
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.: 268-8308
SRP Section: SRP 19
Application Section: 19.1.
Date of RAI Issued: 10/02/2015

Question No. 19-11

10 CFR 52.47(27) requires that a standard design certification applicant provide a description of the design specific PRA and the results. Design Control Document Section 19.1.6, appears to be missing event trees for all plant operational states other than plant operational state 5, which represents mid-loop conditions. However, the plant response to a loss of decay heat removal (DHR) is significantly different if the reactor coolant system (RCS) is intact versus an open RCS. To provide an example of how the different plant operational states were modeled in the probabilistic risk assessment (PRA), the staff is requesting that the applicant add the event trees for all plant operational states for the initiating event, loss of the operating train of the shutdown cooling (SDC) system. The staff considers these low power shutdown (LPSD) event trees part of the PRA results. These event trees will allow the reader to understand the varying plant response to a shutdown initiating event given the different plant operational states.

Response

The twelve (12) event trees for POS 5 are included as Figures 19.1-52 through 19.1-63 in DCD 19.1. In response to this RAI, the low power and shutdown (LPSD) event trees for all plant operational states will be added to the DCD. The supporting discussion will also be revised.

Impact on DCD

DCD 19.1 will be revised to in response to this RAI.

The POS 5 LPSD event trees in Figures 19.1-52 through 19.1-63 will be supplemented to present the event trees for all plant operating states in Figures 19.1-52 through 19.1-208 and also figure for LPSD Containment Event Tree will be changed to Figure 19.1-209 as shown in the Attachment 1

The supporting discussion in DCD section 19.1.6.1.1.4 (page 19.1-171) will be revised also. The text is revised as shown in the Attachment 2.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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

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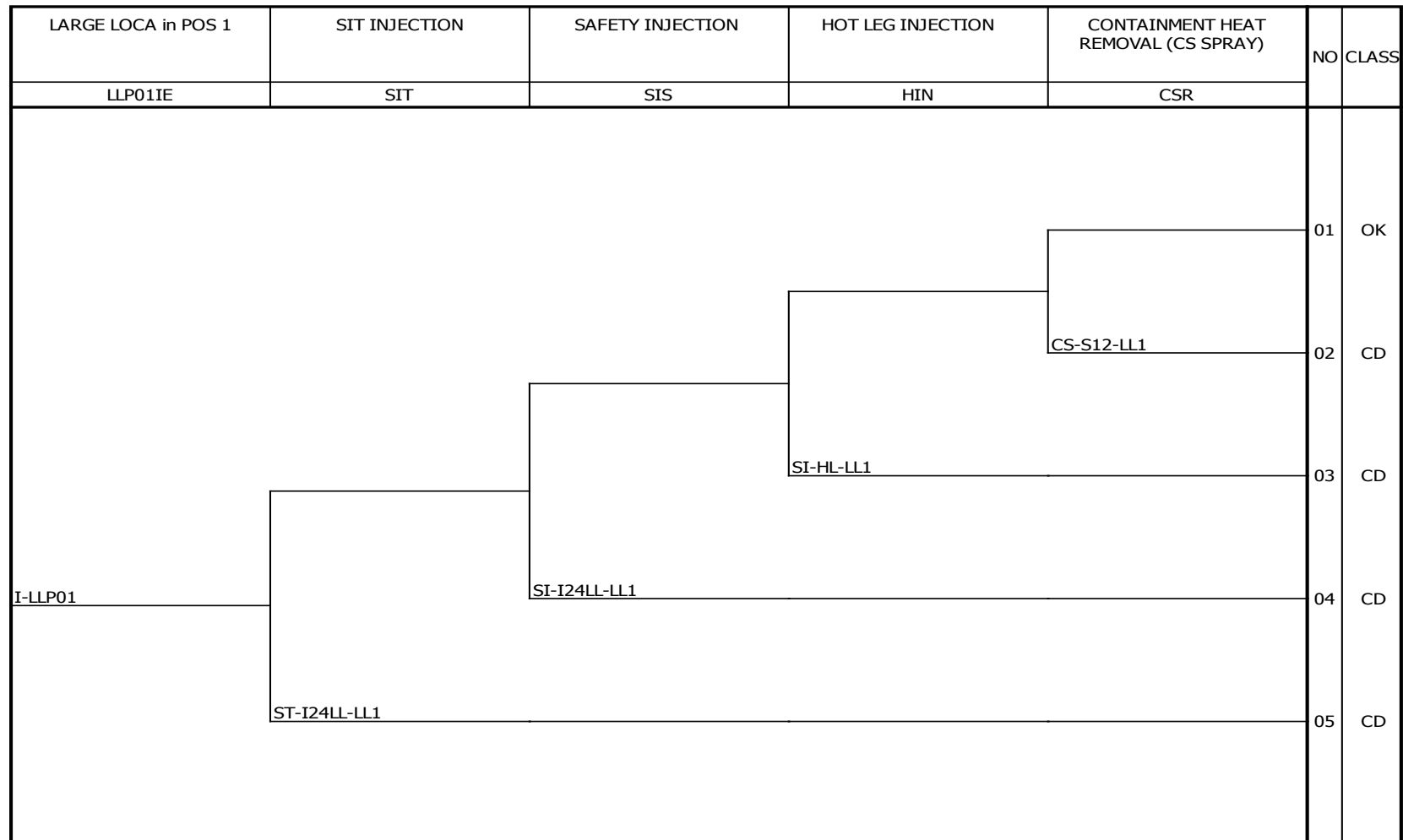


Figure 19.1-52 LPSD Level 1 Event Tree – Large LOCA (LLOCA) in POS 1

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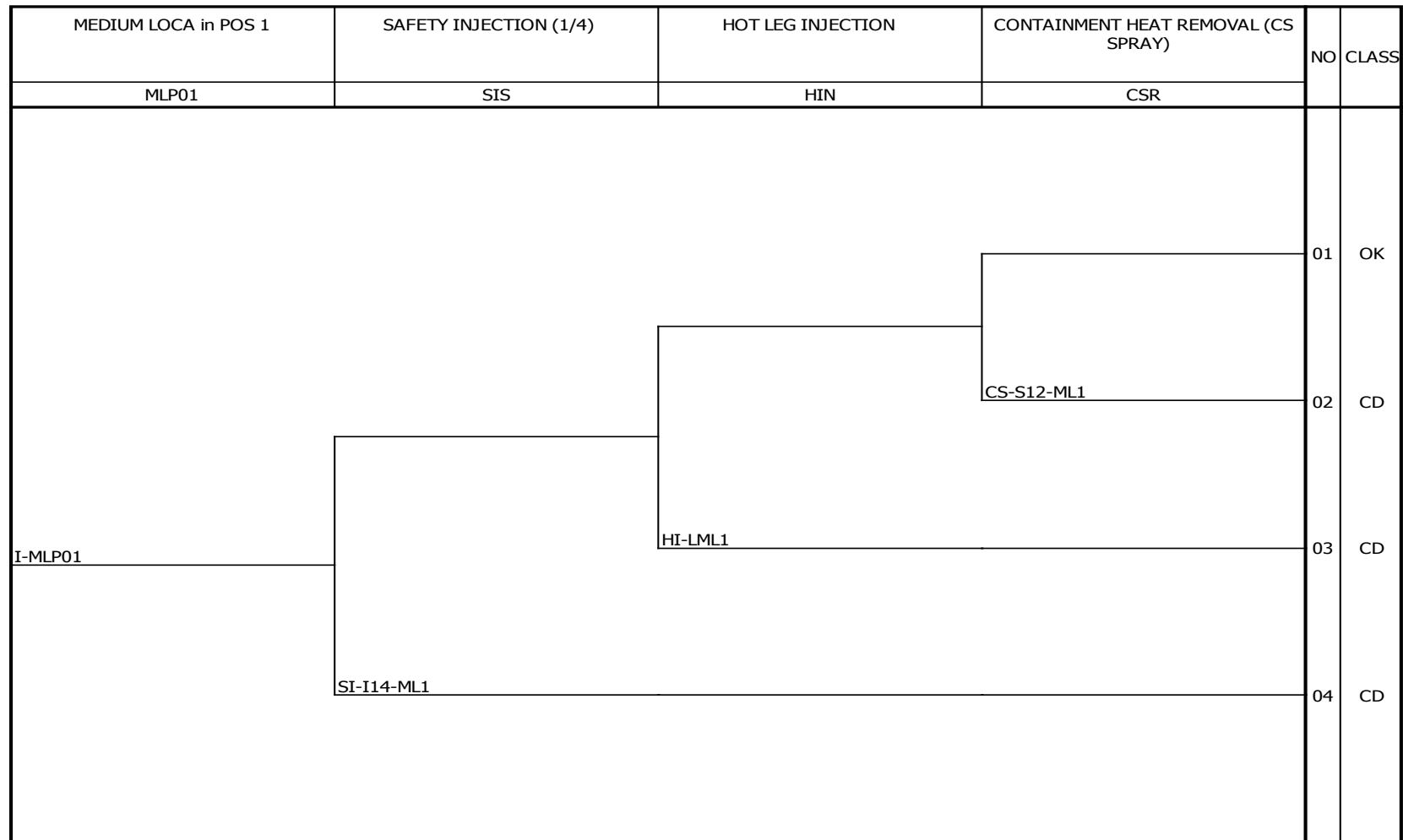


Figure 19.1-53 LPSD Level 1 Event Tree – Medium LOCA (MLOCA) in POS 1

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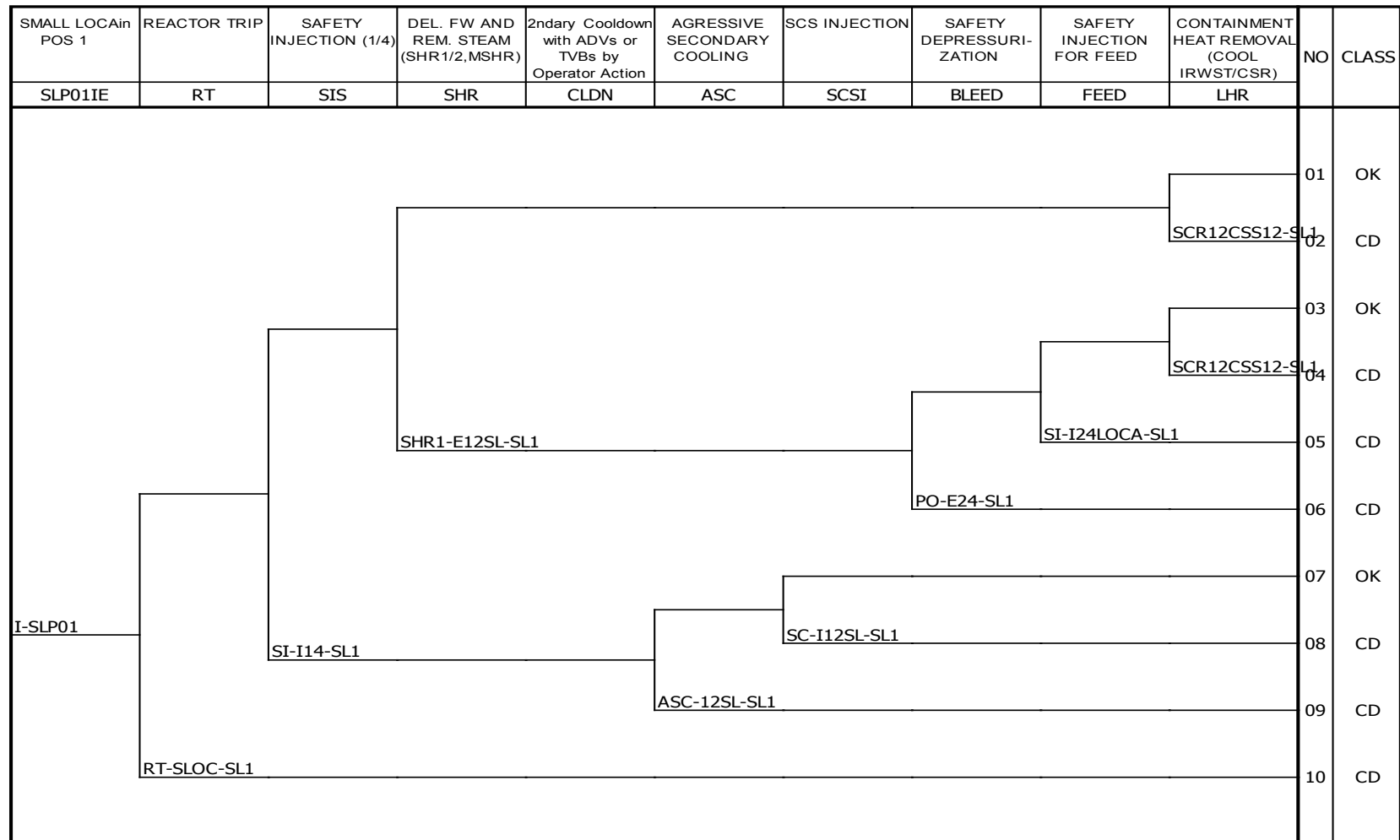


Figure 19.1-54 LPSD Level 1 Event Tree – Small LOCA Pipe Rupture (SL) in POS 1

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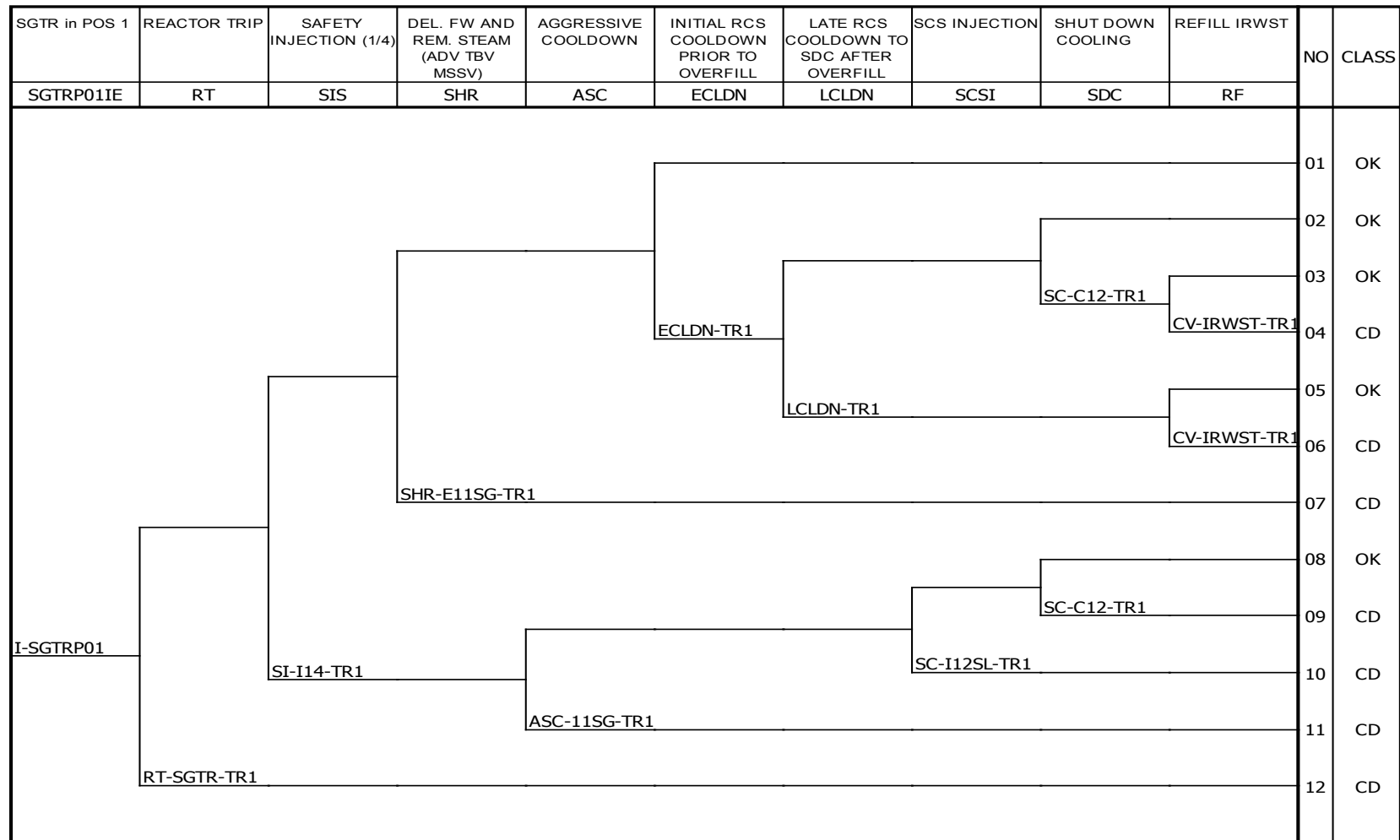


Figure 19.1-55 LPSD Level 1 Event Tree – Steam Generator Tube Rupture (SG) in POS 1

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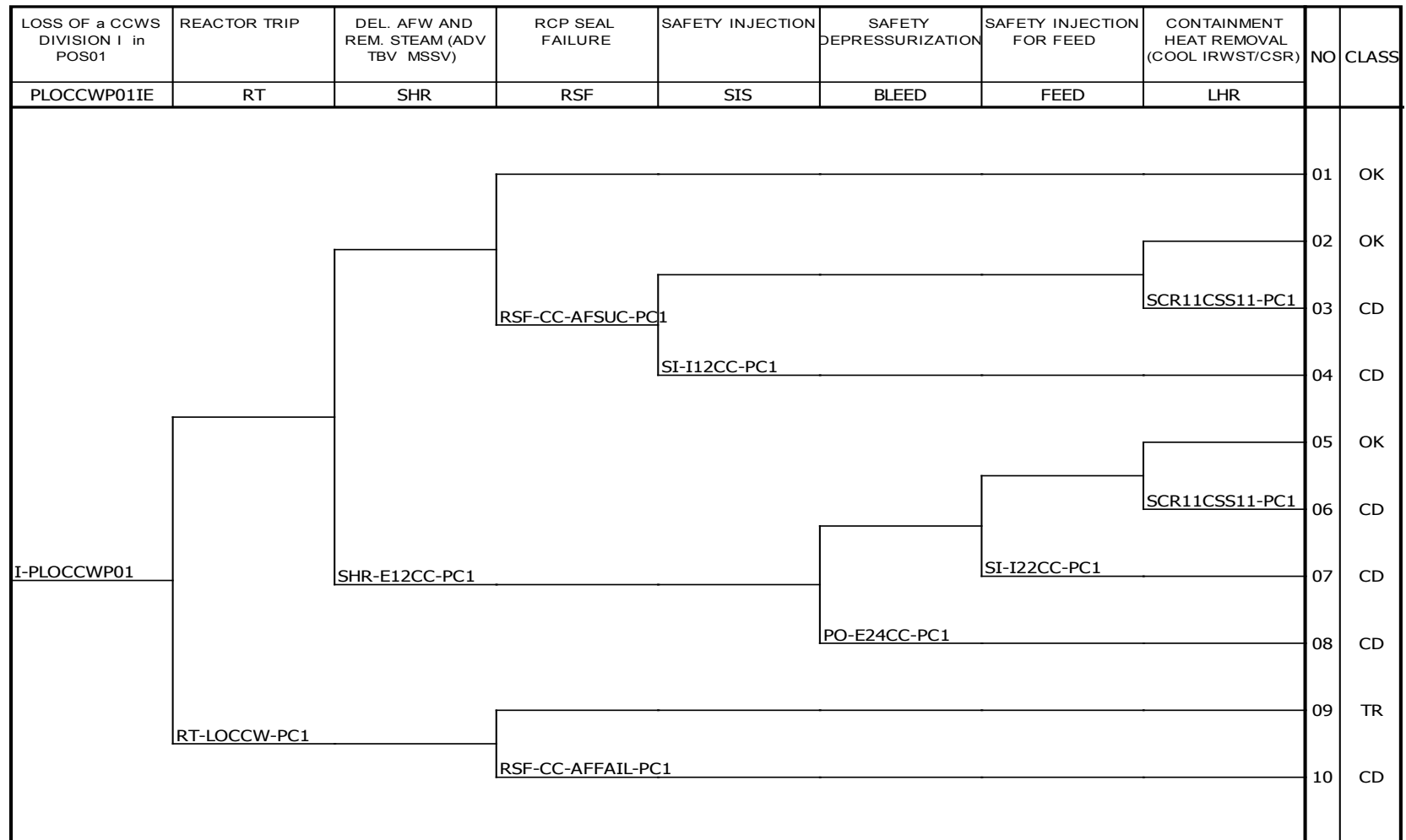


