UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 3, 2023

Vice President, Operations
Entergy Operations, Inc.
River Bend Station
5485 US Highway 61
St. Francisville, LA 70775

SUBJECT: TRANSMITTAL OF FINAL RIVER BEND STATION, UNIT 1 ACCIDENT SEQUENCE PRECURSOR REPORT (LICENSEE EVENT REPORT 458-2022-003)

Dear Sir or Madam:

By letter dated September 1, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22244A098), Entergy Operations, Inc. (the licensee) submitted Licensee Event Report 458-2022-003, "Division '1' Standby Diesel Generator Speed Sensor Power Supply Failure," to the U.S. Nuclear Regulatory Commission (NRC) staff for River Bend Station, Unit 1, pursuant to Title 10 of the *Code of Federal Regulations* Section 50.73. As part of the Accident Sequence Precursor (ASP) Program, the NRC staff reviewed the event to identify potential precursors and to determine the probability of the events leading to a core damage state. The results of the analysis are provided in the enclosure to this letter.

The NRC does not request a formal analysis review, in accordance with Regulatory Issue Summary 2006-24, "Revised Review and Transmittal Process for Accident Sequence Precursor Analyses" (ML060900007), because the analysis resulted in an increase in core damage probability (ΔCDP) of less than 1×10^{-4}.

Final ASP Analysis Summary. A brief summary of the final ASP analysis, including the results, is provided below.

Division '1' Standby Diesel Generator Speed Sensor Power Supply Failure. This event is documented in LER 458-2022-003 dated July 4, 2022.

Executive Summary. On July 4, 2022, a failure was identified in the speed control circuitry of the division 1 standby diesel generator during monthly surveillance testing. The licensee subsequently declared the diesel generator inoperable due to the failure of both power supplies in the speed control circuit. These redundant power supplies provide power to individual speed switches, tachometers, and the emergency response information system. The speed control circuit is designed such that either one of the power supplies is sufficient to allow field flash and loading of the diesel generator. These power supplies were refurbished and installed in December 2020.

The division 1 standby diesel generator was last tested satisfactorily on June 1, 2022. The emergency response information system indicated that the power supplies likely failed on

June 8, 2022. The power supplies were replaced, and the division 1 standby diesel generator was returned to service after post-maintenance testing was completed on July 7, 2022.

The mean ΔCDP for this event is 1×10^{-5} and, therefore, this event is a precursor. The dominant hazards for this ASP analysis are internal events, which contribute approximately 92 percent of the total ΔCDP. High winds (including hurricanes and tornados) and internal floods contribute approximately 5 percent and 3 percent of the total ΔCDP, respectively. Seismic events are minimal risk contributors for this analysis. Due to the lack of modeling of internal fires, the impact of internal fires is considered qualitatively.

Summary of Analysis Results. This operational event resulted in a mean ΔCDP of 1×10^{-5}.

If you have any questions, please contact me at 301-415-8378 or via email at Jason.Drake@nrc.gov.

Sincerely,

/RA/

Jason J. Drake, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-458

Enclosure:
Final ASP Analysis

cc: Listserv

ENCLOSURE

FINAL ACCIDENT SEQUENCE PRECURSOR ANALYSIS

RIVER BEND STATION, UNIT 1

DIVISION 1 STANDBY DIESEL GENERATOR SPEED SENSOR POWER SUPPLY FAILURE
(LER 458-2022-003) - PRECURSOR

Final ASP Analysis – Precursor

Accident Sequence Precursor Program – Office of Nuclear Regulatory Research		
River Bend Station	Division '1' Standby Diesel Generator Speed Sensor Power Supply Failure	
Event Date: 7/4/2022	**LER:** 458-2022-003 **IR:** TBD	**ΔCDP =** 1×10^{-5}
Plant Type:	General Electric Type 6 Boiling-Water Reactor (BWR) with Mark III Containment	
Plant Operating Mode (Reactor Power Level):	Mode 1 (100% Reactor Power)	
Analyst: Christopher Hunter	**Reviewer:** Latonia Enos-Sylla	**Completion Date:** 2/16/2023

1 EXECUTIVE SUMMARY

On July 4, 2022, a failure was identified in the speed control circuitry of the division 1 standby diesel generator during monthly surveillance testing. The licensee subsequently declared the diesel generator inoperable due to the failure of both power supplies in the speed control circuit. These redundant power supplies provide power to individual speed switches, tachometers, and the emergency response information system. The speed control circuit is designed such that either one of the power supplies is sufficient to allow field flash and loading of the diesel generator. These power supplies were refurbished and installed in December 2020.

