TM-AB
  - EPS-DGN-TM-DG3B (*DG 3B-S Unavailable Due to Test and Maintenance*)
  - EPS-FAN-TM-3BSB (*DG-3B Room Fan 3B-SB Unavailable Due to Test and Maintenance*)
- Similar to EP-1, SAPHIRE produced results with duplicate cut sets involving convolution factors. To eliminate these invalid cut sets from the results, the factors OEP-XHE-XX-NR01H2 and OEP-XHE-XX-NR04H2 were set to FALSE.

## ANALYSIS RESULTS

**Importance.** The  $\Delta$ CDP for this analysis is  $6.3 \times 10^{-6}$  which is the sum of the four exposure periods. The ASP Program acceptance threshold is a  $\Delta$ CDP of  $1 \times 10^{-6}$ . Therefore, this event is a precursor.

**Dominant Sequence.** The dominant accident sequences are LOOP/SBO sequence 15-30 ( $\Delta$ CDP =  $3.0 \times 10^{-6}$ ) that contributes approximately 47% of the total internal events  $\Delta$ CDP and LOOP/SBO sequence 15-21-10 ( $\Delta$ CDP =  $2.9 \times 10^{-6}$ ) that contributes approximately 46% of the total internal events  $\Delta$ CDP.<sup>16</sup> [Figure 1](#), [Figure 2](#), and [Figure 3](#) in [Appendix B](#) illustrate these sequences. The cut sets/sequences that contribute to the top 95% and/or at least 1% of the total internal events  $\Delta$ CDP are provided in [Appendix A](#).

The events and important component/system failures in LOOP/SBO sequence 15-30 are:

- A LOOP occurs (initiating event),
- Reactor protection system succeeds,
- Emergency power system fails resulting in a SBO scenario,

<sup>15</sup> Historically, ASP analyses have not separated repair time in the risk calculation. A sensitivity analysis was performed using a failure to run scenario for a 5-day duration and there was negligible risk contribution.

<sup>16</sup> Sequence 15-30 was a contributor in all exposure periods. Sequence 15-21-10 was not a contributor in EP-2.

- Emergency feedwater system fails, and
- Operators fails to recover offsite power in 1 hour.<sup>17</sup>

The events and important component/system failures in LOOP/SBO sequence 15-21-10 are:

- A LOOP occurs (initiating event),
- Reactor protection system succeeds,
- Emergency power system fails resulting in a SBO scenario,
- Operators fail to recover offsite power in 4 hours, and
- Operators fail to recover an EDG in 4 hours.<sup>18,19</sup>

## REFERENCES

1. Waterford 3, "LER 382-2015-007 – Both Emergency Diesel Generators Declared Inoperable," dated October 23, 2015 (ML15296A464).
2. U.S. Nuclear Regulatory Commission, "Waterford Steam Electric Station, Unit 3 – NRC Integrated Inspection Report 50-382/2015-003," dated November 12, 2015 (ML15316A476).
3. U.S. Nuclear Regulatory Commission, "Waterford Steam Electric Station, Unit 3 – NRC Integrated Inspection Report 50-382/2016-002," dated August 5, 2016 (ML16218A383).
4. Idaho National Laboratory, NUREG/CR-6883, "The SPAR-H Human Reliability Analysis Method," August 2005 (ML051950061).
5. Idaho National Laboratory, "INL/EXT-10-18533, SPAR-H Step-by-Step Guidance," May 2011 (ML112060305).
6. U.S. Nuclear Regulatory Commission, "Risk Assessment of Operational Events (RASP) Handbook, Vol. 1 – Internal Events," Revision 2.0, January 2013 (ML13030A049).

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<sup>17</sup> No credit for recovery of an EDG is given for this sequence in any of the four exposure periods.

<sup>18</sup> Credit for recovery of EDG is given for EP-2 and EP-3.

<sup>19</sup> The Waterford SPAR model also includes fault tree modeling for additional mitigation functions (e.g., continued operation of the turbine-driven EFW pump after battery depletion); however, these additional functions are disabled. Additional plant-specific information would be needed to provide credit in ASP analyses.



## Appendix A: SAPHIRE 8 Worksheet(s)

### EP-1: Condition Assessment Summary

Duration	14 days
Solve Method	<b>Single Pass with Cut Set Update</b>
CCDP	2.78E-6
CDP	3.69E-7
<b>ΔCDP</b>	<b>2.41E-6</b>

### Summary of Conditional Event Changes

Event	Description	Cond Value	Nominal Value
EPS-DGN-FR-DG3A	DIESEL GENERATOR 3A-S FAILS TO RUN	True	3.01E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	3.53E-2	5.46E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	2.94E-2	1.73E-1
OEP-XHE-XX-NR01H0	CONVOLUTION FACTOR FOR CCF-OPR (1HR Avail)	True	2.26E-1
OEP-XHE-XX-NR01H1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR AVAIL)	True	2.26E-1
OEP-XHE-XX-NR01H2	CONVOLUTION FACTOR FOR 2FTR-OPR (1HR AVAIL)	False	1.02E-1
OEP-XHE-XX-NR04H0	CONVOLUTION FACTOR FOR CCF-OPR (4HR Avail)	True	3.60E-1
OEP-XHE-XX-NR04H1	CONVOLUTION FACTOR FOR 1FTR-OPR (4HR AVAIL)	True	3.60E-1
OEP-XHE-XX-NR04H2	CONVOLUTION FACTOR FOR 2FTR-OPR (4HR AVAIL)	False	2.23E-1

### Implied Event Changes as per RASP Guidance

Event	Description	Cond Value	Nominal Value
EPS-DGN-CF-RUN	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN	1.36E-2	4.09E-4
EPS-DGN-CF-STRT	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START	0.00E+0	3.61E-5
EPS-DGN-FS-DG3A	DIESEL GENERATOR 3A-S FAILS TO START	False	2.89E-3
EPS-DGN-TM-DG3A	DG 3A-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.43E-2

### Event Tree Dominant Results

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	CCDP	CDP	ΔCDP	Description
LOOP	2.69E-6	2.82E-7	2.41E-6	Waterford 3 PWR H loss of offsite power
<b>Total</b>	<b>2.78E-6</b>	<b>3.69E-7</b>	<b>2.41E-6</b>	