Figure 19.1-56 LPSD Level 1 Event Tree – Partial Loss of Component Cooling Water (CC) in POS 1

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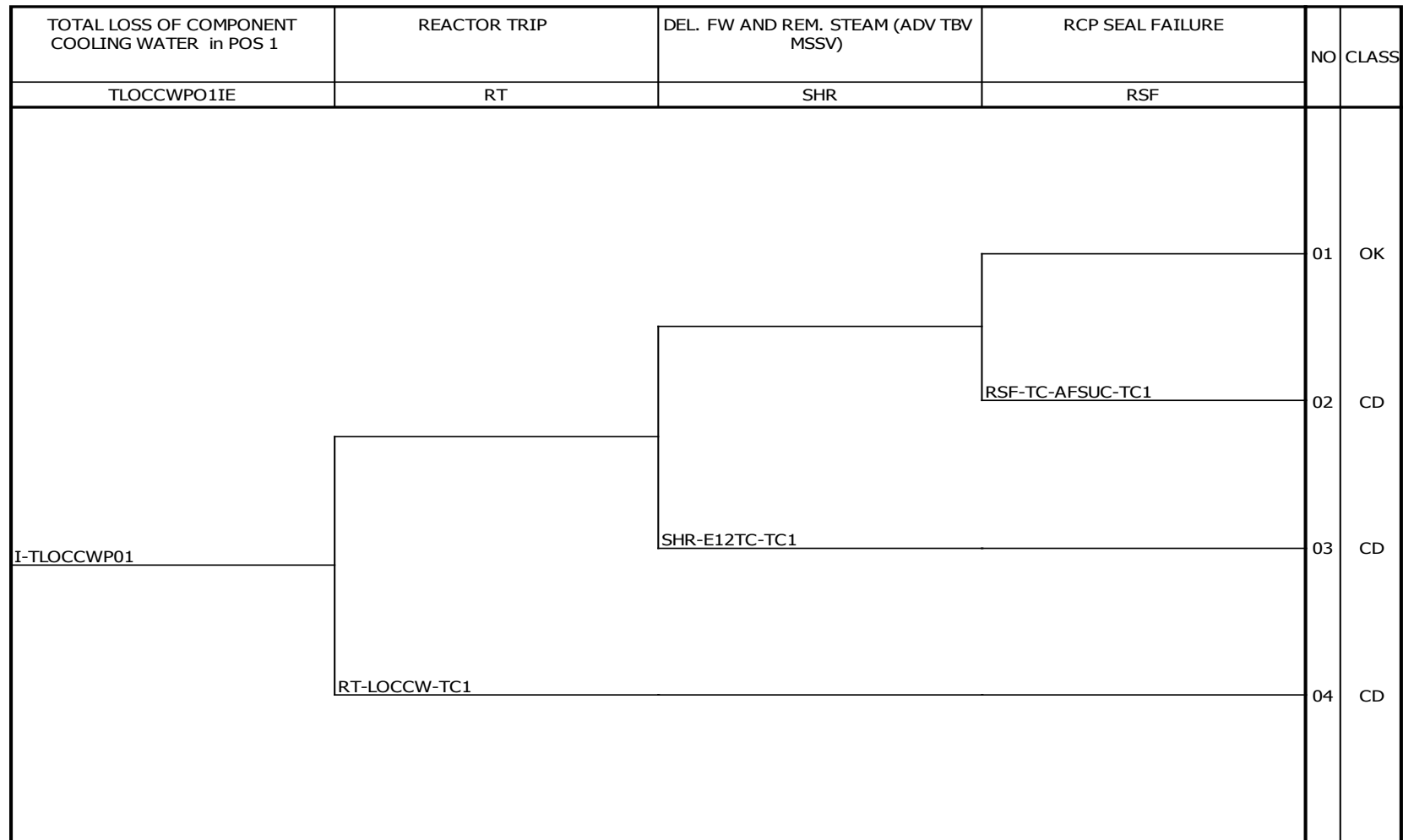


Figure 19.1-57 **LPSD Level 1 Event Tree – Total Loss of Component Cooling Water (TC) in POS 1**

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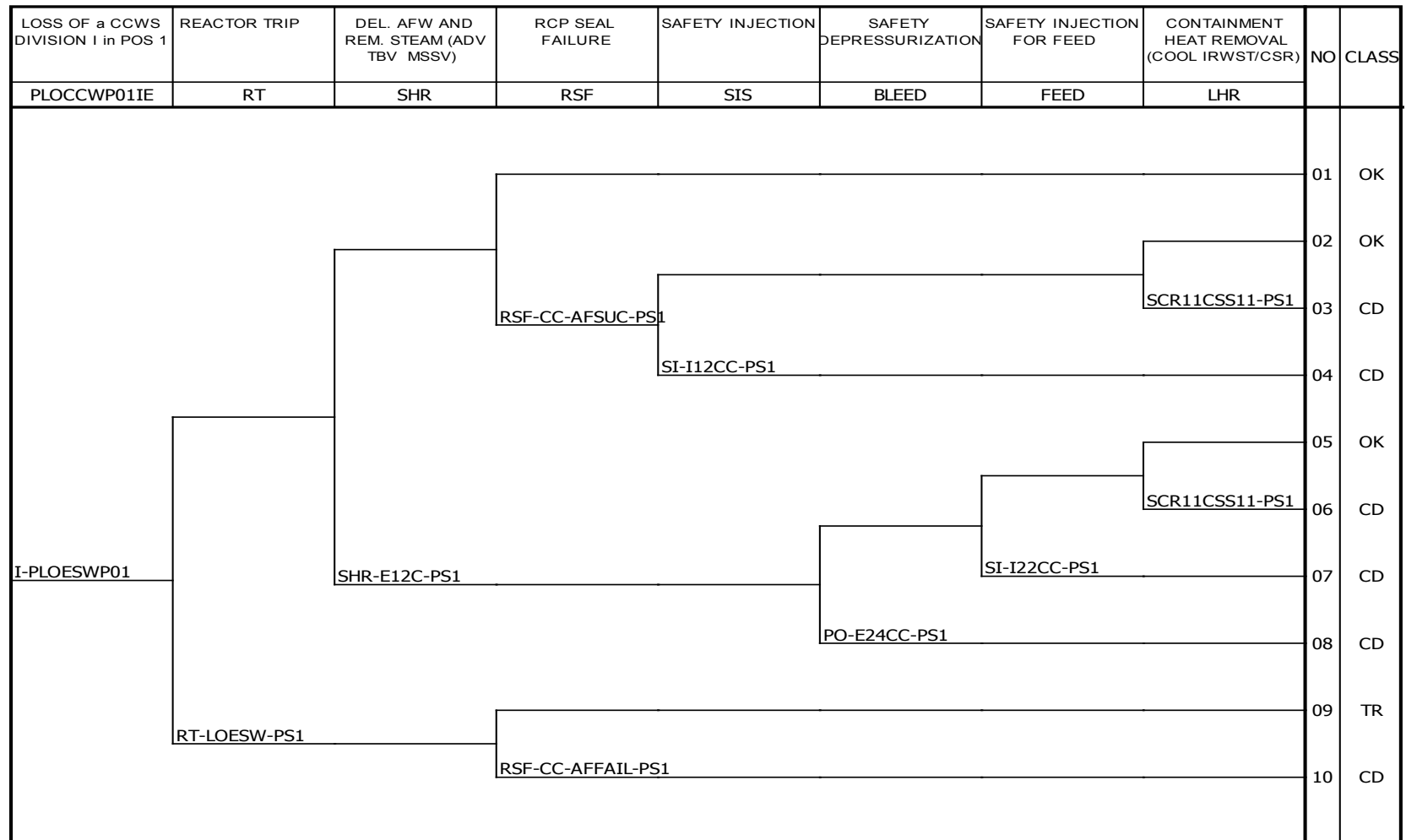


Figure 19.1-58 LPSD Level 1 Event Tree – Partial Loss of Essential Service Water (CC) in POS 1

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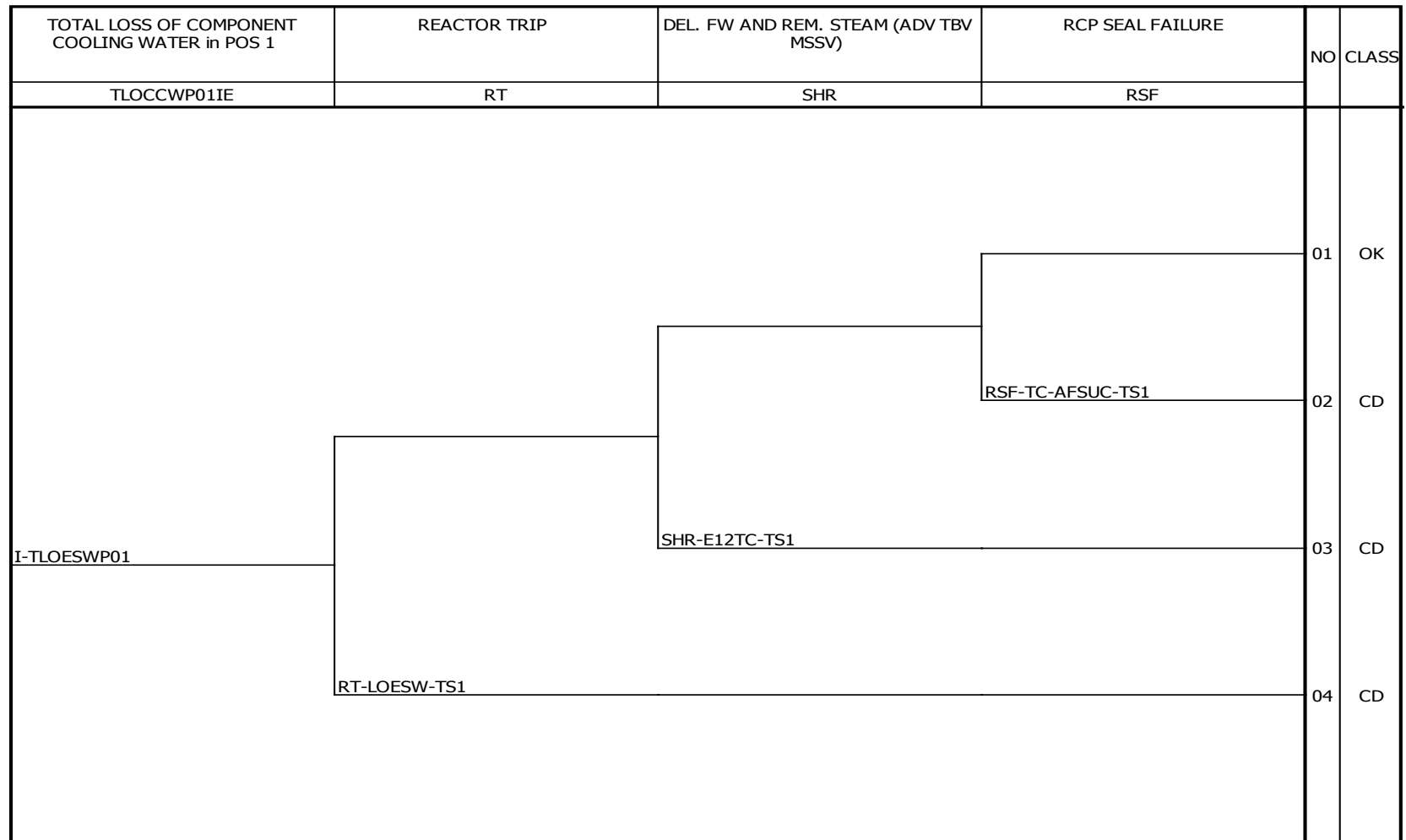


Figure 19.1-59 LPSD Level 1 Event Tree – Total Loss of Essential Service Water (CC) in POS 1

APR1400 DCD TIER 2

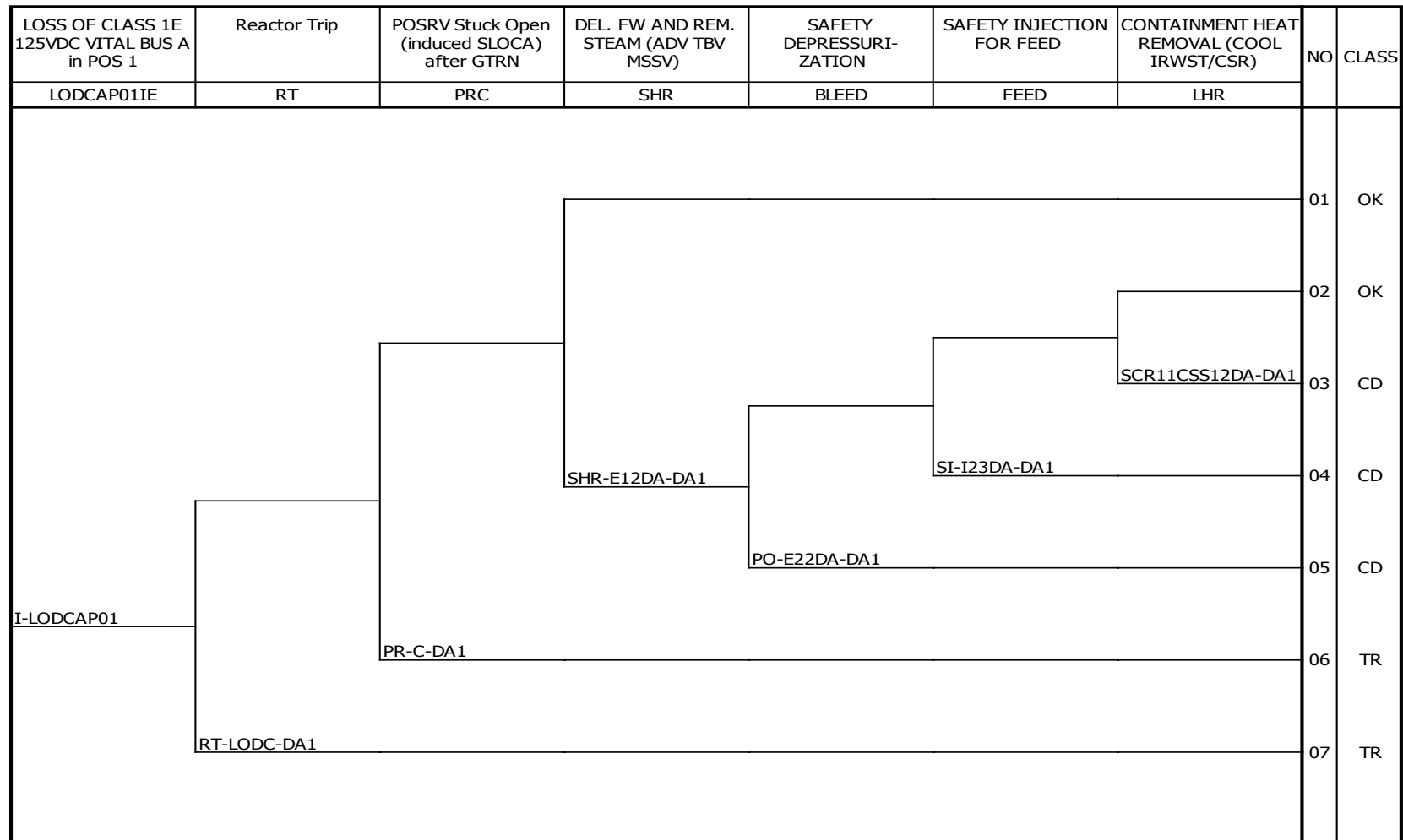


Figure 19.1-60 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel A (DCA) in POS 1