The division 1 standby diesel generator was last tested satisfactorily on June 1st. The emergency response information system indicated that the power supplies likely failed on June 8th. The power supplies were replaced, and the division 1 standby diesel generator was returned to service after post-maintenance testing was completed on July 7th.

The mean core damage probability (ΔCDP) for this event is 1×10^{-5} and, therefore, this event is a precursor. The dominant hazards for this accident sequence precursor (ASP) analysis are internal events, which contribute approximately 92 percent of the total ΔCDP. High winds (including hurricanes and tornados) and internal floods contribute approximately 5 percent and 3 percent of the total ΔCDP, respectively. Seismic events are minimal risk contributors for this analysis. Due to the lack of modeling of internal fires, the impact of internal fires is considered qualitatively.

2 EVENT DETAILS

2.1 Event Description

On July 4, 2022, a failure was identified in the speed control circuitry of the division 1 standby diesel generator during monthly surveillance testing. The licensee subsequently declared the diesel generator inoperable due to the failure of both power supplies in the speed control circuit. These redundant power supplies provide power to individual speed switches, tachometers, and the emergency response information system. The speed control circuit is designed such that either one of the power supplies is sufficient to allow field flash and loading of the diesel generator. These power supplies were refurbished and installed in December 2020.

The division 1 standby diesel generator was last tested satisfactorily on June 1st. The emergency response information system indicated that the power supplies likely failed on June 8th. The power supplies were replaced, and the division 1 standby diesel generator was returned to service after post-maintenance testing was completed on July 7th. Additional information is provided in licensee event report (LER) 485-2022-003, "Division 1 Standby Diesel Generator Speed Sensor Power Supply Failure" (ML22244A098).

2.2 Cause

The direct cause of this event is currently unknown. Licensee troubleshooting identified blown fuses internally to both power supplies. Both of the failed power supplies were sent to an outside vendor for a detailed failure analysis.

3 MODELING

3.1 Basis for ASP Analysis

The ASP Program uses SDP results for degraded conditions when available (and applicable). Discussions with Region 4 staff indicated that no licensee performance deficiency associated with this condition has been identified; however, the LER remains open. Therefore, an independent ASP analysis was performed because there was no performance deficiency identified and its potential risk significance. A search of River Bend Station LERs did not reveal any "windowed" events.[1]

3.2 Analysis Type

This degraded condition was evaluated using a test and limited use (TLU) version of the River Bend Station SPAR model created in December 2022. This TLU model includes revisions to the version 8.80 SPAR model of record based on the review of the licensee's final integrated plan (FIP) for the FLEX mitigation strategies (ML15279A345). This SPAR model includes the following hazards:

- Internal events,
- Internal floods,
- High winds (including hurricanes and tornados), and
- Seismic events.

The lack of modeling of internal fires scenarios is a key uncertainty and is considered qualitatively in Section 4.4.

3.3 SPAR Model Modifications

The following additional SPAR model modifications were required for this initiating event analysis:

- *FLEX Reliability Parameters*. The base SPAR models currently use the reliability parameters of permanently installed equipment as placeholders for FLEX equipment because FLEX-specific reliability parameters were not available when the FLEX logic

[1] Windowed events are when multiple structures, systems, and components are unable to perform their safety function at the same time.

was incorporated into the SPAR models. Updated FLEX reliability parameters are provided in Table 6-1 in Pressurized Water Reactor Owner's Group (PWROG) 18042-NP, "FLEX Equipment Data Collection and Analysis," Revision 1 (ML22123A259). This analysis uses this data because it is more representative of the as-built, as-operated plant.

- *Crediting the FLEX N+1 Diesel Generator*. During an extended loss of AC power (ELAP), it may not be possible for licensee personnel to transport, connect, and start the FLEX N+1 diesel generator to provided battery charging prior to battery depletion in 8 hours. Therefore, this analysis eliminates this base SPAR model credit. This modeling assumption is potentially conservative and is a key uncertainty of this analysis. The effects of the uncertainty are evaluated in Section 4.4.