### Dominant Sequence Results

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	Sequence	CCDP	CDP	ΔCDP	Description
LOOP	15-21-10	2.08E-6	2.07E-7	1.88E-6	/RPS, EPS, /EFW-B, /SRV-B, CBO, RSUB, /RCPSI04, OPR-04H, DGR-04H, EFW-MAN, SG-DEP-LT1
LOOP	14	3.65E-7	4.44E-8	3.21E-7	/RPS, /EPS, EFW-L
LOOP	15-30	1.33E-7	2.33E-8	1.10E-7	/RPS, EPS, EFW-B, OPR-01H, DGR-01H
LOOP	12	1.06E-7	6.27E-9	9.94E-8	/RPS, /EPS, /EFW-L, SRV-L, /HPI-L, OPR-02H, HPR-L
<b>Total</b>		<b>2.78E-6</b>	<b>3.69E-7</b>	<b>2.41E-6</b>	

**Referenced Fault Trees**

Fault Tree	Description
CBO	CONTROLLED BLEEDOFF ISOLATED
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
DGR-04H	DIESEL GENERATOR RECOVERY IN 4 HOURS
EFW-B	EMERGENCY FEEDWATER WITH SBO-FTF APPLIED
EFW-L	EMERGENCY FEEDWATER WITH LOOP-FTF APPLIED
EFW-MAN	MANUAL CONTROL EFW
EPS	EMERGENCY POWER
HPR-L	HIGH PRESSURE RECIRCULATION
OPR-01H	OFFSITE POWER RECOVERY IN 1 HOUR
OPR-02H	OFFSITE POWER RECOVERY IN 2 HOURS
OPR-04H	OFFSITE POWER RECOVERY IN 4 HRS
RSUB	REACTOR COOLANT SUBCOOLING MAINTAINED
SG-DEP-LT1	DEPRESSURIZE SGs (DEPENDENT)
SRV-L	SRVS CHALLENGED DURING LOOP

**Cut Set Report - LOOP 15-21-10**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	5.43E-5	100	Displaying 65 Cut Sets. (65 Original)
1	2.51E-5	46.27	IE-LOOP, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR04H
2	1.20E-5	22.07	IE-LOOP, EPS-DGN-TM-DG3B, OEP-XHE-XL-NR04H
3	1.14E-5	20.92	IE-LOOP, EPS-DGN-CF-RUN, OEP-XHE-XL-NR04H
4	2.42E-6	4.45	IE-LOOP, EPS-DGN-FS-DG3B, OEP-XHE-XL-NR04H
5	1.67E-6	3.08	IE-LOOP, EPS-FAN-TM-3BSB, OEP-XHE-XL-NR04H
6	8.05E-7	1.48	IE-LOOP, EPS-MOV-CC-CCWB, OEP-XHE-XL-NR04H
7	7.04E-7	1.30	IE-LOOP, EPS-FAN-FS-3BSB, OEP-XHE-XL-NR04H

**Cut Set Report - LOOP 14**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	9.52E-6	100	Displaying 259 Cut Sets. (259 Original)
1	4.47E-6	46.91	IE-LOOP, EFW-MDP-TM-B, EFW-TDP-FR-AB
2	1.12E-6	11.80	IE-LOOP, EFW-TDP-FR-AB, EFW-XHE-XR-MDPB
3	1.06E-6	11.18	IE-LOOP, EFW-MDP-FS-B, EFW-TDP-FR-AB
4	7.34E-7	7.71	IE-LOOP, EFW-MDP-TM-B, EFW-TDP-FS-AB
5	4.07E-7	4.28	IE-LOOP, EFW-MDP-FR-B, EFW-TDP-FR-AB
6	1.85E-7	1.94	IE-LOOP, EFW-TDP-FS-AB, EFW-XHE-XR-MDPB
7	1.75E-7	1.84	IE-LOOP, EFW-MDP-FS-B, EFW-TDP-FS-AB
8	1.53E-7	1.61	IE-LOOP, EFW-TDP-TM-AB, EFW-XHE-XR-MDPB
9	1.45E-7	1.53	IE-LOOP, EFW-MDP-FS-B, EFW-TDP-TM-AB
10	1.13E-7	1.19	IE-LOOP, EFW-MDP-TM-B, EFW-XHE-XR-TDP

**Cut Set Report - LOOP 15-30**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	3.47E-6	100	Displaying 153 Cut Sets. (153 Original)
1	1.19E-6	34.42	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H
2	5.70E-7	16.42	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-TM-DG3B, OEP-XHE-XL-NR01H
3	5.40E-7	15.56	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-CF-RUN, OEP-XHE-XL-NR01H
4	1.96E-7	5.66	IE-LOOP, EFW-TDP-FS-AB, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H
5	1.63E-7	4.70	IE-LOOP, EFW-TDP-TM-AB, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H
6	1.15E-7	3.31	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-FS-DG3B, OEP-XHE-XL-NR01H
7	9.37E-8	2.70	IE-LOOP, EFW-TDP-FS-AB, EPS-DGN-TM-DG3B, OEP-XHE-XL-NR01H
8	8.88E-8	2.56	IE-LOOP, EFW-TDP-FS-AB, EPS-DGN-CF-RUN, OEP-XHE-XL-NR01H
9	7.94E-8	2.29	IE-LOOP, EFW-TDP-FR-AB, EPS-FAN-TM-3BSB, OEP-XHE-XL-NR01H
10	7.38E-8	2.12	IE-LOOP, EFW-TDP-TM-AB, EPS-DGN-CF-RUN, OEP-XHE-XL-NR01H
11	3.83E-8	1.10	IE-LOOP, EFW-TDP-FR-AB, EPS-MOV-CC-CCWB, OEP-XHE-XL-NR01H

**Cut Set Report - LOOP 12**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
Total	2.75E-6	100	Displaying 2 Cut Sets. (2 Original)
1	1.38E-6	50.00	IE-LOOP,OEP-XHE-XL-NR02H,PPR-SRV-CO-L,PPR-SRV-OO-317B
2	1.38E-6	50.00	IE-LOOP,OEP-XHE-XL-NR02H,PPR-SRV-CO-L,PPR-SRV-OO-317A