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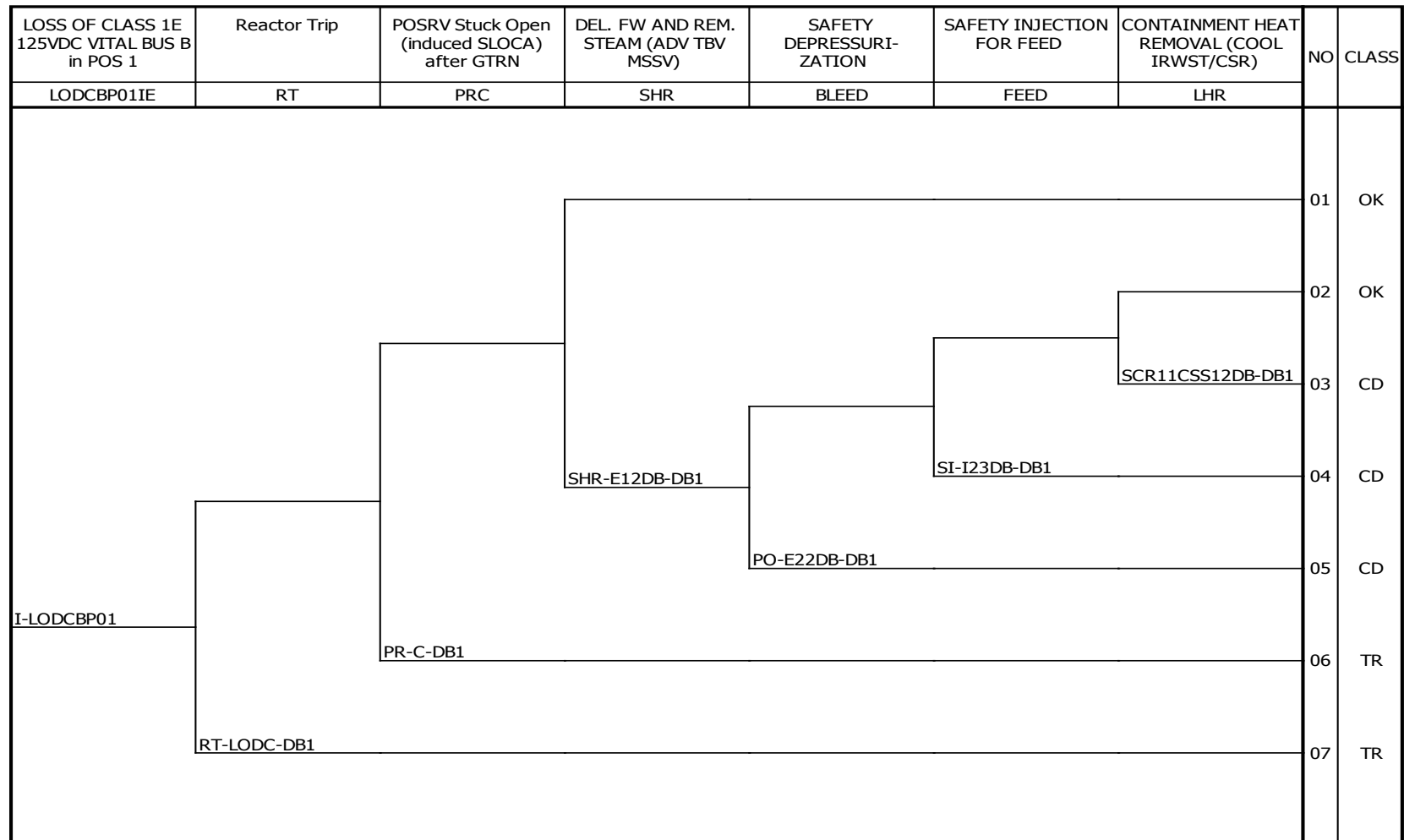


Figure 19.1-61 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel B (DCB) in POS 1

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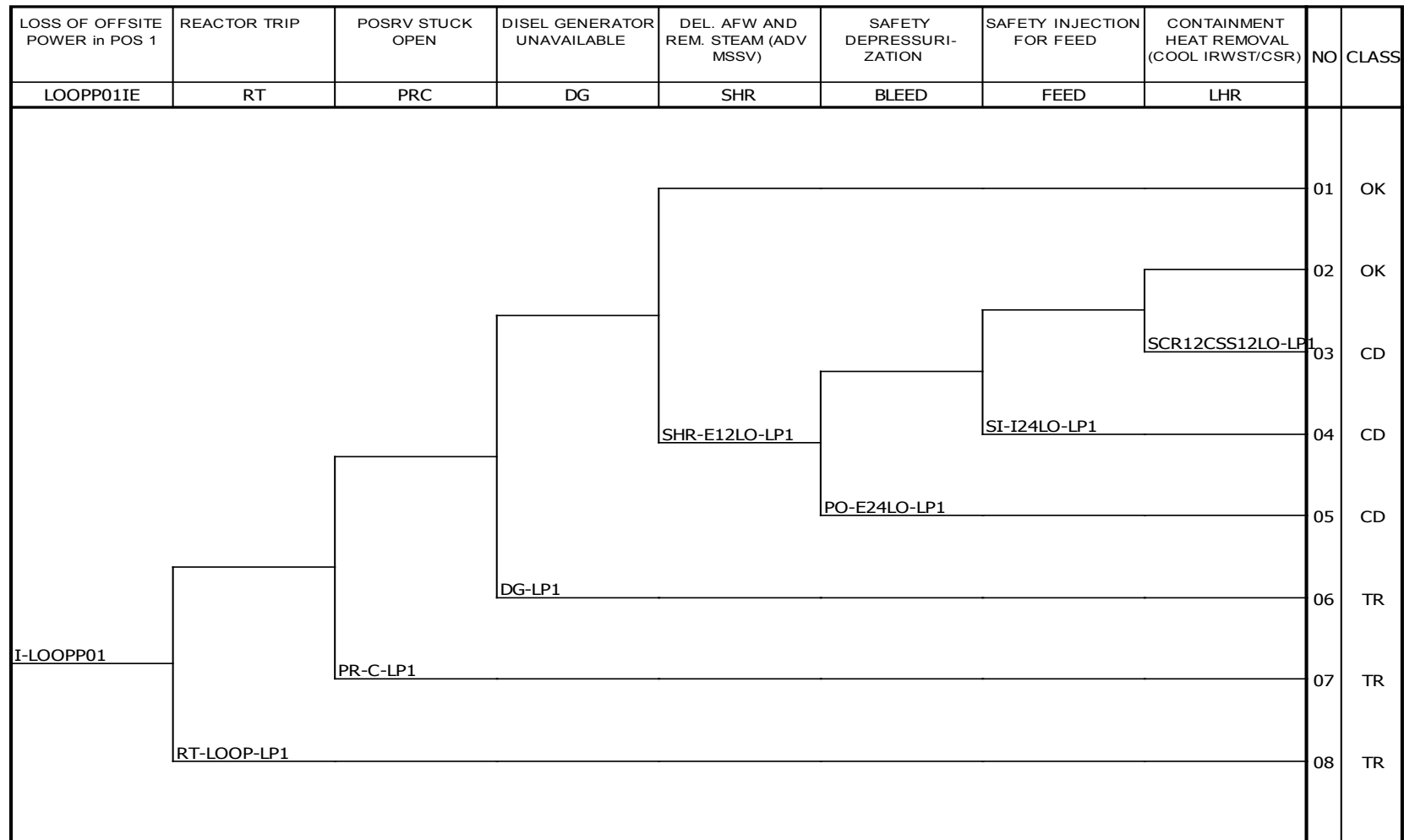


Figure 19.1-62 LPSD Level 1 Event Tree – Loss of Offsite Power (LP) in POS 1

APR1400 DCD TIER 2

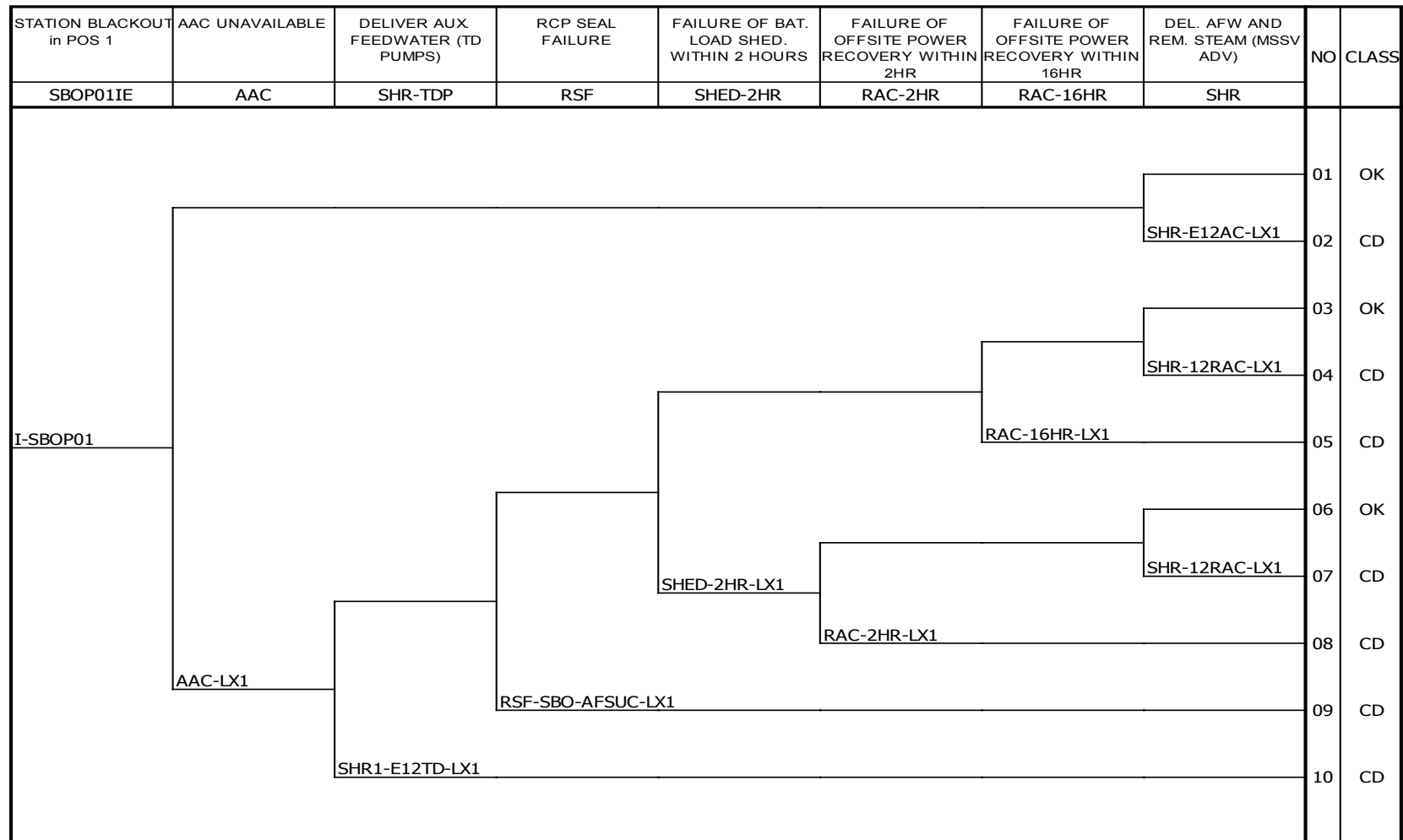


Figure 19.1-63 LPSD Level 1 Event Tree – Station Blackout (LX) in POS 1

APR1400 DCD TIER 2

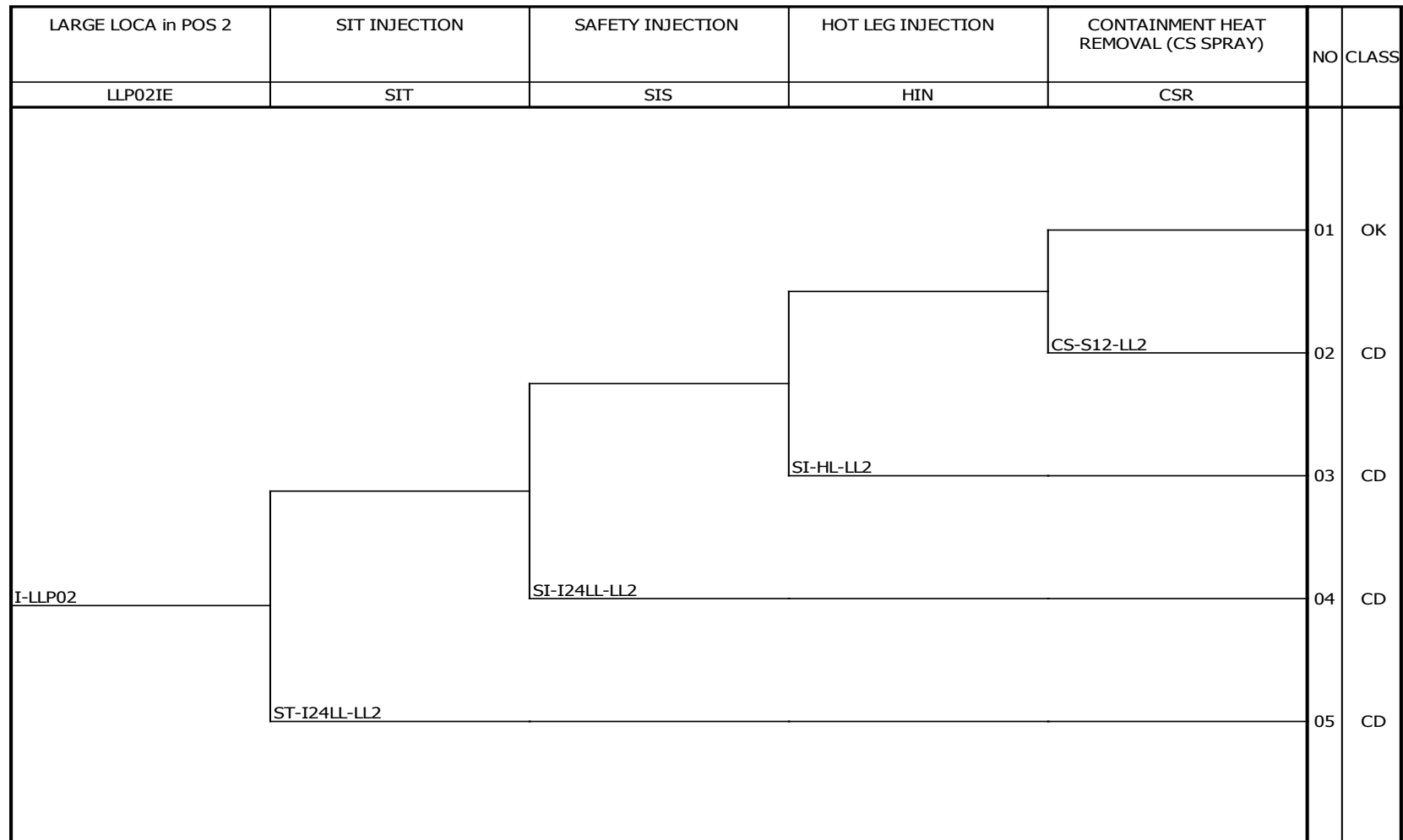


Figure 19.1-64 LPSD Level 1 Event Tree – Large LOCA (LLOCA) in POS 2

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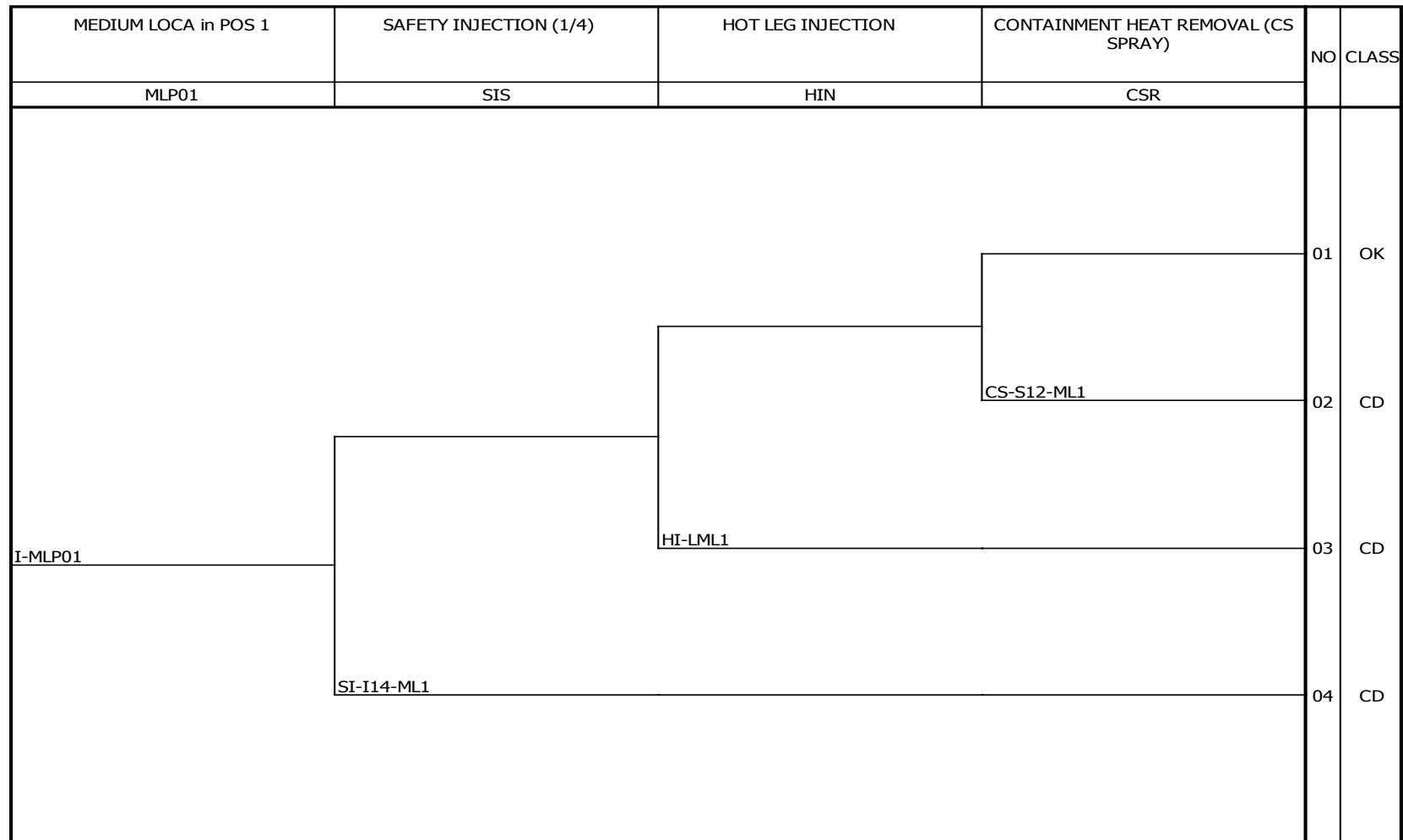