3.4 Exposure Time

The emergency response information system indicated that the power supplies likely failed on June 8th. The power supplies were replaced on July 7th. Because the time of failure is known, the exposure time was calculated using the following equation from Section 2.3 of Volume 1 (internal events) of the Risk Assessment of Operational Events (or RASP) Handbook (ML17348A149):

$$T = t + repair\ time = 27\ days + 3\ days = 30\ days$$

3.5 Analysis Assumptions

The following modeling assumptions were required to reflect the plant status and event circumstances for this initiating event assessment:

- Basic event EPS-DGN-FS-DGA (*diesel generator A fails to start*) was set to TRUE because the division 1 standby diesel generator would have failed to start due to the unavailable field flash as a result of the failure of both power supplies in the speed control circuit. No credit for recovery of the division 1 standby diesel generator was provided in this analysis.

4 ANALYSIS RESULTS

4.1 Results

The mean ΔCDP for this analysis is calculated to be 1.2×10^{-5}. The ASP Program threshold is 1×10^{-6} for degraded conditions; therefore, this event is a precursor. The parameter uncertainty results for this analysis provided below:

Table 1. Parameter Uncertainty Results

5%	Median	Point Estimate	Mean	95%
2.7×10^{-6}	8.4×10^{-6}	1.4×10^{-5}	1.2×10^{-5}	3.1×10^{-5}

4.2 Dominant Hazards[2]

The dominant hazard for this analysis is internal events (ΔCDP = 1.2×10^{-5}), which contribute approximately 92 percent of the total ΔCDP. High winds (including hurricanes and tornados) and internal floods contribute approximately 5 percent (ΔCDP = 6.9×10^{-7}) and 3 percent (ΔCDP = $\times10^{-7}$), respectively. Seismic events hazards are minimal contributors to the total ΔCDP for this analysis

4.3 Dominant Sequences

The dominant accident sequence is loss of offsite power (LOOP) sequence 53-03-09 (ΔCDP = 7.2×10^{-6}), which contributes approximately 53 percent of the total ΔCDP. The sequences that contribute at least 5.0 percent to the total ΔCDP are provided in the following table. These dominant sequences are shown graphically in Figures A-1, A-2, and A-3 of Appendix A.

Table 2. Dominant Sequences

Sequence	ΔCDP	%	Description
LOOP 59-03-09	7.2×10^{-6}	53.1%	LOOP due to internal events (all types including consequential) occurs; successful reactor trip; failures of the emergency power system result in a station blackout (SBO); reactor core isolation cooling (RCIC) and high-pressure coolant spray (HPCS) successfully maintain reactor coolant system (RCS) inventory; operators successfully declare ELAP; FLEX diesel generator fails resulting in the subsequent loss of safety-related DC power; and operator failure to restore AC power within 8 hours results in core damage.
LOOP 59-09-09	1.5×10^{-6}	11.0%	LOOP due to internal events (all types) occurs; successful reactor trip; failures of the emergency power system result in an SBO; HPCS fails, but RCIC successfully maintains RCS inventory; operators successfully declare ELAP; FLEX diesel generator fails resulting in the subsequent loss of safety-related DC power; and operator failure to restore AC power within 8 hours results in core damage.
HWD and HCN 59-03-09	6.9×10^{-7}	5.1%	LOOP due to high winds (including hurricanes) occurs; successful reactor trip; failures of the emergency power system result in an SBO; RCIC and HPCS successfully maintain RCS inventory; operators successfully declare ELAP; FLEX diesel generator fails resulting in the subsequent loss of safety-related DC power; and operator failure to restore AC power within 8 hours results in core damage.

[2] The ΔCDPs provided in Sections 4.2 and 4.3 are point estimates.

Sequence	ΔCDP	%	Description
LOOP 7	6.9×10^{-7}	5.1%	LOOP due to internal events (all types) occurs; successful reactor trip; emergency power system successfully provides safety-related AC power; RCIC or HPCS successfully maintain RCS inventory; suppression pool cooling fails; operators successfully depressurize the reactor; shutdown cooling fails; and failure of containment heat removal and venting results in core damage.

4.4 Key Uncertainties

The following are the key uncertainties of this ASP analysis.

- *Lack of Internal Fire Modeling in the SPAR Model.* The key modeling uncertainty for this analysis is lack of internal fire scenarios in the River Bend SPAR model. To address this uncertainty, the risk information provided by the licensee for various risk-informed applications (e.g., technical specification change) was reviewed. River Bend license amendment requests to date state that the licensee does not have a PRA for internal fires and references its individual plant examination for external events (IPEEE) for a quantitative assessment of the risk associated with internal fires. However, discussion with Region 4 staff revealed that the licensee has recently completed a PRA for internal fires.