**Referenced Events**

Event	Description	Probability
EFW-MDP-FR-B	EFW MDP B FAILS TO RUN	3.62E-4
EFW-MDP-FS-B	EFW MDP B FAILS TO START	9.47E-4
EFW-MDP-TM-B	EFW MDP B UNAVAILABLE DUE TO TEST AND MAINTENANCE	3.98E-3
EFW-TDP-FR-AB	EFW TDPA/B FAILS TO RUN	3.95E-2
EFW-TDP-FS-AB	EFW TDP A/B FAILS TO START	6.49E-3
EFW-TDP-TM-AB	EFW TDP A/B UNAVAILABLE DUE TO TEST AND MAINTENANCE	5.39E-3
EFW-XHE-XR-MDPB	OPERATOR FAILS TO RESTORE EFW MDPB AFTER T&M	1.00E-3
EFW-XHE-XR-TDP	OPERATOR FAILS TO RESTORE EFW TDP AFTER T&M	1.00E-3
EPS-DGN-CF-RUN	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN	1.36E-2
EPS-DGN-FR-DG3B	DIESEL GENERATOR 3B-S FAILS TO RUN	3.01E-2
EPS-DGN-FS-DG3B	DIESEL GENERATOR 3B-S FAILS TO START	2.89E-3
EPS-DGN-TM-DG3B	DG 3B-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	1.43E-2
EPS-FAN-FS-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO START	8.42E-4
EPS-FAN-TM-3BSB	DG-3B ROOM FAN 3B-SB UNAVAILABLE DUE TO T & M	2.00E-3
EPS-MOV-CC-CCWB	FAILURE OF CCW EXIT MOV TO DG-B TO OPEN	9.63E-4
IE-LOOP	LOSS OF OFFSITE POWER	2.84E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	3.53E-2
OEP-XHE-XL-NR02H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS	3.39E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	2.94E-2
PPR-SRV-CO-L	SRVs OPEN DURING LOOP	1.48E-1
PPR-SRV-OO-317A	SRV 317A FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4
PPR-SRV-OO-317B	SRV 317B FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4

**EP-2: Condition Assessment Summary**

Duration	14 days
Solve Method	<b>Multiple Pass</b>
CCDP	2.37E-6
CDP	3.69E-7
<b>ΔCDP</b>	<b>2.00E-6</b>

**Summary of Conditional Event Changes**

Event	Description	Cond Value	Nominal Value
EPS-DGN-FR-DG3A	DIESEL GENERATOR 3A-S FAILS TO RUN	True	3.01E-2
EPS-FAN-FS-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO START	True	8.42E-4
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	4.00E-3	True
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	3.53E-2	5.46E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	2.94E-2	1.73E-1

**Implied Event Changes as per RASP Guidance**

Event	Description	Cond Value	Nominal Value
EPS-DGN-CF-RUN	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN	1.36E-2	4.09E-4
EPS-DGN-CF-STRT	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START	0.00E+0	3.61E-5
EPS-DGN-FS-DG3A	DIESEL GENERATOR 3A-S FAILS TO START	False	2.89E-3
EPS-DGN-TM-DG3A	DG 3A-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.43E-2
EPS-FAN-CF-FTR	COMMON CAUSE FAILURE DG ROOM FANS TO RUN	4.72E-6	4.72E-6
EPS-FAN-CF-FTS	COMMON CAUSE FAILURE DG ROOM FANS TO START	2.11E-5	2.11E-5
EPS-FAN-FR-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO RUN	1.00E+0	1.29E-4
EPS-FAN-TM-3BSB	DG-3B ROOM FAN 3B-SB UNAVAILABLE DUE TO T & M	True	2.00E-3
EPS-XHE-XL-NR04H1	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS (GIVEN FAILURE AT 1)	4.00E-3	8.02E-1

**Event Tree Dominant Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	CCDP	CDP	ΔCDP	Description
LOOP	2.27E-6	2.82E-7	1.99E-6	Waterford 3 PWR H loss of offsite power
<b>Total</b>	<b>2.37E-6</b>	<b>3.69E-7</b>	<b>2.00E-6</b>	

**Dominant Sequence Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	Sequence	CCDP	CDP	ΔCDP	Description
LOOP	15-30	2.10E-6	2.33E-8	2.07E-6	/RPS, EPS, EFW-B, OPR-01H, DGR-01H
LOOP	15-27	2.76E-8	3.15E-10	2.73E-8	/RPS, EPS, /EFW-B, SRV-B, OPR-01H, DGR-01H
<b>Total</b>		<b>2.37E-6</b>	<b>3.69E-7</b>	<b>2.00E-6</b>	

**Referenced Fault Trees**

Fault Tree	Description
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
EFW-B	EMERGENCY FEEDWATER WITH SBO-FTF APPLIED
EPS	EMERGENCY POWER
OPR-01H	OFFSITE POWER RECOVERY IN 1 HOUR
SRV-B	SRVs FAIL DURING SBO

**Cut Set Report - LOOP 15-30**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	5.47E-5	100	Displaying 21 Cut Sets. (21 Original)
1	3.97E-5	72.63	IE-LOOP,EFW-TDP-FR-AB,OEP-XHE-XL-NR01H
2	6.53E-6	11.94	IE-LOOP,EFW-TDP-FS-AB,OEP-XHE-XL-NR01H
3	5.42E-6	9.92	IE-LOOP,EFW-TDP-TM-AB,OEP-XHE-XL-NR01H
4	1.01E-6	1.84	IE-LOOP,EFW-XHE-XM-CSPMKUP,OEP-XHE-XL-NR01H
5	1.01E-6	1.84	IE-LOOP,EFW-XHE-XR-TDP,OEP-XHE-XL-NR01H
6	9.68E-7	1.77	IE-LOOP,AFW-MOV-CC-CSTCSP,OEP-XHE-XL-NR01H

**Cut Set Report - LOOP 15-27**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
Total	7.19E-7	100	Displaying 2 Cut Sets. (2 Original)
1	3.59E-7	50.00	IE-LOOP,OEP-XHE-XL-NR01H,PPR-SRV-CO-SBO,PPR-SRV-OO-317B
2	3.59E-7	50.00	IE-LOOP,OEP-XHE-XL-NR01H,PPR-SRV-CO-SBO,PPR-SRV-OO-317A