Figure 19.1-65 LPSD Level 1 Event Tree – Medium LOCA (MLOCA) in POS 2

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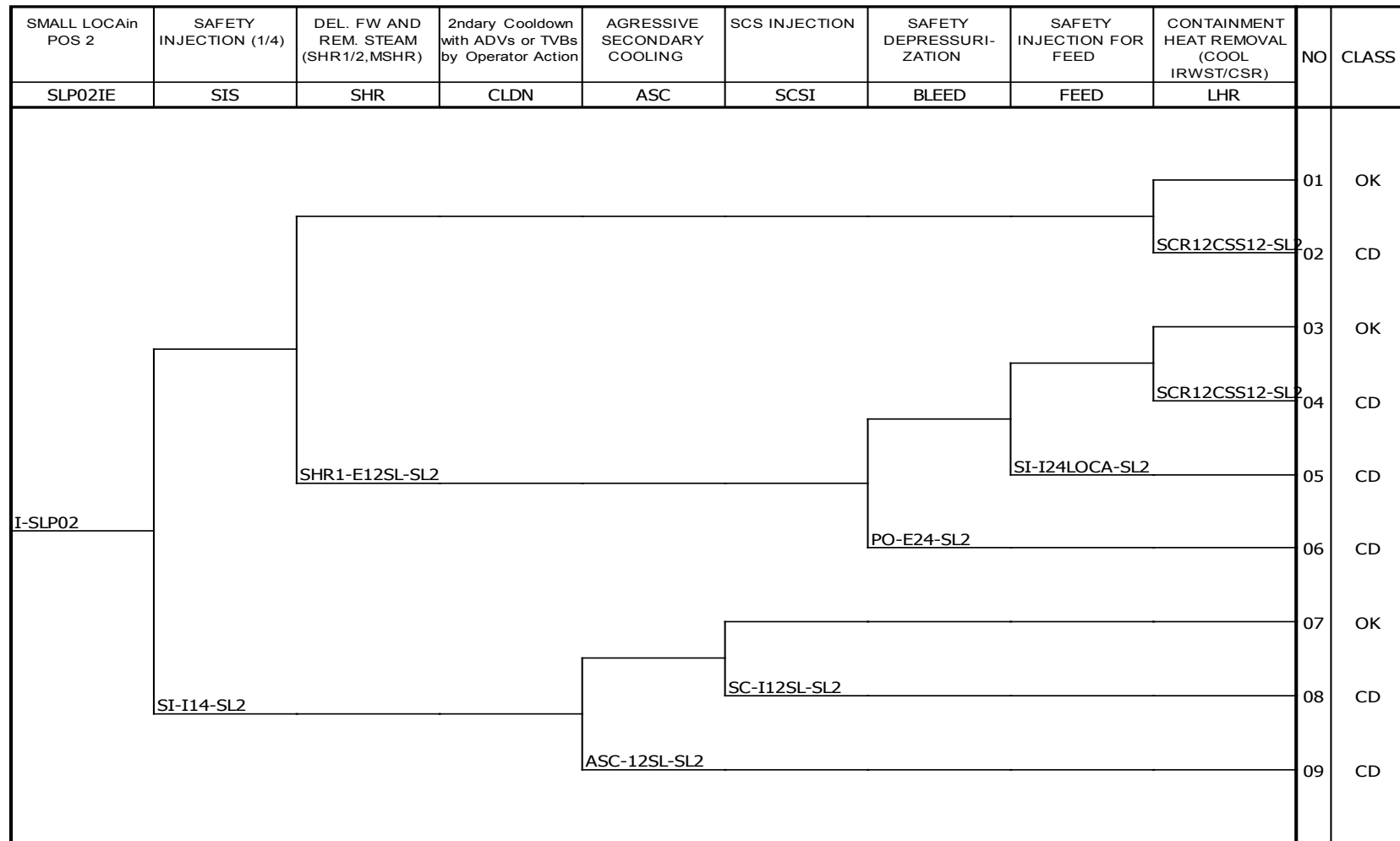


Figure 19.1-66 LPSD Level 1 Event Tree – Small LOCA Pipe Rupture (SL) in POS 2

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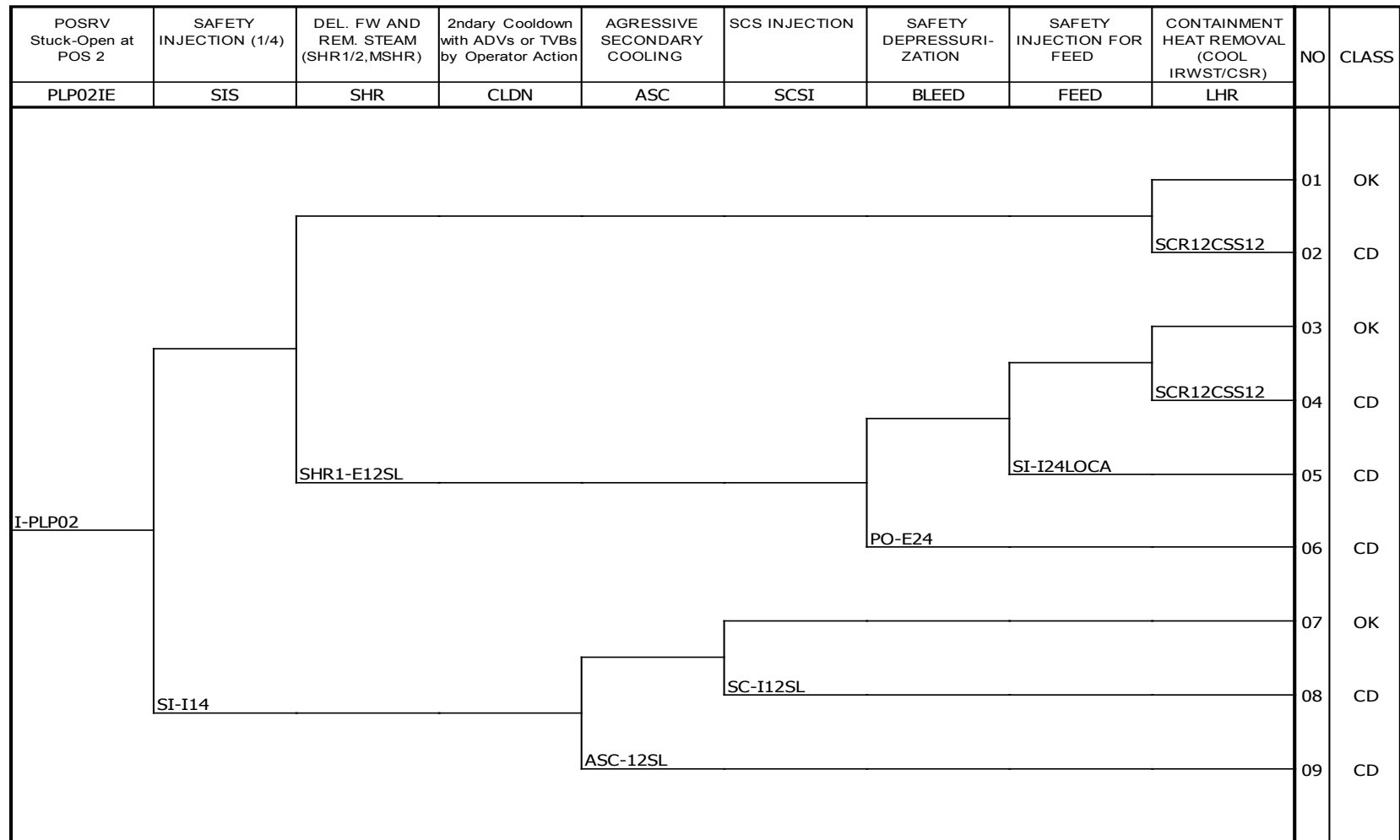


Figure 19.1-67 LPSD Level 1 Event Tree – POSRV Fails to Reclose (PL) in POS 2

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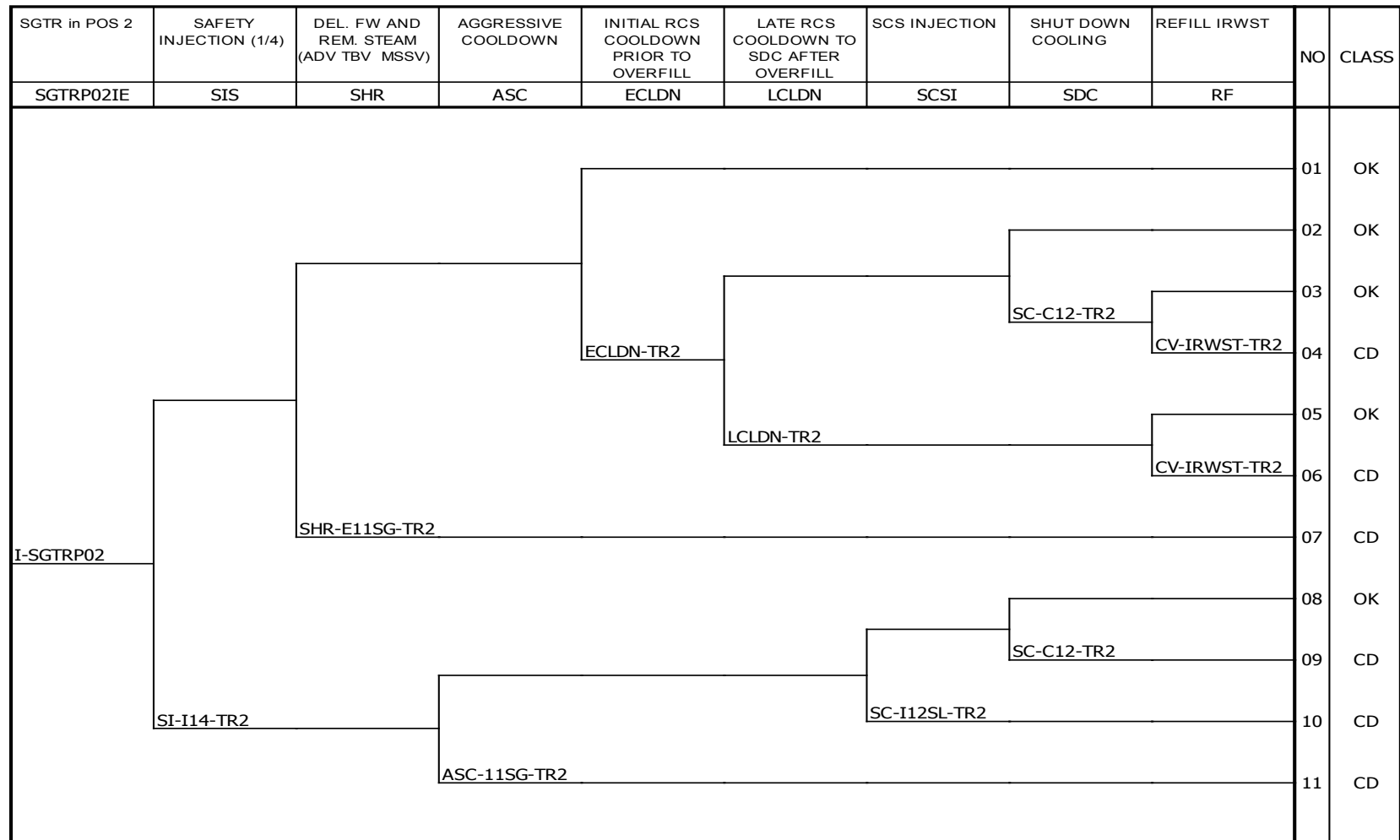


Figure 19.1-68 LPSD Level 1 Event Tree – Steam Generator Tube Rupture (SG) in POS 2

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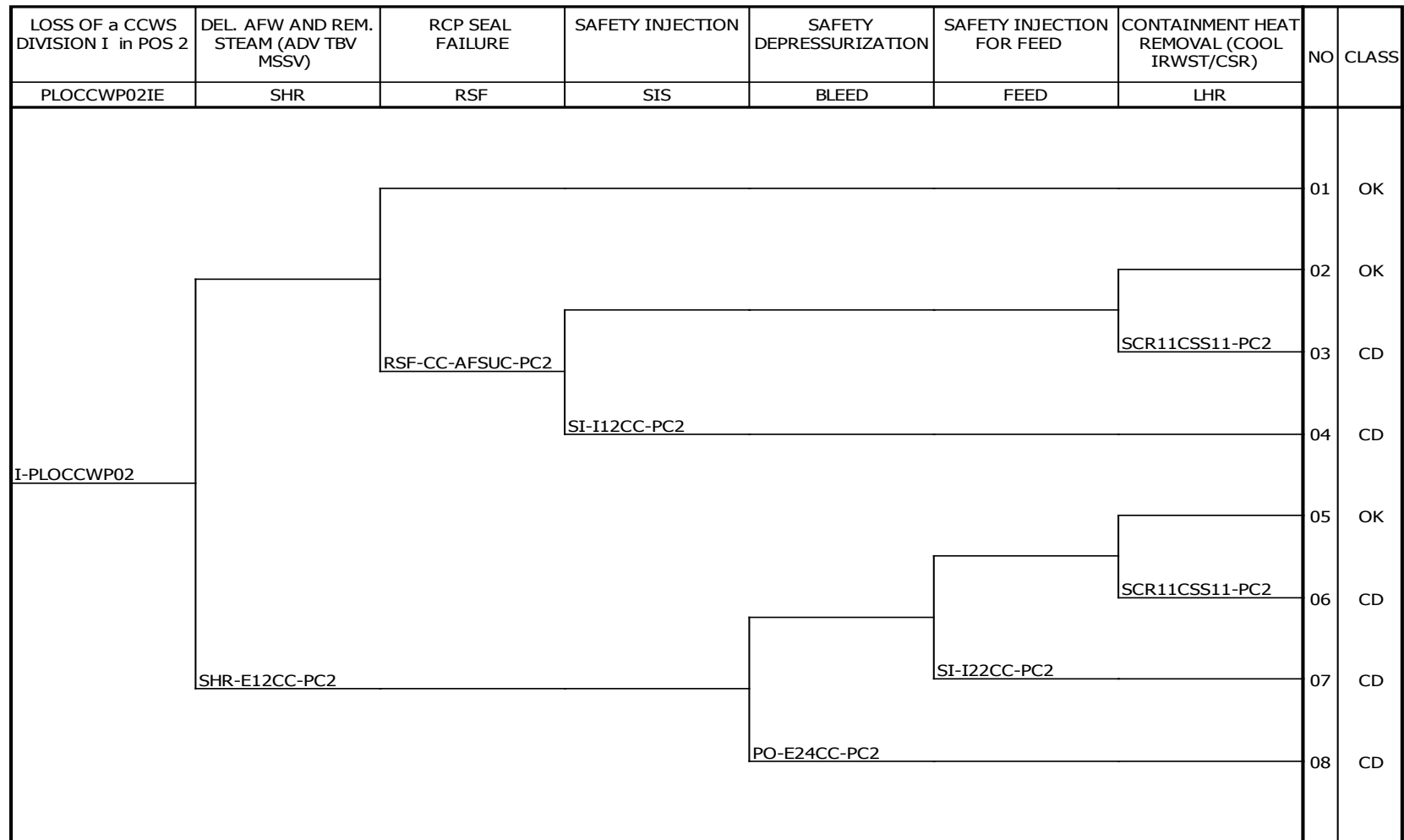


Figure 19.1-69 LPSD Level 1 Event Tree – Partial Loss of Component Cooling Water (CC) in POS 2

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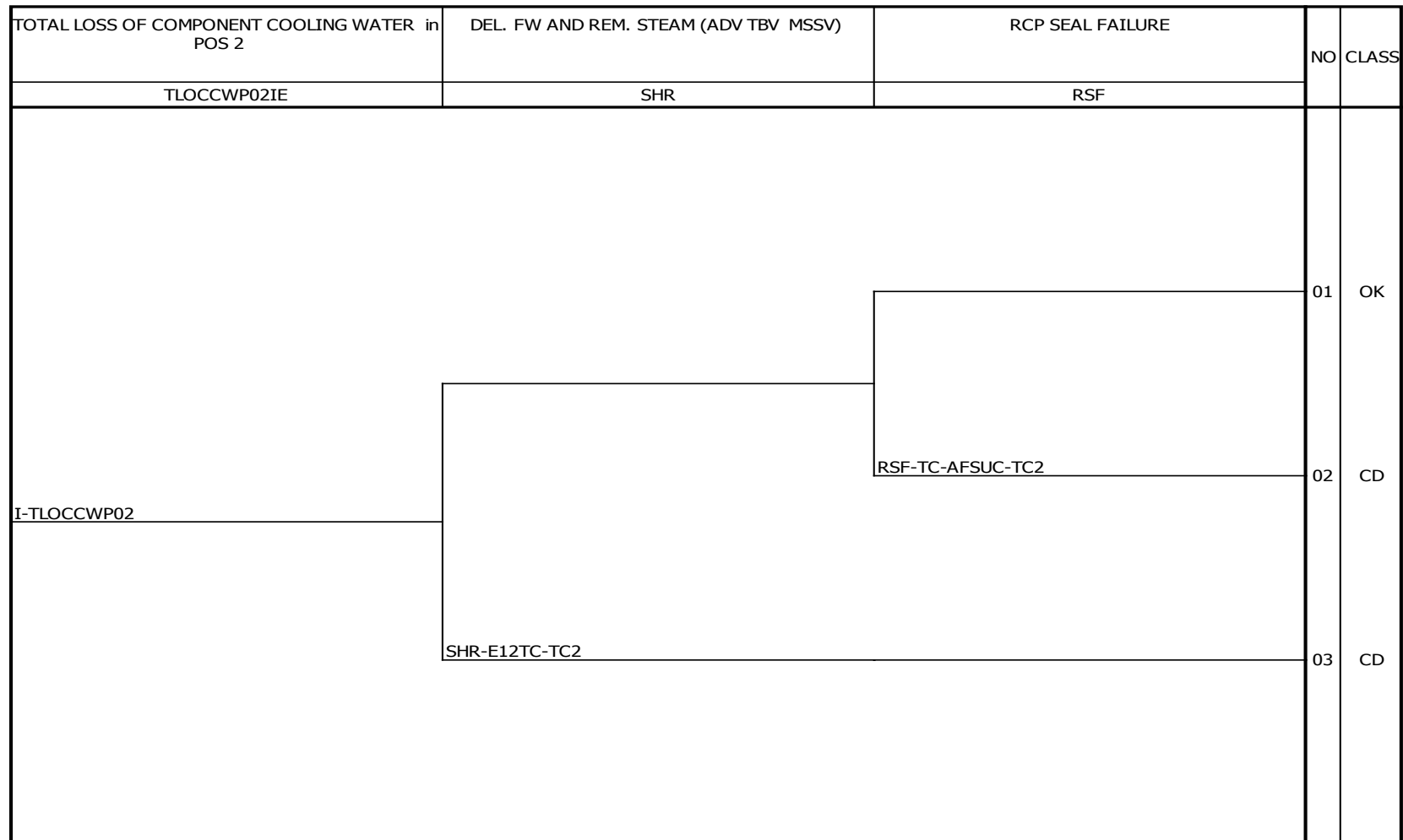


Figure 19.1-70 LPSD Level 1 Event Tree – Total Loss of Component Cooling Water (TC) in POS 2