  A review of the River Bend IPEEE results show that areas identified as important are likely to impact the risk of this condition (i.e., areas in which a fire would result in a LOOP or partial LOOP). However, a quantitative estimate of this risk impact is not possible given the information provided by the IPEEE. However, based on the importance measures of the division '1' standby diesel generator in the licensee fire PRA, its failure is expected to have risk impact in the low 10^{-6} range for internal fires. Therefore, the overall ΔCDP is would likely remain in the 10^{-5} range and would not increase to the significant precursor threshold of greater than or equal to 10^{-3}.

- *Crediting the FLEX N+1 Diesel Generator.* A sensitivity calculation was performed to evaluate the uncertainty associated with crediting the FLEX N+1 diesel generator in the best estimate analysis. This calculation resulted in mean ΔCDP of 7×10^{-6} (a decrease of 37 percent of the best estimate ΔCDP).

Appendix A: Key Event Trees

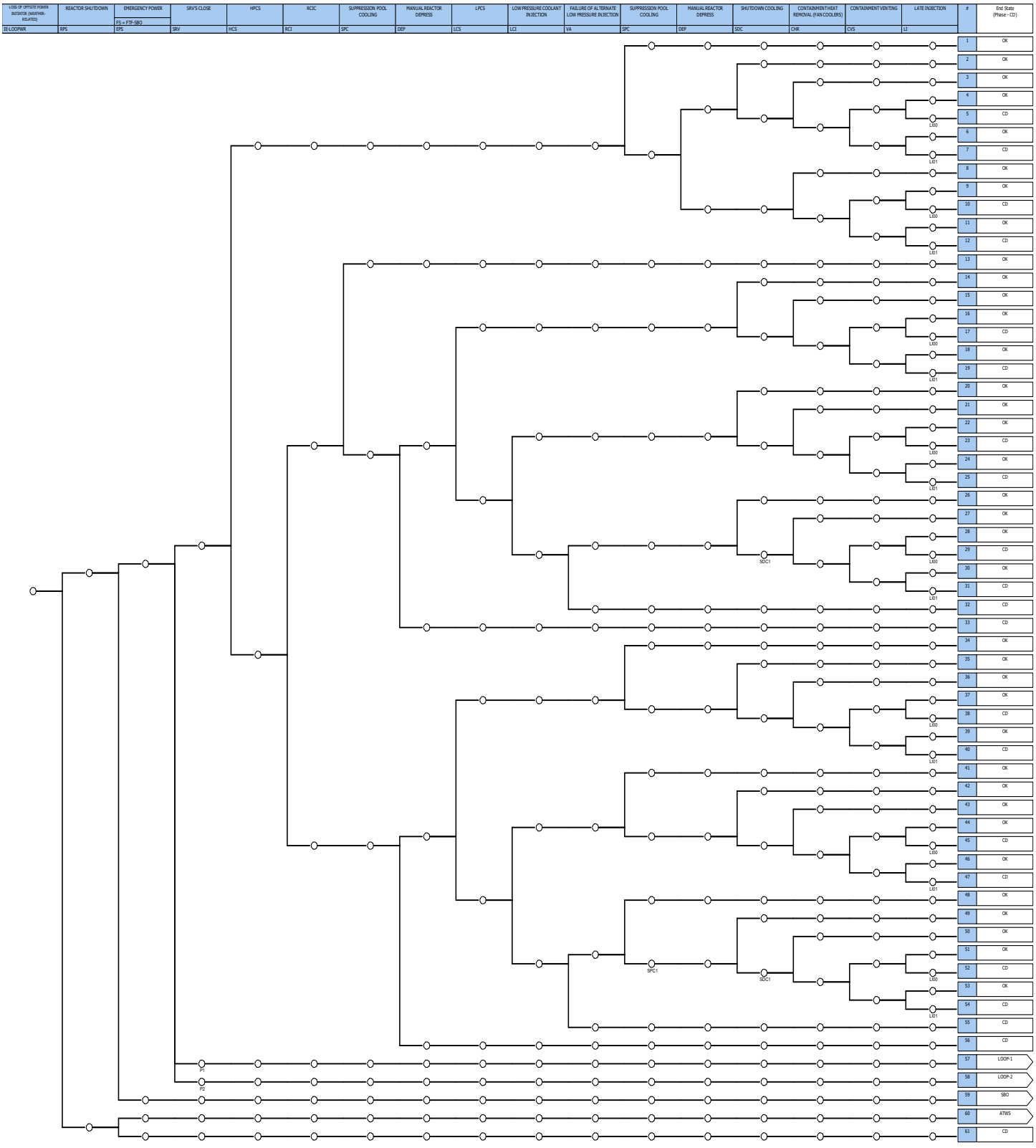

Figure A-1. Weather-Related LOOP Event Tree

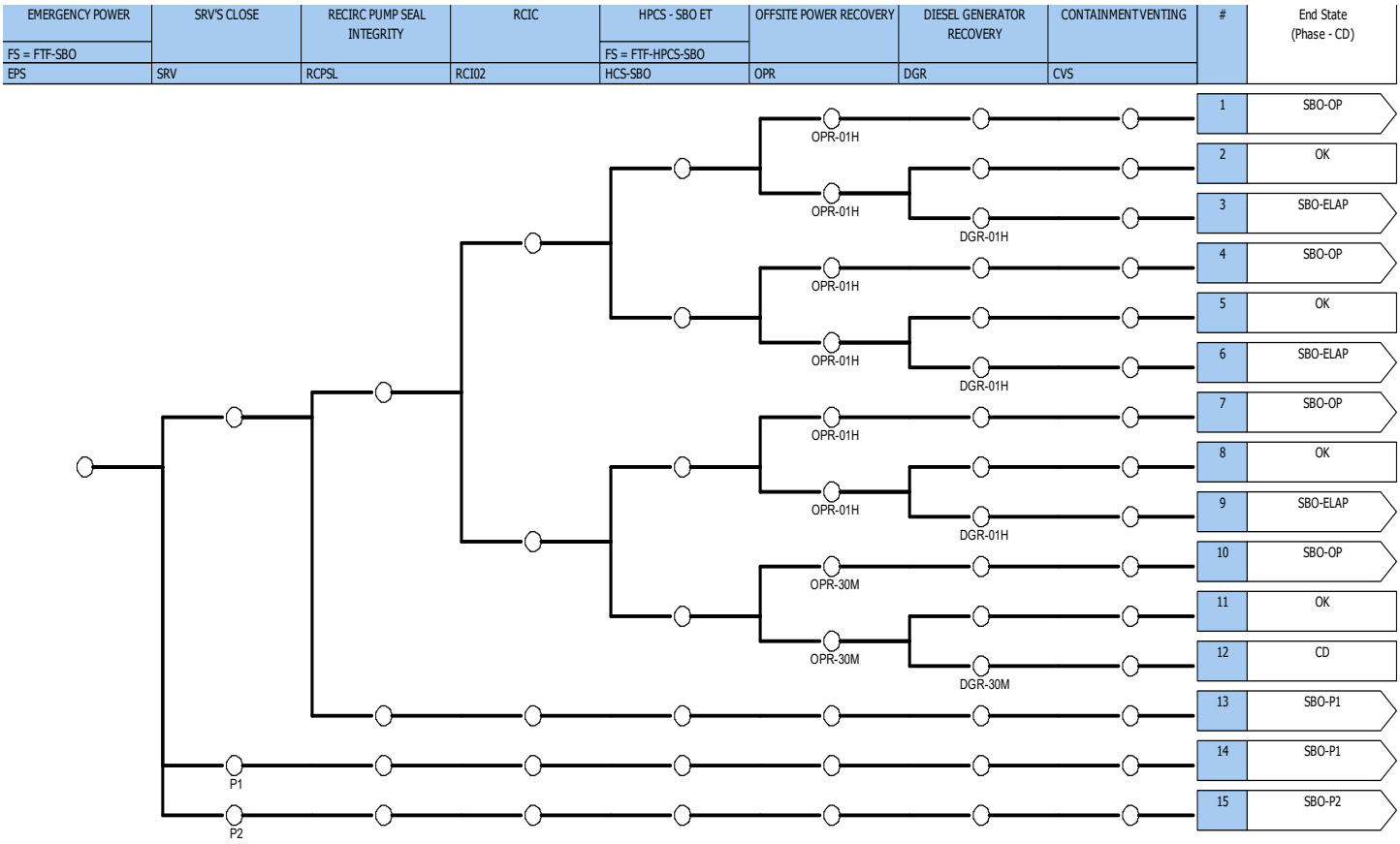

Figure A-2. SBO Event Tree

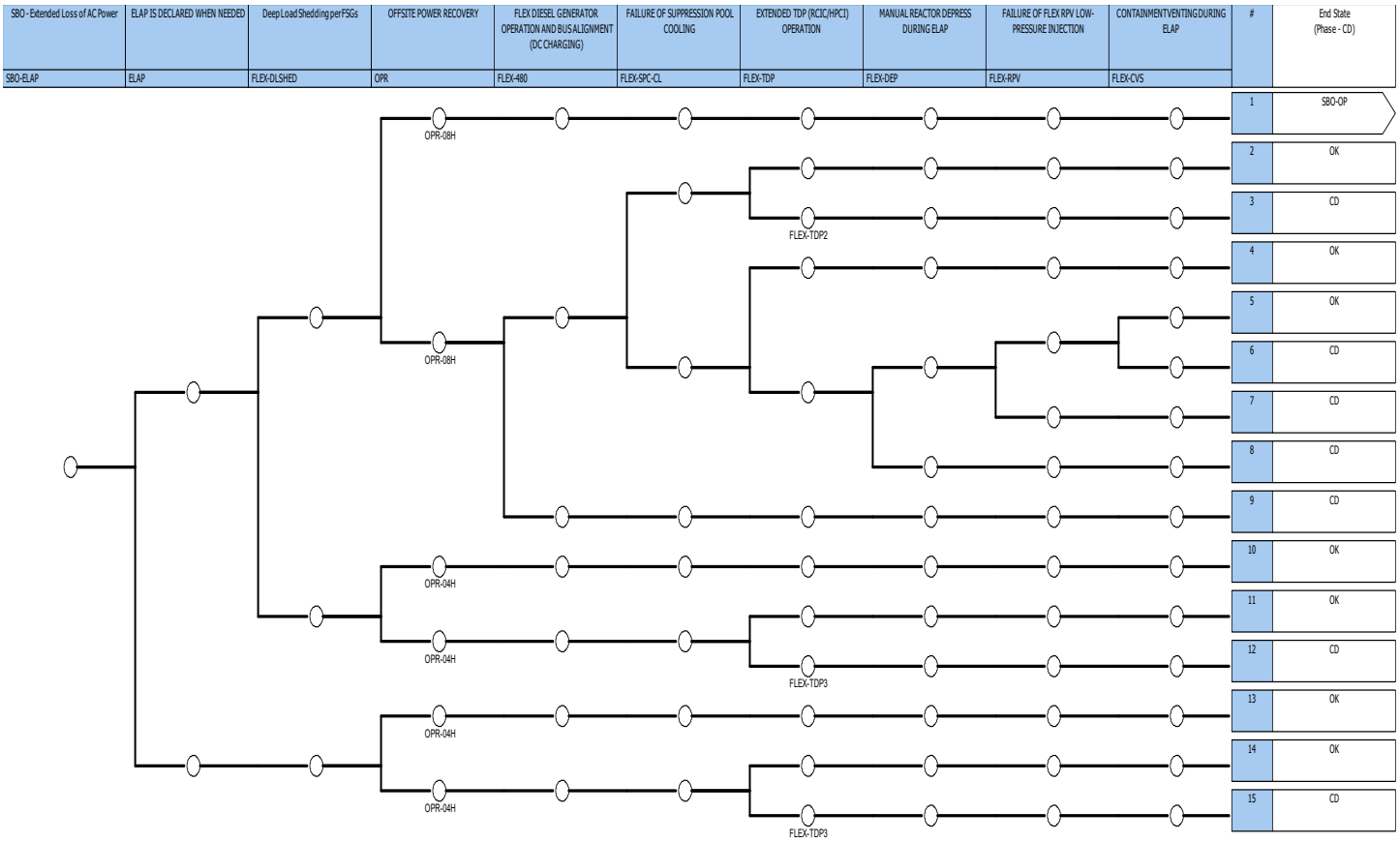

Figure A-3. SBO-ELAP Event Tree

Final Accident Sequence Precursor Analysis - River Bend Station, Division '1' Standby Diesel Generator Speed Sensor Power Supply Failure LER 458-2022-003 - Precursor DATE February 16, 2023

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