**Referenced Events**

Event	Description	Probability
AFW-MOV-CC-CSTCSP	CONDENSATE STORAGE TANK CROSS-CONNECT MOV TO CSP FAILS TO OPEN	9.63E-4
EFW-TDP-FR-AB	EFW TDPA/B FAILS TO RUN	3.95E-2
EFW-TDP-FS-AB	EFW TDP A/B FAILS TO START	6.49E-3
EFW-TDP-TM-AB	EFW TDP A/B UNAVAILABLE DUE TO TEST AND MAINTENANCE	5.39E-3
EFW-XHE-XM-CSPMKUP	OPERATOR FAILS TO ALIGN BACKUP WATER SOURCE TO CSP	1.00E-3
EFW-XHE-XR-TDP	OPERATOR FAILS TO RESTORE EFW TDP AFTER T&M	1.00E-3
IE-LOOP	LOSS OF OFFSITE POWER	2.84E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	3.53E-2
PPR-SRV-CO-SBO	SRVs OPEN DURING SBO	3.70E-1
PPR-SRV-OO-317A	SRV 317A FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4
PPR-SRV-OO-317B	SRV 317B FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4

**EP-3: Condition Assessment Summary**

Duration	8 hours
Solve Method	<b>Multiple Pass</b>
CCDP	7.30E-7
CDP	8.77E-9
<b>ΔCDP</b>	<b>7.21E-7</b>

**Summary of Conditional Event Changes**

Event	Description	Cond Value	Nominal Value
EFW-TDP-TM-AB	EFW TDP A/B UNAVAILABLE DUE TO TEST AND MAINTENANCE	False	5.39E-3
EPS-DGN-FR-DG3A	DIESEL GENERATOR 3A-S FAILS TO RUN	True	3.01E-2
EPS-FAN-FS-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO START	True	8.42E-4
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	4.00E-3	True

**Implied Event Changes as per RASP Guidance**

Event	Description	Cond Value	Nominal Value
EPS-DGN-CF-RUN	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN	1.36E-2	4.09E-4
EPS-DGN-CF-STRT	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START	0.00E+0	3.61E-5
EPS-DGN-FS-DG3A	DIESEL GENERATOR 3A-S FAILS TO START	False	2.89E-3
EPS-DGN-TM-DG3A	DG 3A-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.43E-2
EPS-FAN-CF-FTR	COMMON CAUSE FAILURE DG ROOM FANS TO RUN	4.72E-6	4.72E-6
EPS-FAN-CF-FTS	COMMON CAUSE FAILURE DG ROOM FANS TO START	2.11E-5	2.11E-5
EPS-FAN-FR-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO RUN	1.00E+0	1.29E-4
EPS-FAN-TM-3BSB	DG-3B ROOM FAN 3B-SB UNAVAILABLE DUE TO T & M	True	2.00E-3
EPS-XHE-XL-NR04H1	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS (GIVEN FAILURE AT 1)	4.00E-3	8.02E-1

**Event Tree Dominant Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	CCDP	CDP	ΔCDP	Description
LOOP	7.28E-7	6.70E-9	7.21E-7	Waterford 3 PWR H loss of offsite power
<b>Total</b>	<b>7.30E-7</b>	<b>8.77E-9</b>	<b>7.21E-7</b>	

**Dominant Sequence Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	Sequence	CCDP	CDP	ΔCDP	Description
LOOP	15-30	6.92E-7	5.56E-10	6.92E-7	/RPS, EPS, EFW-B, OPR-01H, DGR-01H
LOOP	15-21-10	1.80E-8	4.92E-9	1.31E-8	/RPS, EPS, /EFW-B, /SRV-B, CBO, RSUB, /RCPSI04, OPR-04H, DGR-04H, EFW-MAN, SG-DEP-LT1
LOOP	15-27	1.01E-8	7.50E-12	1.01E-8	/RPS, EPS, /EFW-B, SRV-B, OPR-01H, DGR-01H
<b>Total</b>		<b>7.30E-7</b>	<b>8.77E-9</b>	<b>7.21E-7</b>	

**Referenced Fault Trees**

Fault Tree	Description
CBO	CONTROLLED BLEEDOFF ISOLATED
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
DGR-04H	DIESEL GENERATOR RECOVERY IN 4 HOURS
EFW-B	EMERGENCY FEEDWATER WITH SBO-FTF APPLIED
EFW-MAN	MANUAL CONTROL EFW
EPS	EMERGENCY POWER

Fault Tree	Description
OPR-01H	OFFSITE POWER RECOVERY IN 1 HOUR
OPR-04H	OFFSITE POWER RECOVERY IN 4 HRS
RSUB	REACTOR COOLANT SUBCOOLING MAINTAINED
SG-DEP-LT1	DEPRESSURIZE SGs (DEPENDENT)
SRV-B	SRVs FAIL DURING SBO

### Cut Set Report - LOOP 15-30

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	7.58E-4	100	Displaying 24 Cut Sets. (24 Original)
1	6.14E-4	80.95	IE-LOOP,EFW-TDP-FR-AB,OEP-XHE-XL-NR01H
2	1.01E-4	13.31	IE-LOOP,EFW-TDP-FS-AB,OEP-XHE-XL-NR01H
3	1.55E-5	2.05	IE-LOOP,EFW-XHE-XM-CSPMKUP,OEP-XHE-XL-NR01H
4	1.55E-5	2.05	IE-LOOP,EFW-XHE-XR-TDP,OEP-XHE-XL-NR01H
5	1.50E-5	1.97	IE-LOOP,AFW-MOV-CC-CSTCSP,OEP-XHE-XL-NR01H

### Cut Set Report - LOOP 15-21-10

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
Total	1.97E-5	100	Displaying 1 Cut Sets. (1 Original)
1	1.97E-5	100.00	IE-LOOP,EPS-XHE-XL-NR04H,OEP-XHE-XL-NR04H