APR1400 DCD TIER 2

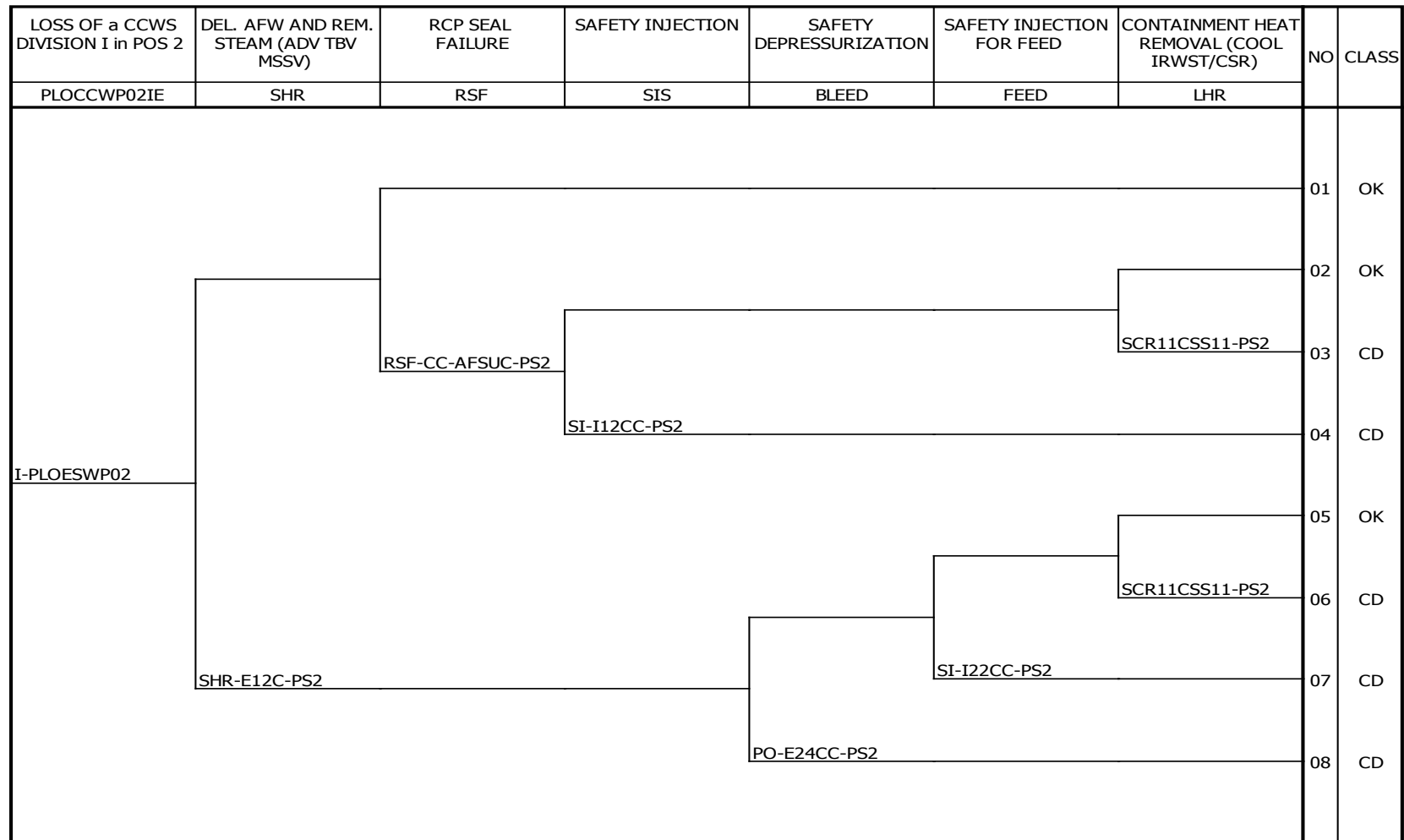


Figure 19.1-71 LPSD Level 1 Event Tree – Partial Loss of Essential Service Water (CC) in POS 2

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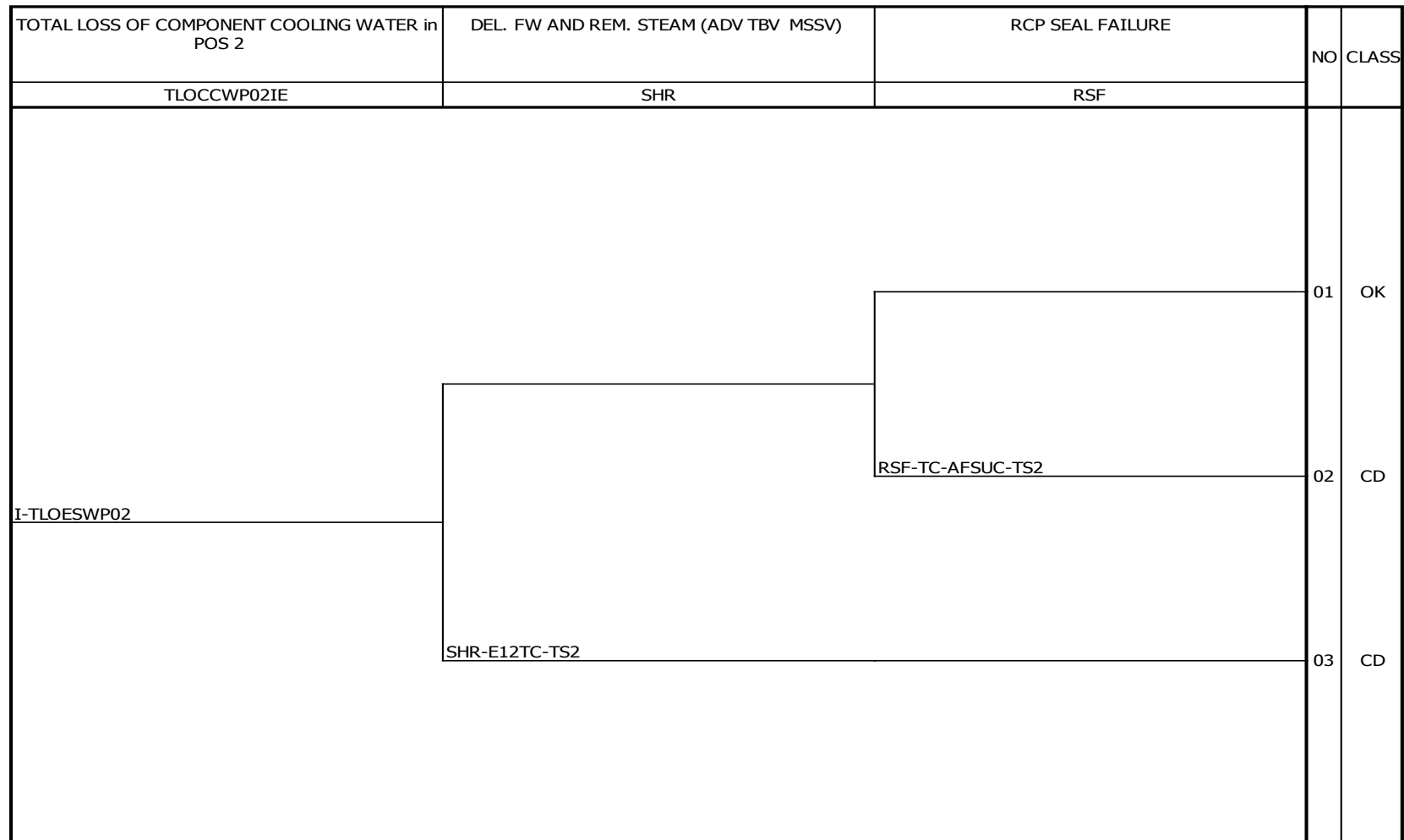


Figure 19.1-72 LPSD Level 1 Event Tree – Total Loss of Essential Service Water (CC) in POS 2

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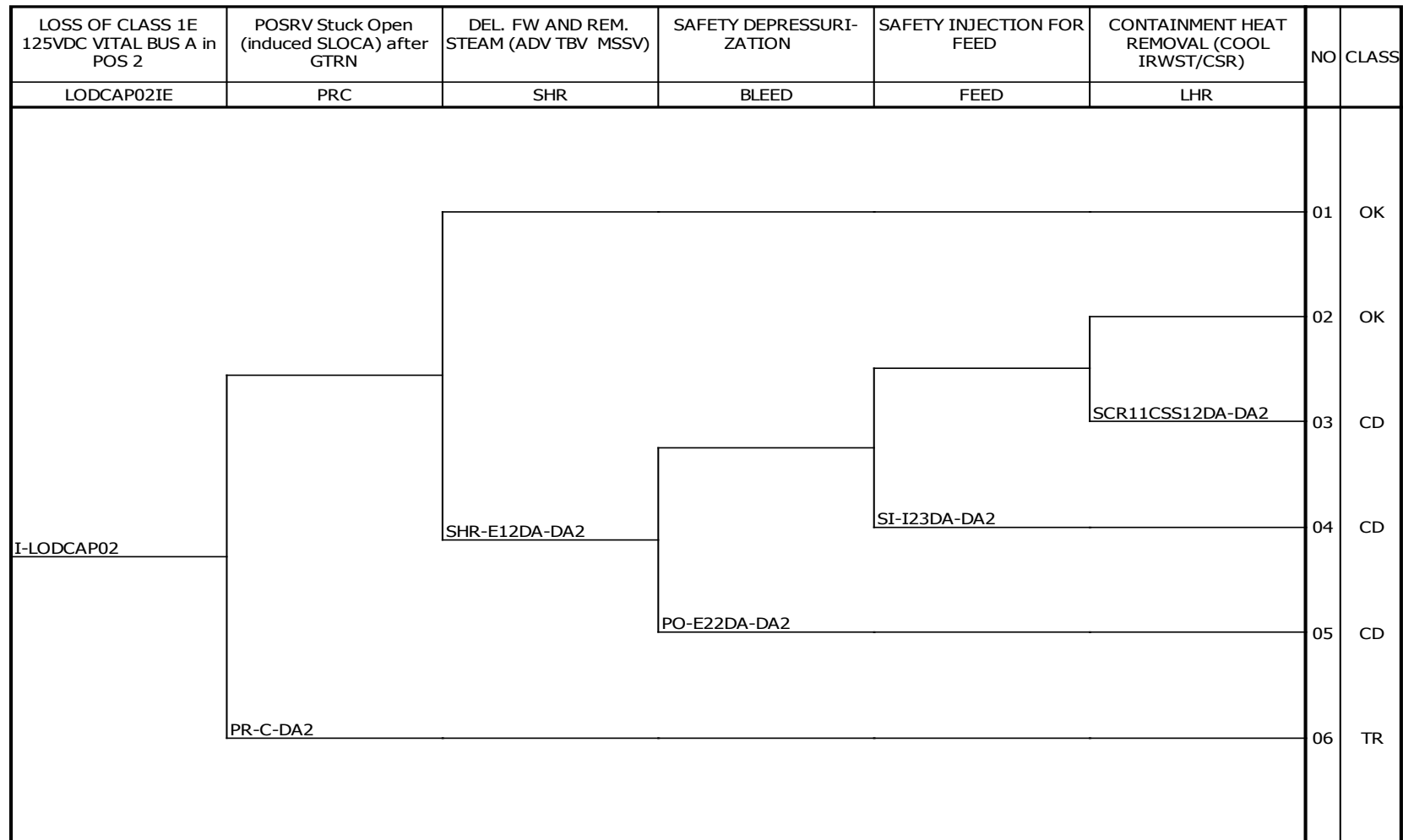


Figure 19.1-73 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel A (DCA) in POS 2

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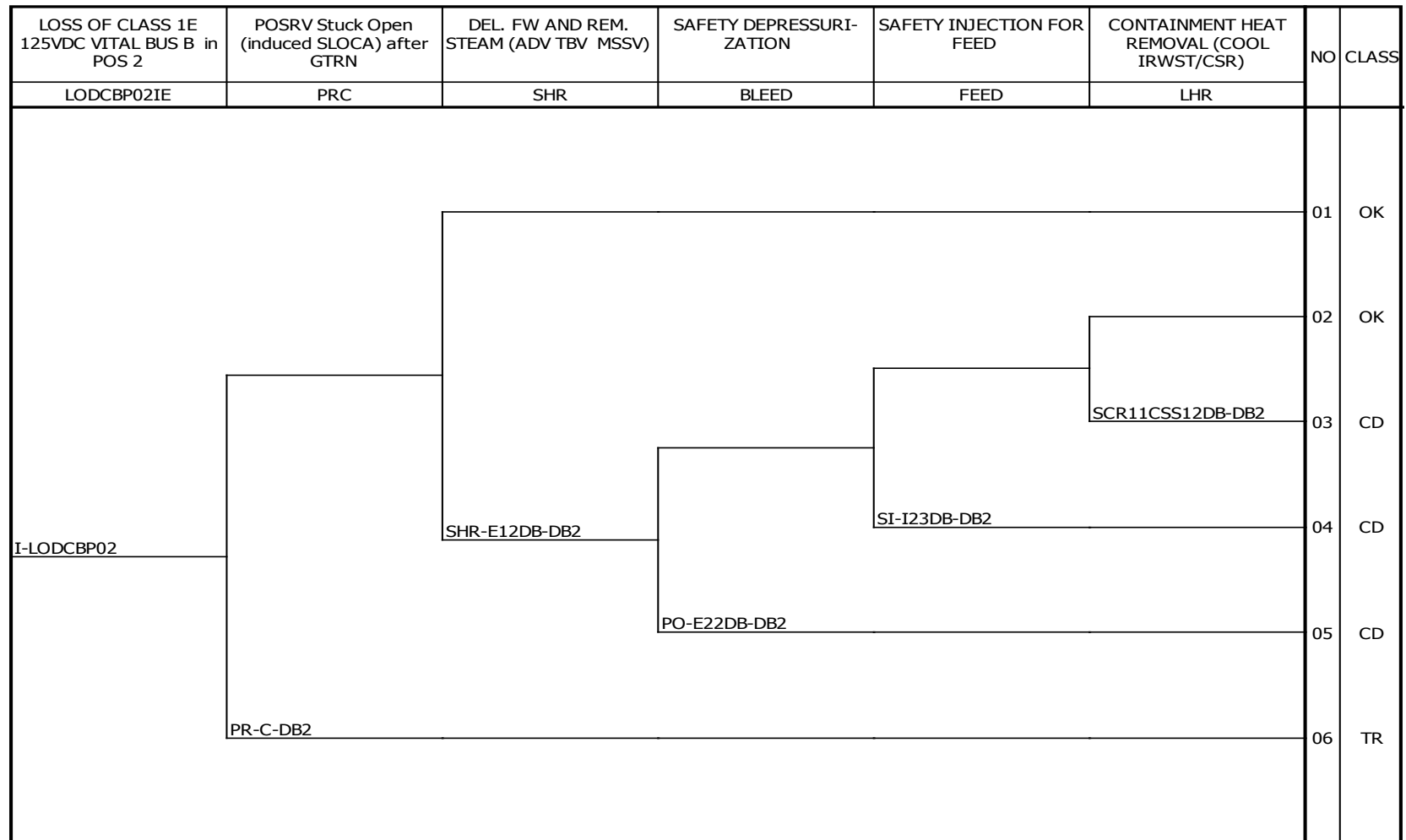


Figure 19.1-74 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel B (DCB) in POS 2

APR1400 DCD TIER 2

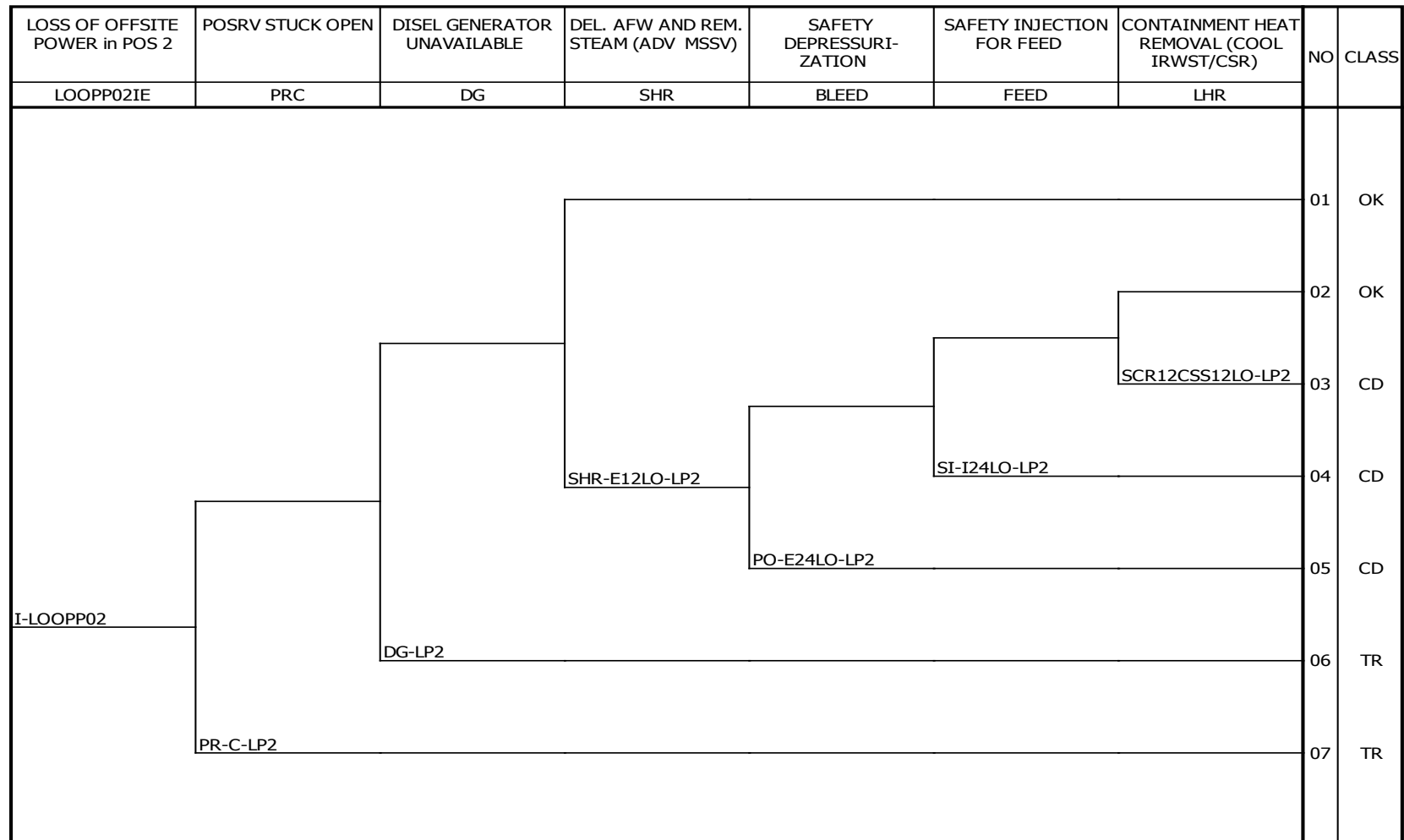


Figure 19.1-75 LPSD Level 1 Event Tree – Loss of Offsite Power (LP) in POS 2

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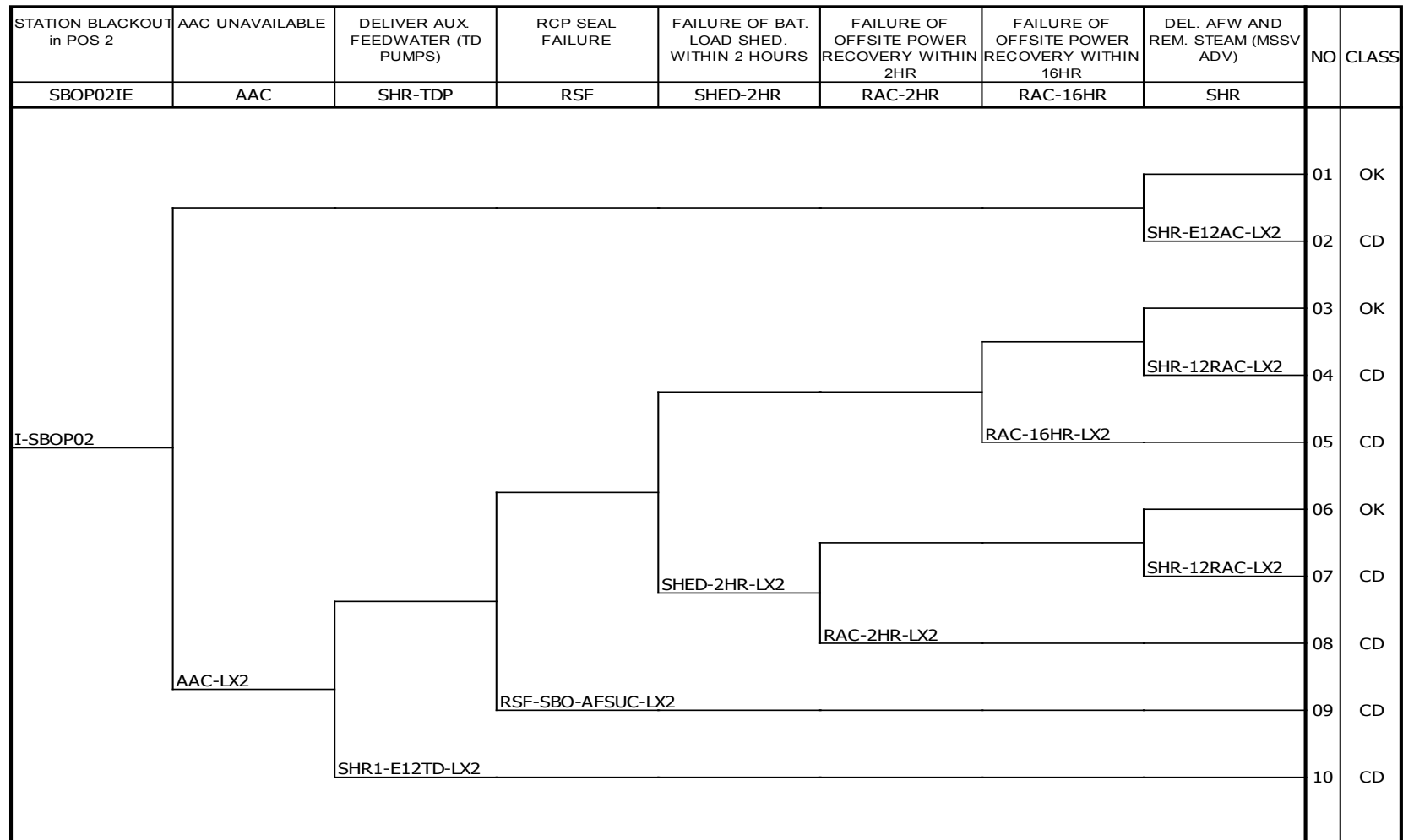


Figure 19.1-76 LPSD Level 1 Event Tree – Station Blackout (LX) in POS 2

APR1400 DCD TIER 2

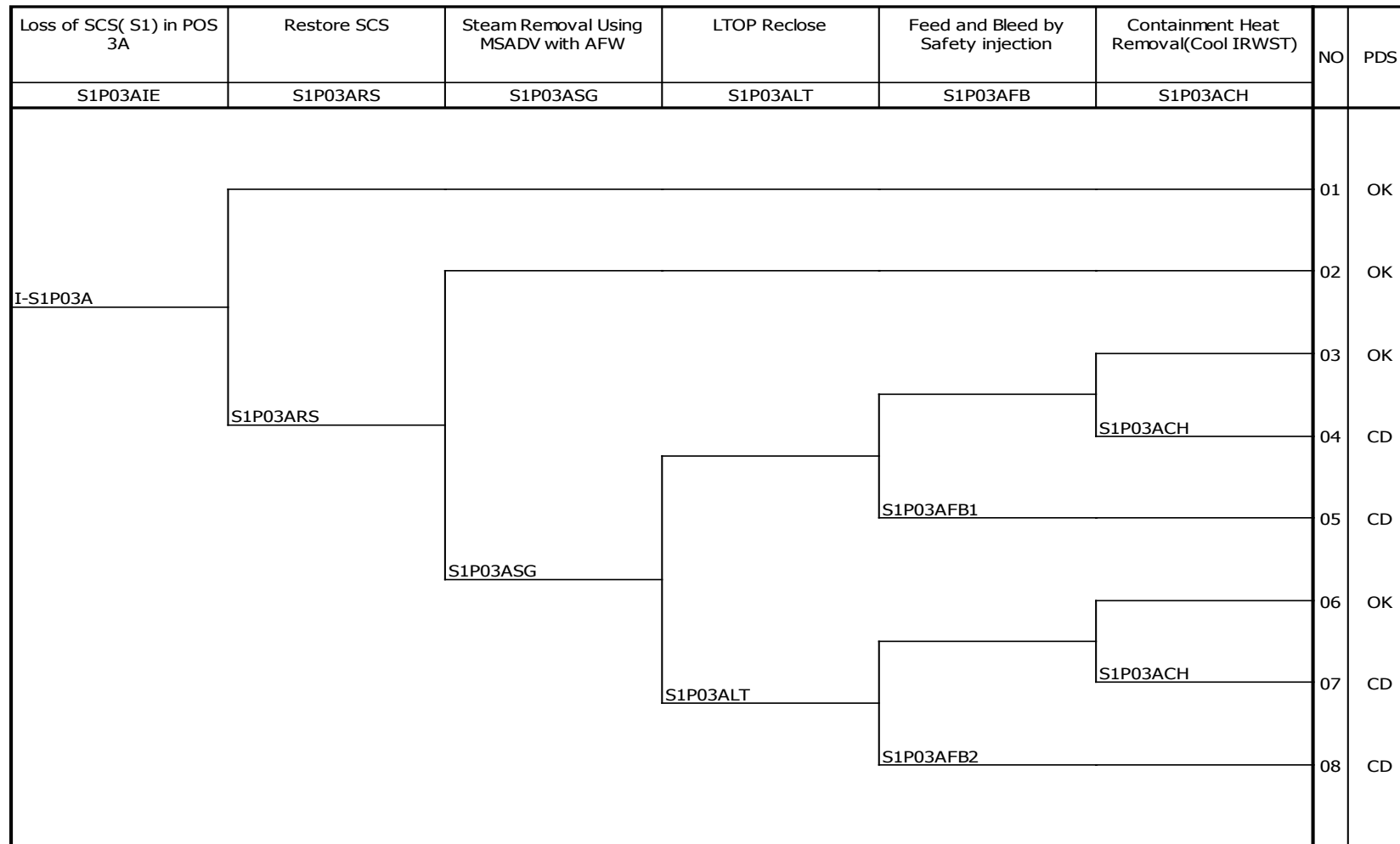


Figure 19.1-77 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 3A

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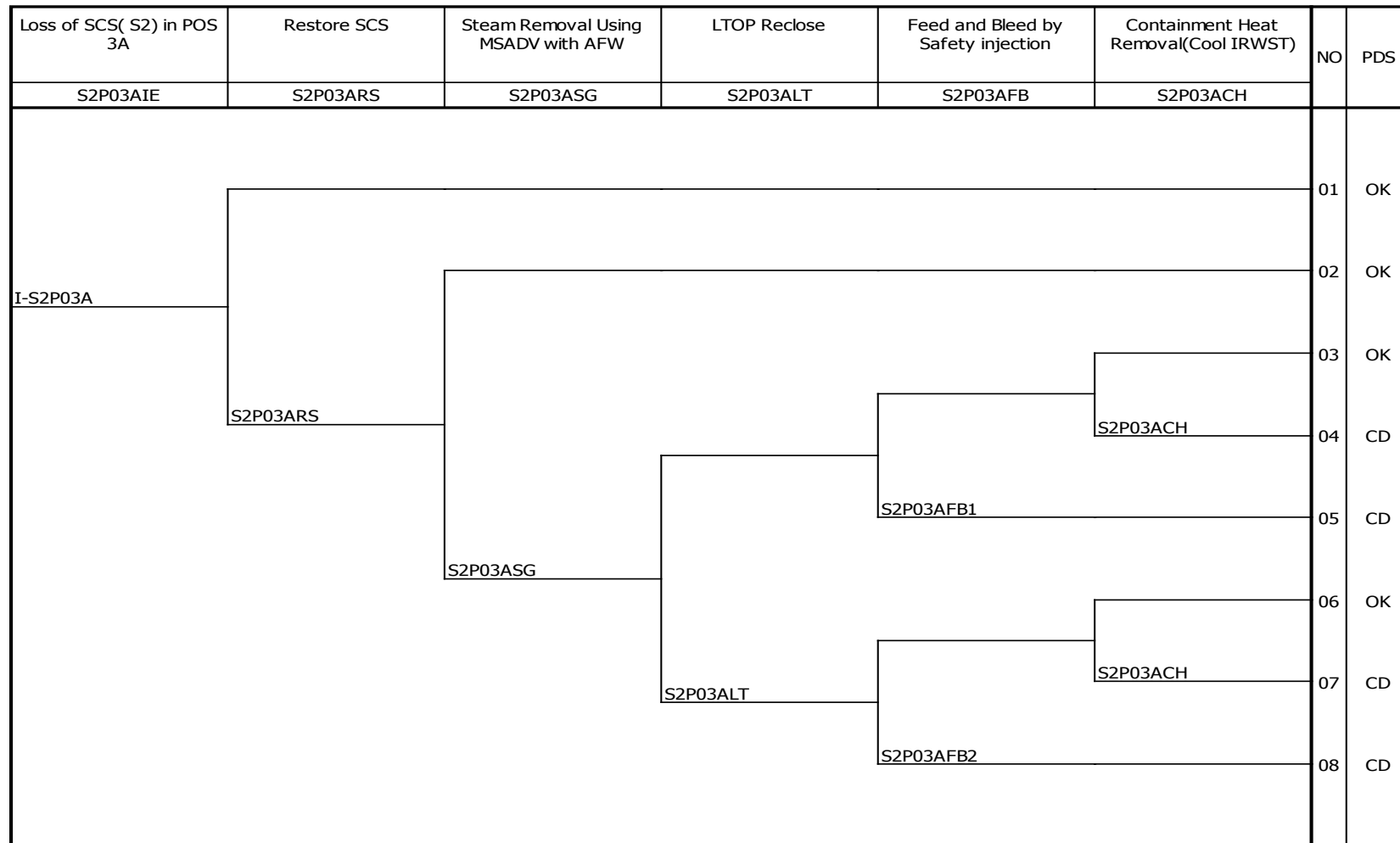


Figure 19.1-78 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 3A

APR1400 DCD TIER 2

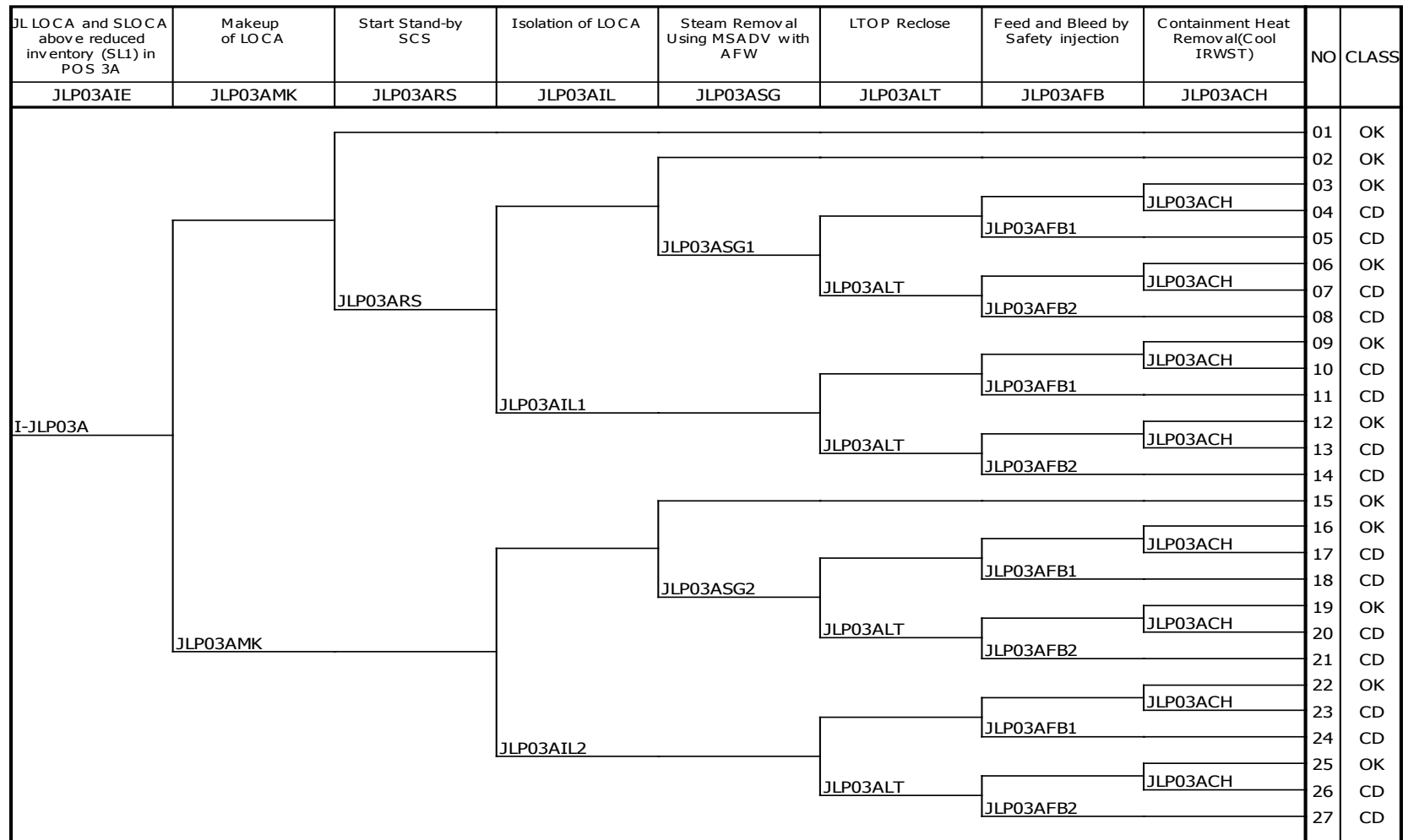


Figure 19.1-79 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 3A

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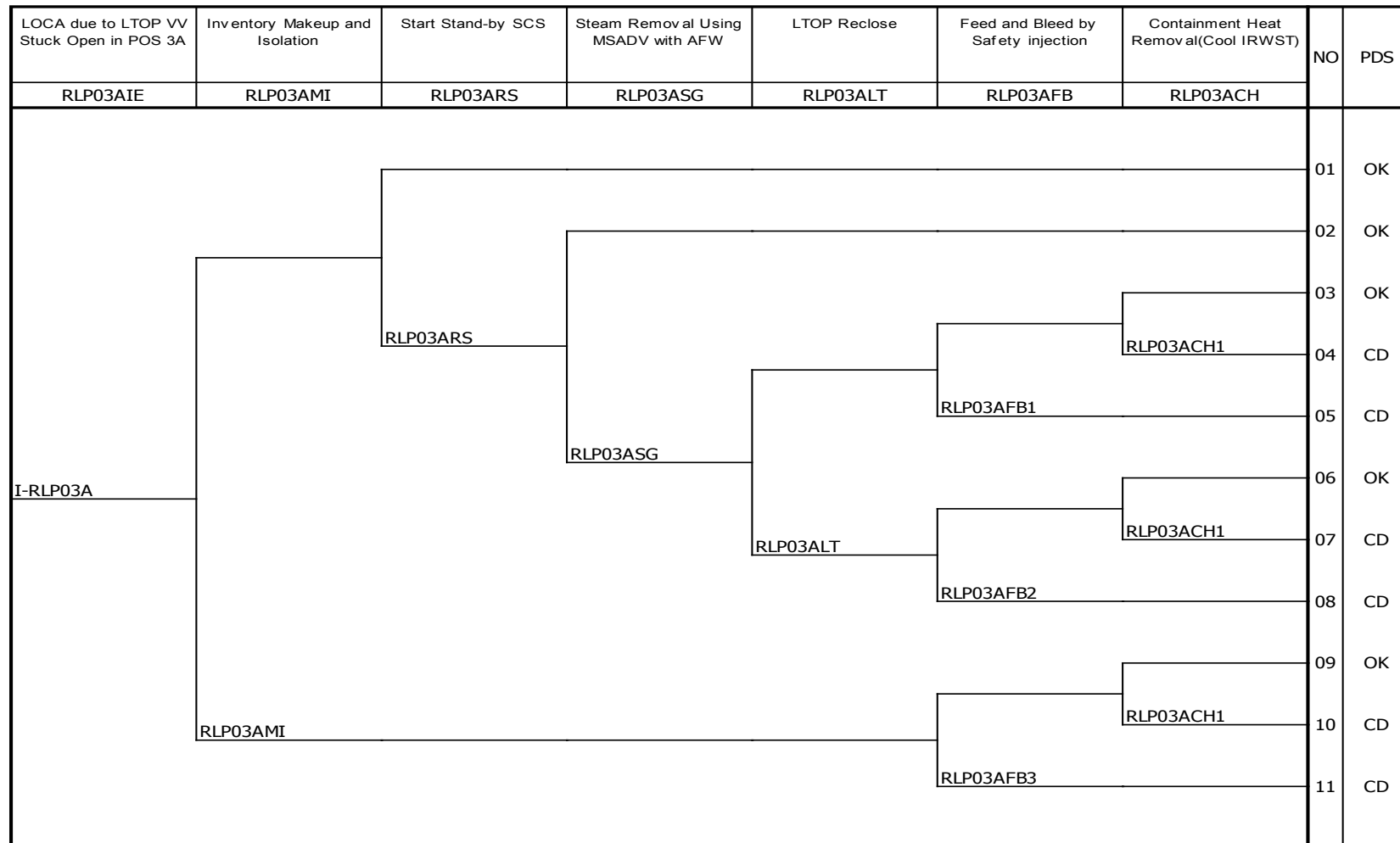


Figure 19.1-80 LPSD Level 1 Event Tree - LTOP Relief Valve Fails to Reclose (RL) in POS 3A