### Cut Set Report - LOOP 15-27

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
Total	1.11E-5	100	Displaying 2 Cut Sets. (2 Original)
1	5.55E-6	50.00	IE-LOOP,OEP-XHE-XL-NR01H,PPR-SRV-CO-SBO,PPR-SRV-OO-317B
2	5.55E-6	50.00	IE-LOOP,OEP-XHE-XL-NR01H,PPR-SRV-CO-SBO,PPR-SRV-OO-317A

### Referenced Events

Event	Description	Probability
AFW-MOV-CC-CSTCSP	CONDENSATE STORAGE TANK CROSS-CONNECT MOV TO CSP FAILS TO OPEN	9.63E-4
EFW-TDP-FR-AB	EFW TDPA/B FAILS TO RUN	3.95E-2
EFW-TDP-FS-AB	EFW TDP A/B FAILS TO START	6.49E-3
EFW-XHE-XM-CSPMKUP	OPERATOR FAILS TO ALIGN BACKUP WATER SOURCE TO CSP	1.00E-3
EFW-XHE-XR-TDP	OPERATOR FAILS TO RESTORE EFW TDP AFTER T&M	1.00E-3
EPS-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 4 HOURS	4.00E-3
IE-LOOP	LOSS OF OFFSITE POWER	2.84E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	5.46E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	1.73E-1
PPR-SRV-CO-SBO	SRVs OPEN DURING SBO	3.70E-1
PPR-SRV-OO-317A	SRV 317A FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4
PPR-SRV-OO-317B	SRV 317B FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4

**EP-4: Condition Assessment Summary**

Duration	5 days
Solve Method	<b>Single Pass with Cut Set Update</b>
CCDP	1.33E-6
CDP	1.32E-7
<b>ΔCDP</b>	<b>1.20E-6</b>

**Summary of Conditional Event Changes**

Event	Description	Cond Value	Nominal Value
EFW-MDP-TM-B	EFW MDP B UNAVAILABLE DUE TO TEST AND MAINTENANCE	False	3.98E-3
EFW-TDP-TM-AB	EFW TDP A/B UNAVAILABLE DUE TO TEST AND MAINTENANCE	False	5.39E-3
EPS-DGN-TM-DG3A	DG 3A-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	True	1.43E-2
EPS-DGN-TM-DG3B	DG 3B-S UNAVAILABLE DUE TO TEST AND MAINTENANCE	False	1.43E-2
EPS-FAN-TM-3BSB	DG-3B ROOM FAN 3B-SB UNAVAILABLE DUE TO T&M	False	2.00E-3
OEP-XHE-XX-NR01H2	CONVOLUTION FACTOR FOR 2FTR-OPR (1HR AVAIL)	False	1.02E-1
OEP-XHE-XX-NR04H2	CONVOLUTION FACTOR FOR 2FTR-OPR (4HR AVAIL)	False	2.23E-1

**Implied Event Changes as per RASP Guidance**

Event	Description	Cond Value	Nominal Value
EPS-DGN-CF-RUN	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO RUN	4.09E-4	4.09E-4
EPS-DGN-CF-STRT	COMMON CAUSE FAILURE OF DIESEL GENERATORS TO START	3.61E-5	3.61E-5
EPS-DGN-FR-DG3A	DIESEL GENERATOR 3A-S FAILS TO RUN	1.00E+0	3.01E-2
EPS-DGN-FS-DG3A	DIESEL GENERATOR 3A-S FAILS TO START	1.00E+0	2.89E-3

**Event Tree Dominant Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	CCDP	CDP	ΔCDP	Description
LOOP	1.30E-6	1.01E-7	1.20E-6	Waterford 3 PWR H loss of offsite power
<b>Total</b>	<b>1.33E-6</b>	<b>1.32E-7</b>	<b>1.20E-6</b>	

**Dominant Sequence Results**

Only items contributing at least 1.0% to the total CCDP are displayed.

Event Tree	Sequence	CCDP	CDP	ΔCDP	Description
LOOP	15-21-10	1.08E-6	7.38E-8	1.01E-6	/RPS, EPS, /EFW-B, /SRV-B, CBO, RSUB, /RCPSI04, OPR-04H, DGR-04H, EFW-MAN, SG-DEP-LT1
LOOP	15-30	1.25E-7	8.34E-9	1.16E-7	/RPS, EPS, EFW-B, OPR-01H, DGR-01H
LOOP	14	5.22E-8	1.59E-8	3.63E-8	/RPS, /EPS, EFW-L
LOOP	12	3.77E-8	2.24E-9	3.55E-8	/RPS, /EPS, /EFW-L, SRV-L, /HPI-L, OPR-02H, HPR-L
<b>Total</b>		<b>1.33E-6</b>	<b>1.32E-7</b>	<b>1.20E-6</b>	

**Referenced Fault Trees**

Fault Tree	Description
CBO	CONTROLLED BLEEDOFF ISOLATED
DGR-01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN 1 HOUR
DGR-04H	DIESEL GENERATOR RECOVERY IN 4 HOURS
EFW-B	EMERGENCY FEEDWATER WITH SBO-FTF APPLIED
EFW-L	EMERGENCY FEEDWATER WITH LOOP-FTF APPLIED
EFW-MAN	MANUAL CONTROL EFW



Fault Tree	Description
EPS	EMERGENCY POWER
HPR-L	HIGH PRESSURE RECIRCULATION
OPR-01H	OFFSITE POWER RECOVERY IN 1 HOUR
OPR-02H	OFFSITE POWER RECOVERY IN 2 HOURS
OPR-04H	OFFSITE POWER RECOVERY IN 4 HRS
RSUB	REACTOR COOLANT SUBCOOLING MAINTAINED
SG-DEP-LT1	DEPRESSURIZE SGs (DEPENDENT)
SRV-L	SRVS CHALLENGED DURING LOOP

### Cut Set Report - LOOP 15-21-10

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	7.90E-5	100	Displaying 88 Cut Sets. (88 Original)
1	5.33E-5	67.55	IE-LOOP, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR04H, OEP-XHE-XX-NR04H1
2	1.43E-5	18.05	IE-LOOP, EPS-DGN-FS-DG3B, OEP-XHE-XL-NR04H
3	4.75E-6	6.01	IE-LOOP, EPS-MOV-CC-CCWB, OEP-XHE-XL-NR04H
4	4.15E-6	5.26	IE-LOOP, EPS-FAN-FS-3BSB, OEP-XHE-XL-NR04H