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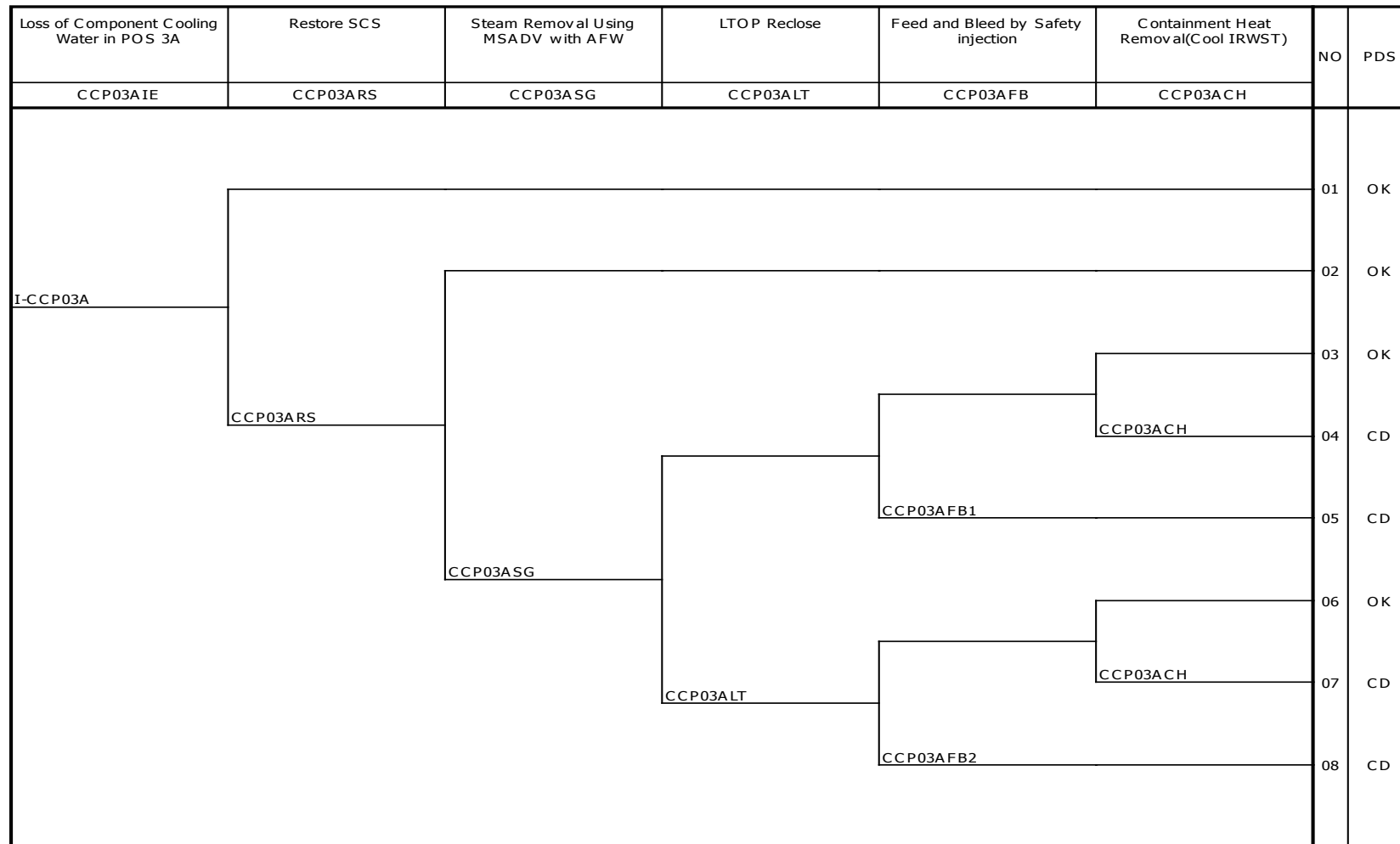


Figure 19.1-81 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 3A

APR1400 DCD TIER 2

Total Loss of Component Cooling Water in POS 3A		NO	PDS
TCP03AIE			
I-TCP03A			
		01	CD

Figure 19.1-82 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 3A 1

APR1400 DCD TIER 2

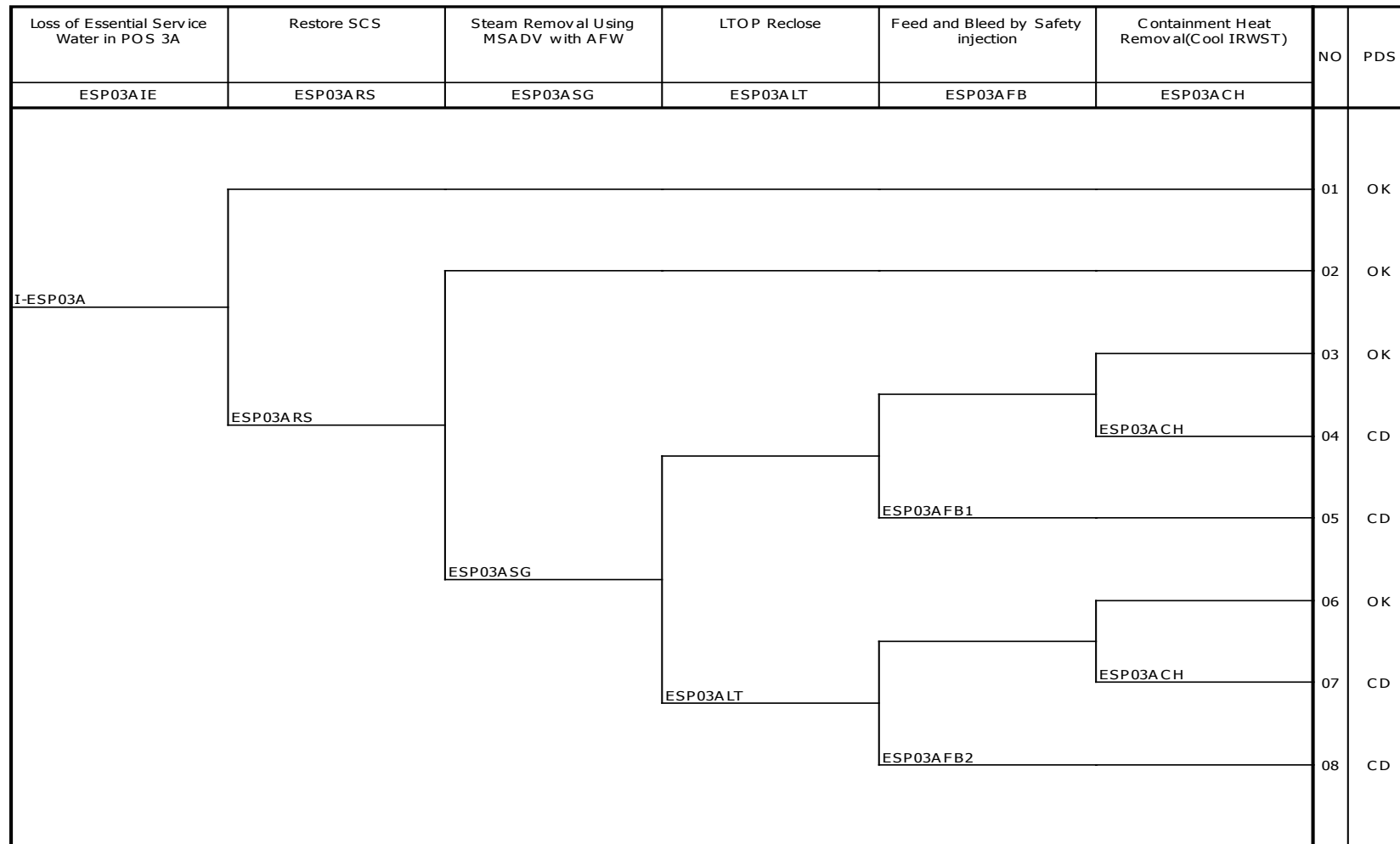


Figure 19.1-83 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 3A

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 3A		NO	PDS
TSP03AIE			
I-TSP03A		01	CD

Figure 19.1-84 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 3A

APR1400 DCD TIER 2

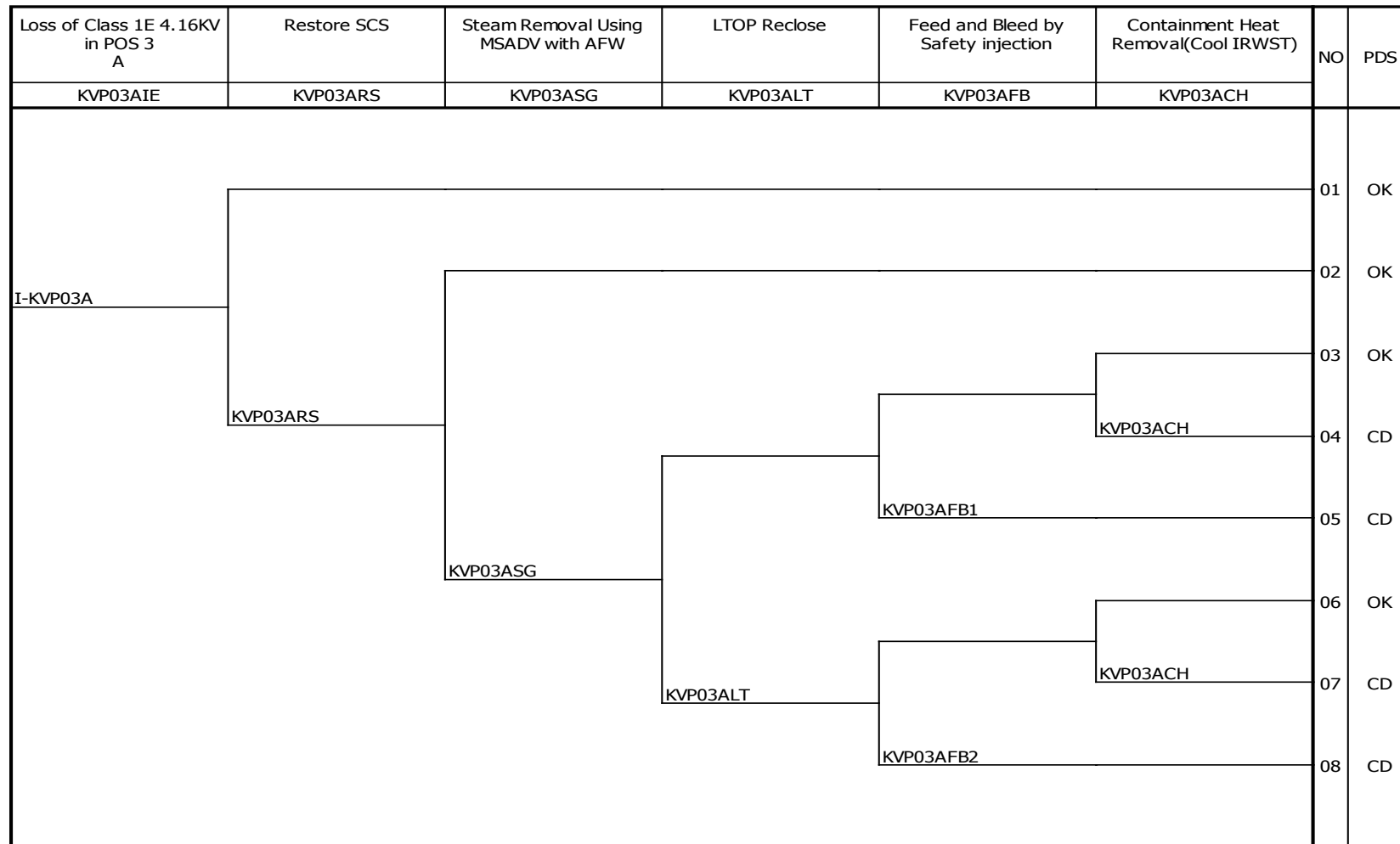


Figure 19.1-85 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 3A

APR1400 DCD TIER 2

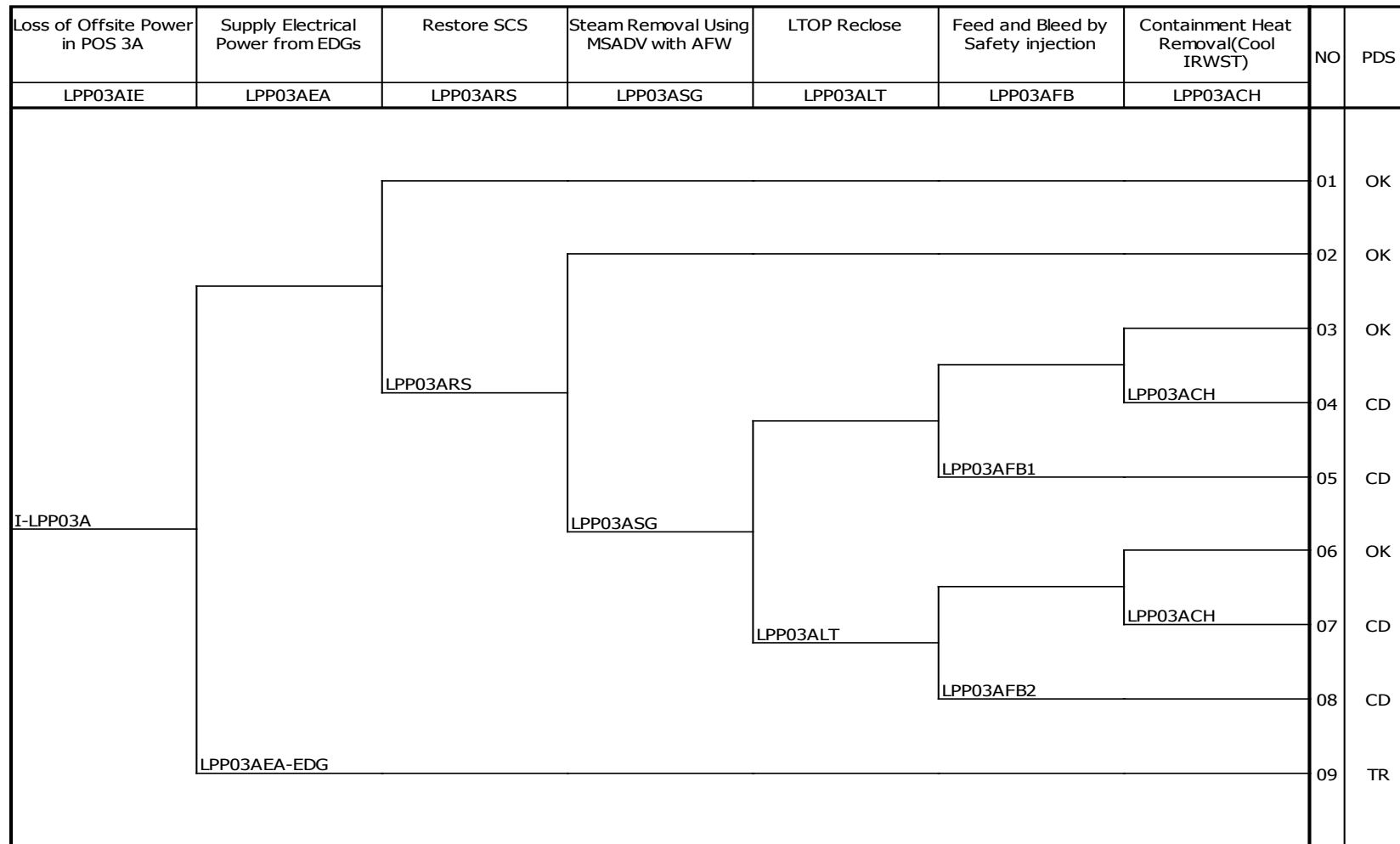
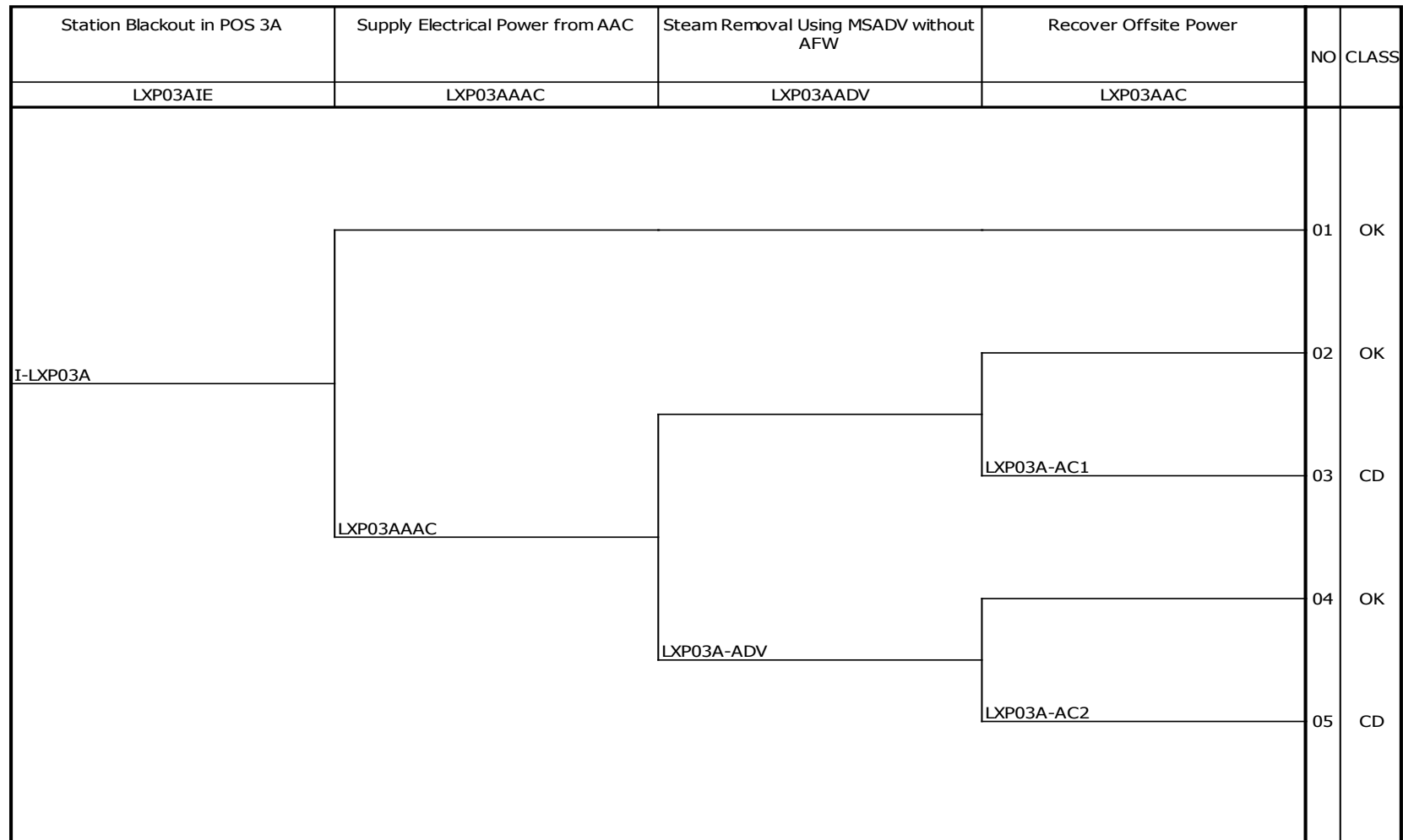


Figure 19.1-86 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 3A

APR1400 DCD TIER 2**Figure 19.1-87 LPSD Level 1 Event Tree - Statation Blackout (LX) in POS 3A**