### Cut Set Report - LOOP 15-30

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	9.10E-6	100	Displaying 222 Cut Sets. (222 Original)
1	4.17E-6	45.82	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H, OEP-XHE-XX-NR01H1
2	1.77E-6	19.50	IE-LOOP, EFW-TDP-FR-AB, EPS-DGN-FS-DG3B, OEP-XHE-XL-NR01H
3	6.85E-7	7.53	IE-LOOP, EFW-TDP-FS-AB, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H, OEP-XHE-XX-NR01H1
4	5.91E-7	6.50	IE-LOOP, EFW-TDP-FR-AB, EPS-MOV-CC-CCWB, OEP-XHE-XL-NR01H
5	5.17E-7	5.68	IE-LOOP, EFW-TDP-FR-AB, EPS-FAN-FS-3BSB, OEP-XHE-XL-NR01H
6	2.92E-7	3.21	IE-LOOP, EFW-TDP-FS-AB, EPS-DGN-FS-DG3B, OEP-XHE-XL-NR01H
7	1.06E-7	1.16	IE-LOOP, EFW-XHE-XR-TDP, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H, OEP-XHE-XX-NR01H1
8	1.06E-7	1.16	IE-LOOP, EFW-XHE-XM-CSPMKUP, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H, OEP-XHE-XX-NR01H1
9	1.02E-7	1.12	IE-LOOP, AFW-MOV-CC-CSTCSP, EPS-DGN-FR-DG3B, OEP-XHE-XL-NR01H, OEP-XHE-XX-NR01H1
10	9.71E-8	1.07	IE-LOOP, EFW-TDP-FS-AB, EPS-MOV-CC-CCWB, OEP-XHE-XL-NR01H

### Cut Set Report - LOOP 14

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
	3.81E-6	100	Displaying 202 Cut Sets. (202 Original)
1	1.12E-6	29.51	IE-LOOP, EFW-TDP-FR-AB, EFW-XHE-XR-MDPB
2	1.06E-6	27.96	IE-LOOP, EFW-MDP-FS-B, EFW-TDP-FR-AB
3	4.07E-7	10.69	IE-LOOP, EFW-MDP-FR-B, EFW-TDP-FR-AB
4	1.85E-7	4.85	IE-LOOP, EFW-TDP-FS-AB, EFW-XHE-XR-MDPB
5	1.75E-7	4.60	IE-LOOP, EFW-MDP-FS-B, EFW-TDP-FS-AB
6	9.46E-8	2.48	IE-LOOP, EFW-TDP-FR-AB, EHV-FAN-FS-17B, EHV-XHE-XM-ALTCL
7	8.65E-8	2.27	IE-LOOP, EFW-AOV-CF-2289AB
8	8.65E-8	2.27	IE-LOOP, EFW-AOV-CF-2234AB
9	7.04E-8	1.85	IE-LOOP, EFW-MDP-CF-START, EFW-TDP-FR-AB
10	6.69E-8	1.76	IE-LOOP, EFW-MDP-FR-B, EFW-TDP-FS-AB
11	3.87E-8	1.02	IE-LOOP, ACW-MDP-FS-B, EFW-XHE-XM-CSPMKUP

**Cut Set Report - LOOP 12**

Only items contributing at least 1% to the total are displayed.

#	CCDF	Total%	Cut Set
Total	2.75E-6	100	Displaying 2 Cut Sets. (2 Original)
1	1.38E-6	50.00	IE-LOOP,OEP-XHE-XL-NR02H,PPR-SRV-CO-L,PPR-SRV-OO-317B
2	1.38E-6	50.00	IE-LOOP,OEP-XHE-XL-NR02H,PPR-SRV-CO-L,PPR-SRV-OO-317A

**Referenced Events**

Event	Description	Probability
ACW-MDP-FS-B	ACCW MDP B FAILS TO START	1.36E-3
AFW-MOV-CC-CSTCSP	CONDENSATE STORAGE TANK CROSS-CONNECT MOV TO CSP FAILS TO OPEN	9.63E-4
EFW-AOV-CF-2234AB	CCF OF EFW SG FCVs 223A/B&224A/B TO OPEN	3.04E-6
EFW-AOV-CF-2289AB	CCF OF EFW SG FIVs 228A/B&229A/B TO OPEN	3.04E-6
EFW-MDP-CF-START	CCF OF EFW MDPs A & B TO START	6.26E-5
EFW-MDP-FR-B	EFW MDP B FAILS TO RUN	3.62E-4
EFW-MDP-FS-B	EFW MDP B FAILS TO START	9.47E-4
EFW-TDP-FR-AB	EFW TDP A/B FAILS TO RUN	3.95E-2
EFW-TDP-FS-AB	EFW TDP A/B FAILS TO START	6.49E-3
EFW-XHE-XM-CSPMKUP	OPERATOR FAILS TO ALIGN BACKUP WATER SOURCE TO CSP	1.00E-3
EFW-XHE-XR-MDPB	OPERATOR FAILS TO RESTORE EFW MDPB AFTER T&M	1.00E-3
EFW-XHE-XR-TDP	OPERATOR FAILS TO RESTORE EFW TDP AFTER T&M	1.00E-3
EHV-FAN-FS-17B	FAILURE OF FAN AH-17(3B-SB) TO START	8.42E-4
EHV-XHE-XM-ALTCL	OPERATOR FAILS TO ALIGN ALT COOLING METHOD	1.00E-1
EPS-DGN-FR-DG3B	DIESEL GENERATOR 3B-S FAILS TO RUN	3.01E-2
EPS-DGN-FS-DG3B	DIESEL GENERATOR 3B-S FAILS TO START	2.89E-3
EPS-FAN-FS-3BSB	DG-3B ROOM FAN 3B-SB FAILS TO START	8.42E-4
EPS-MOV-CC-CCWB	FAILURE OF CCW EXIT MOV TO DG-B TO OPEN	9.63E-4
IE-LOOP	LOSS OF OFFSITE POWER	2.84E-2
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1 HOUR	5.46E-1
OEP-XHE-XL-NR02H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 2 HOURS	3.39E-1
OEP-XHE-XL-NR04H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 4 HOURS	1.73E-1
OEP-XHE-XX-NR01H1	CONVOLUTION FACTOR FOR 1FTR-OPR (1HR AVAIL)	2.26E-1
OEP-XHE-XX-NR04H1	CONVOLUTION FACTOR FOR 1FTR-OPR (4HR AVAIL)	3.60E-1
PPR-SRV-CO-L	SRVs OPEN DURING LOOP	1.48E-1
PPR-SRV-OO-317A	SRV 317A FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4
PPR-SRV-OO-317B	SRV 317B FAILS TO RECLOSE AFTER PASSING STEAM	9.66E-4

### Appendix B: Key Event Trees

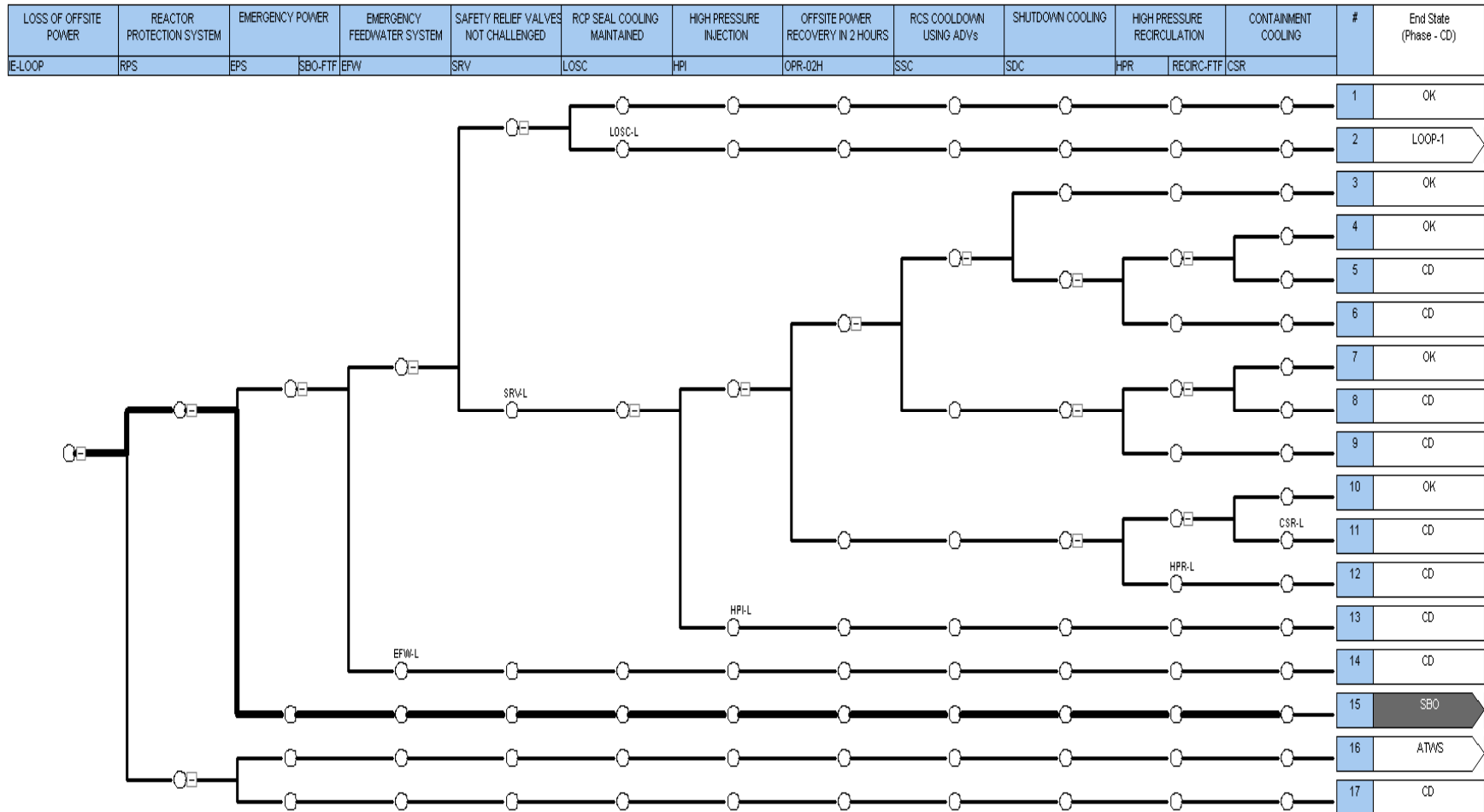


Figure 1: Waterford LOOP Event Tree

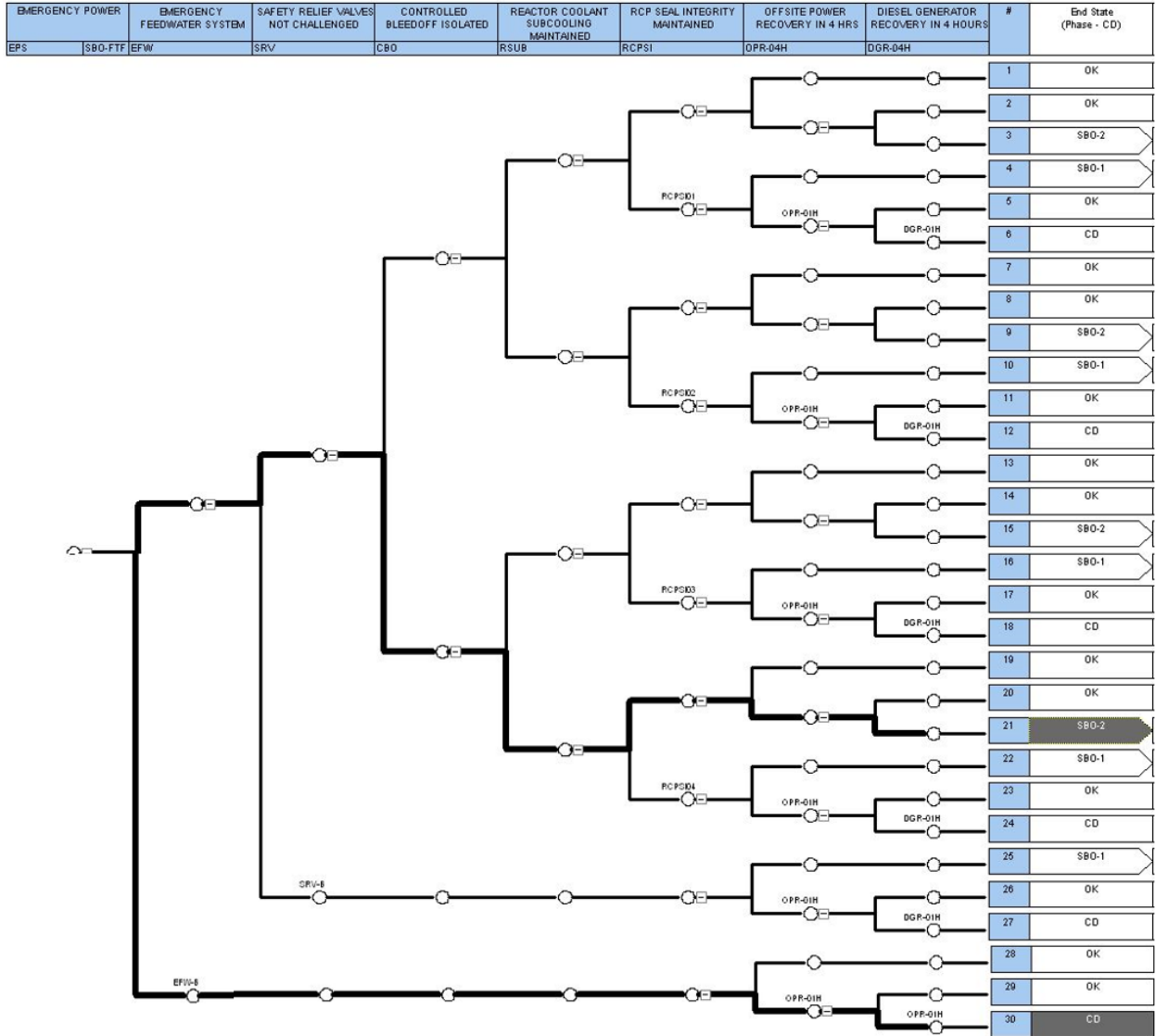


Figure 2: Waterford SBO Event Tree

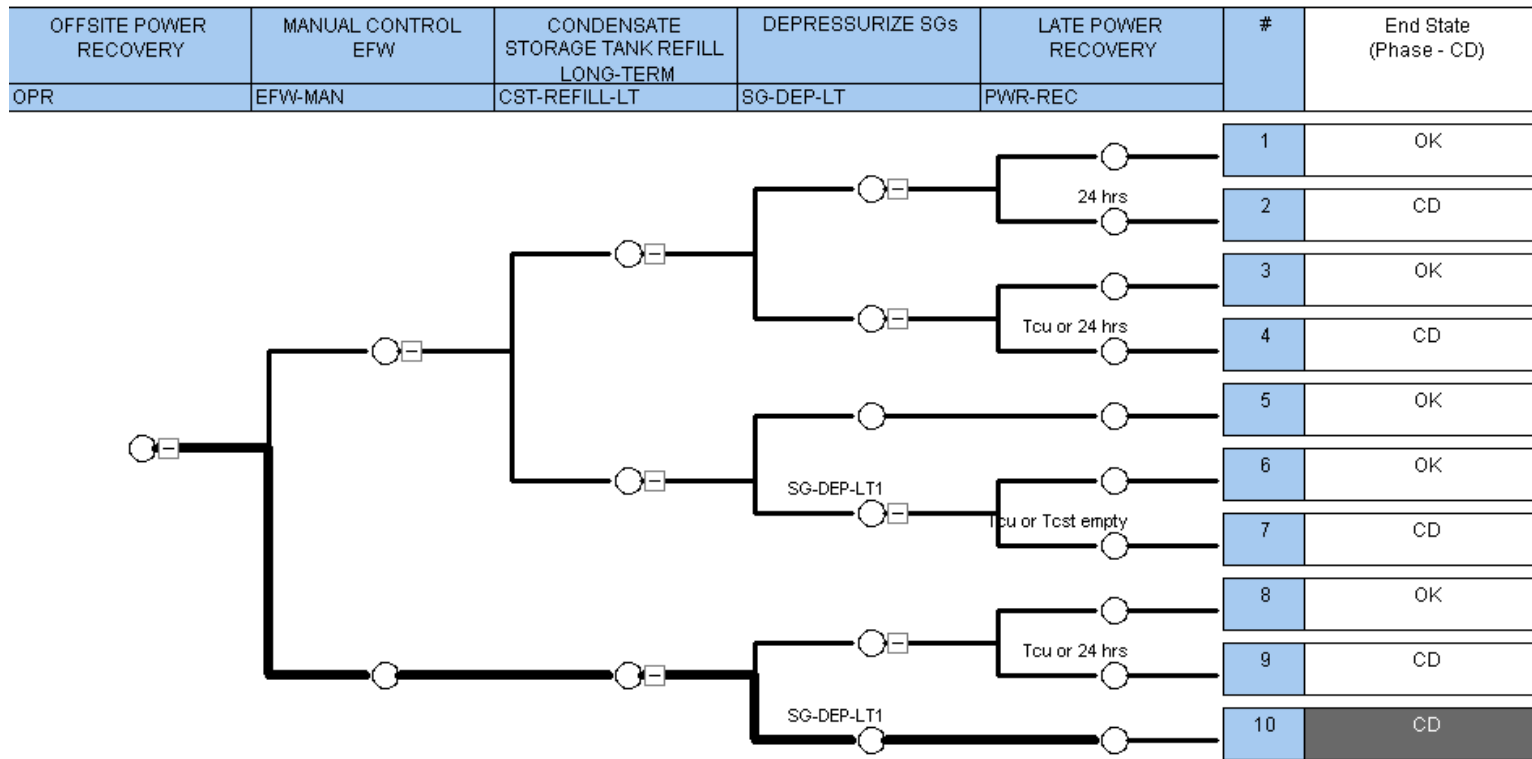


Figure 3: Waterford SBO-2 Event Tree