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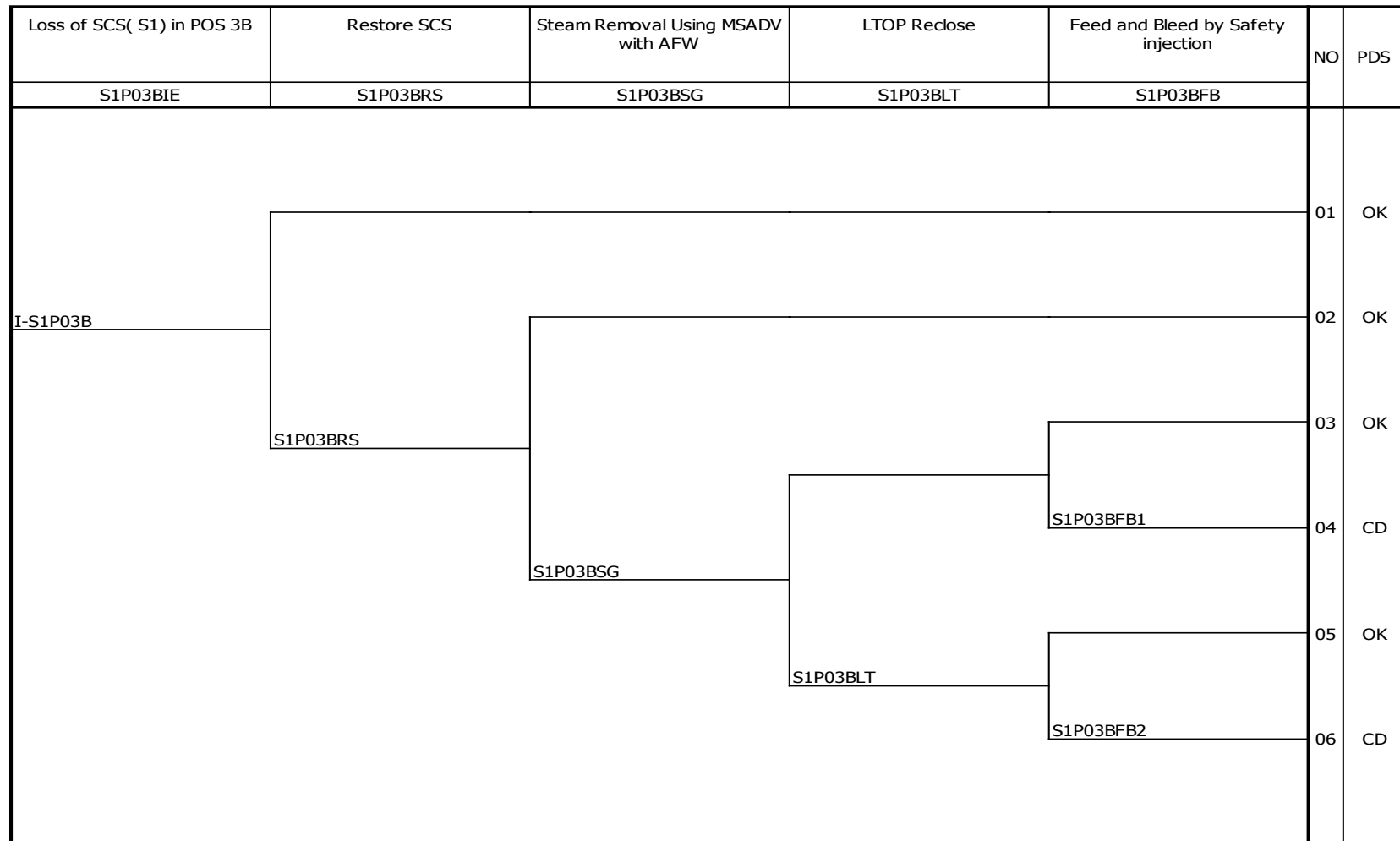


Figure 19.1-88 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 3B

APR1400 DCD TIER 2

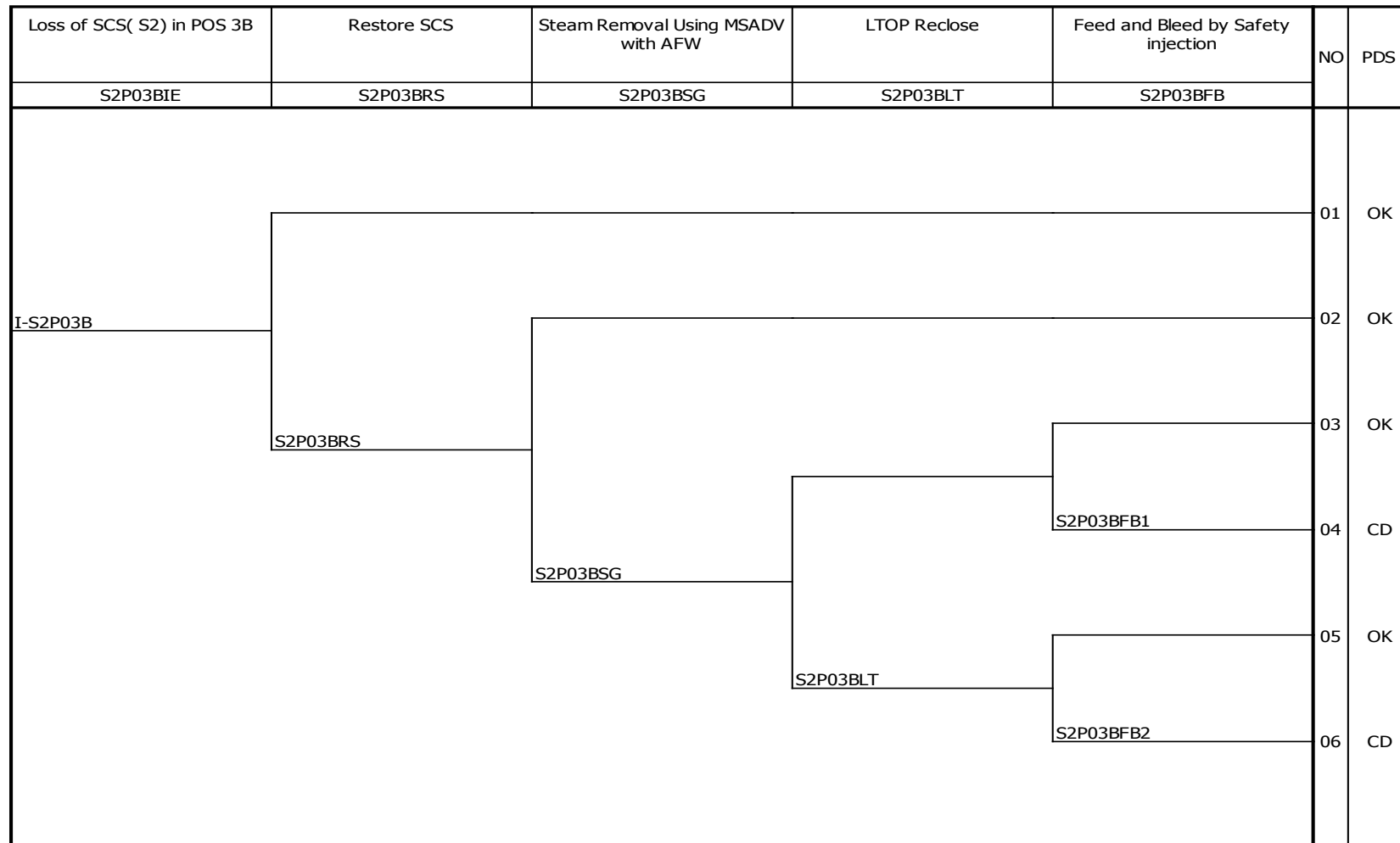


Figure 19.1-89 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 3B

APR1400 DCD TIER 2

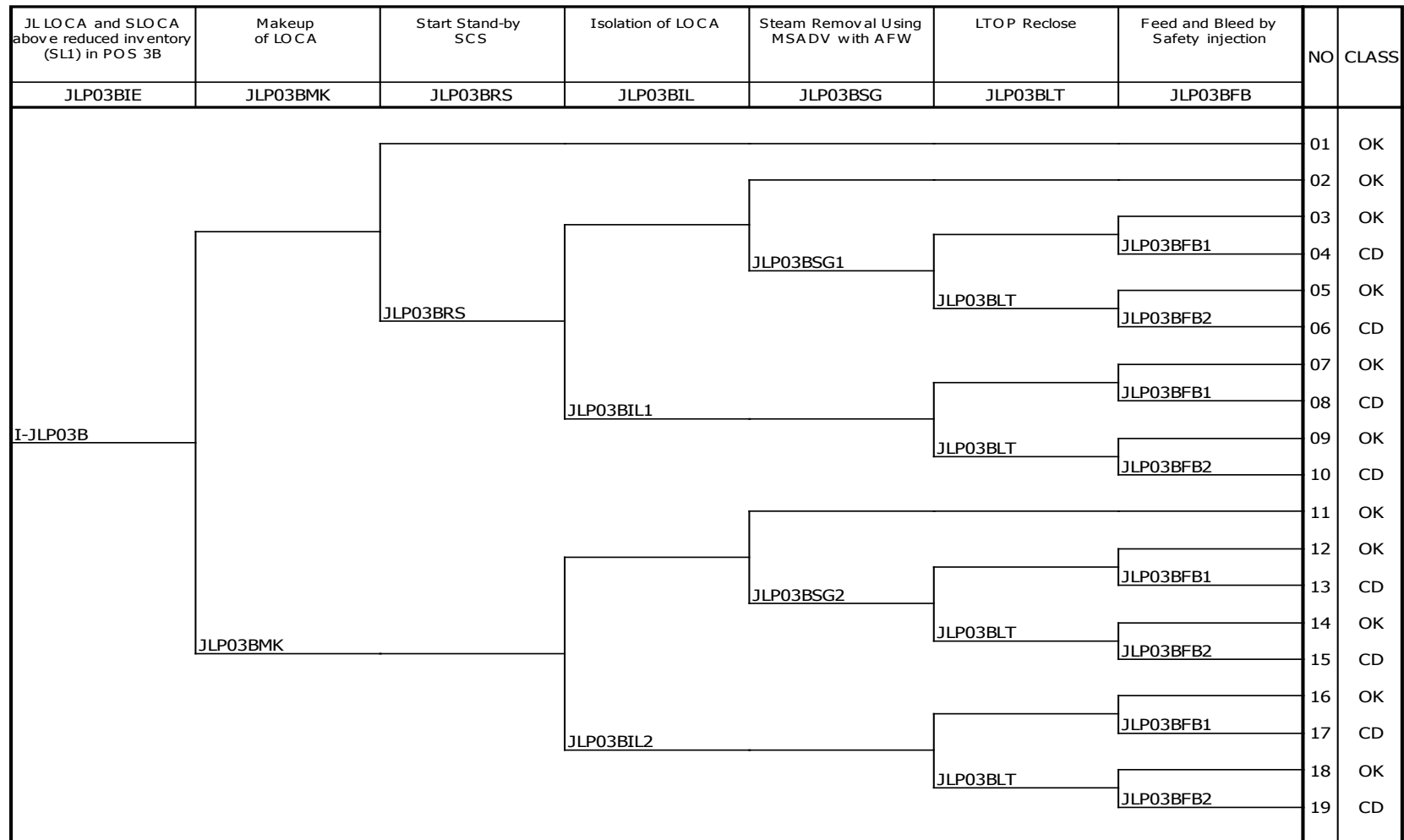


Figure 19.1-90 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 3B

APR1400 DCD TIER 2

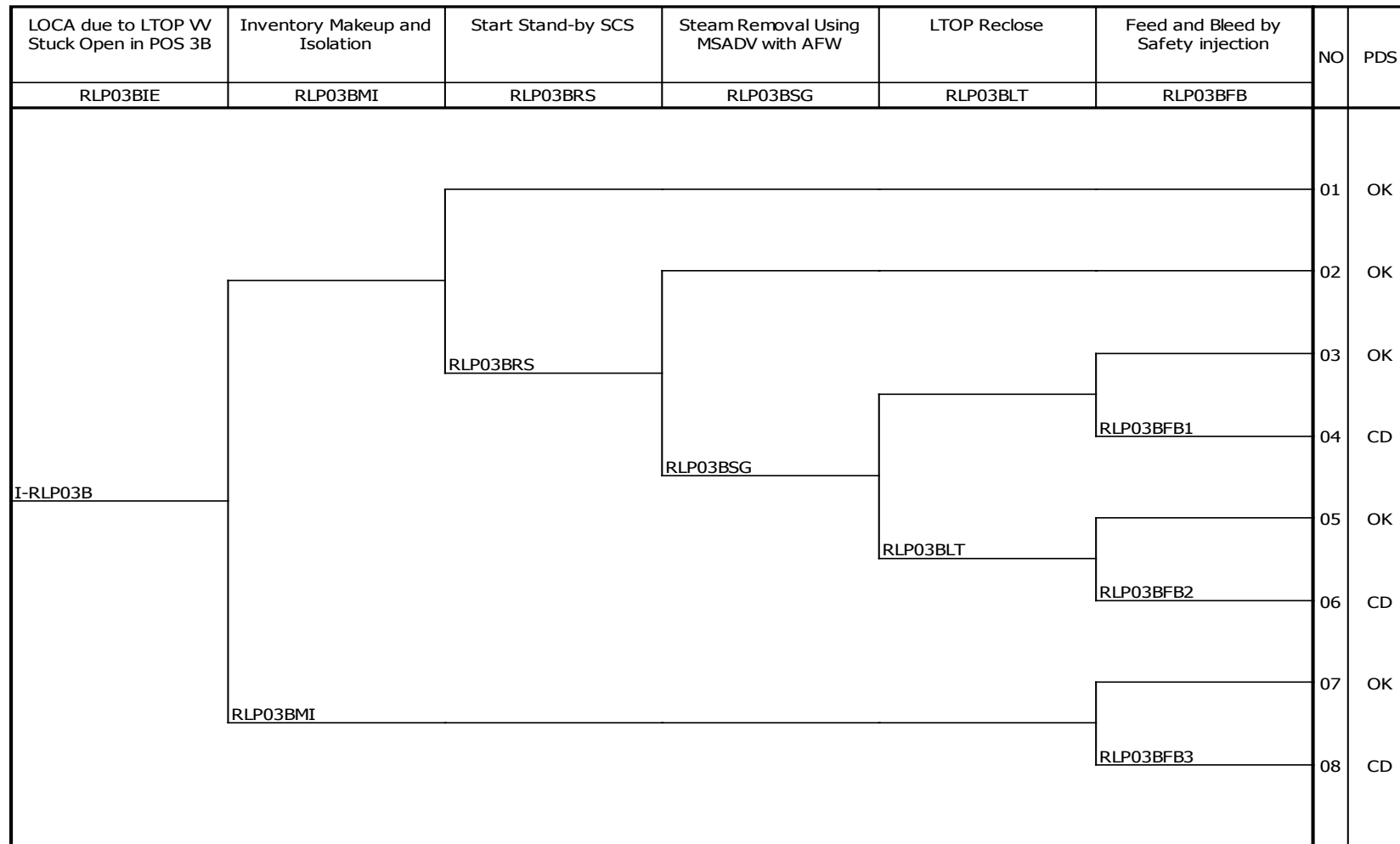


Figure 19.1-91 LPSD Level 1 Event Tree - LTOP Relief Valve Fails to Reclose (RL) in POS 3B

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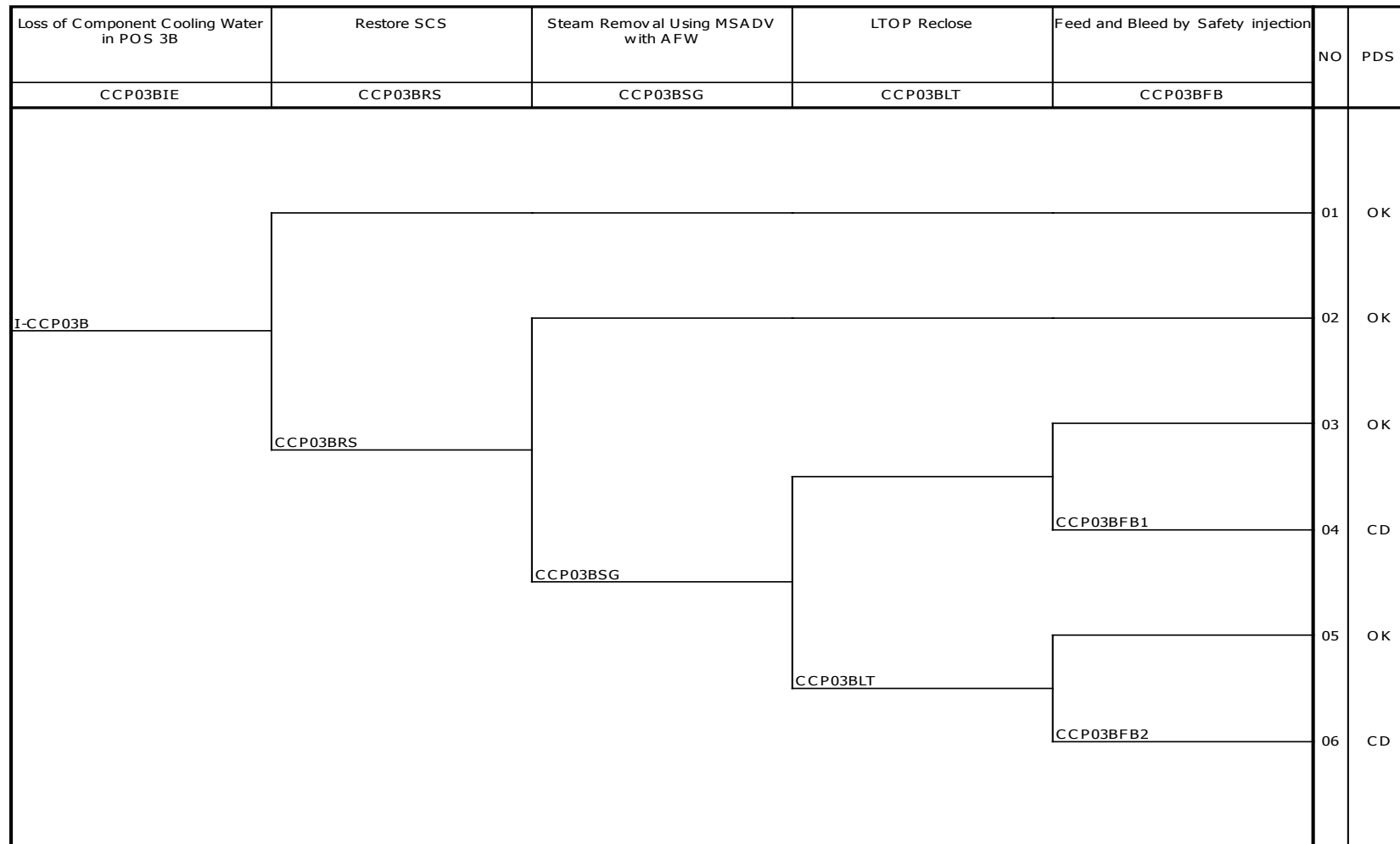
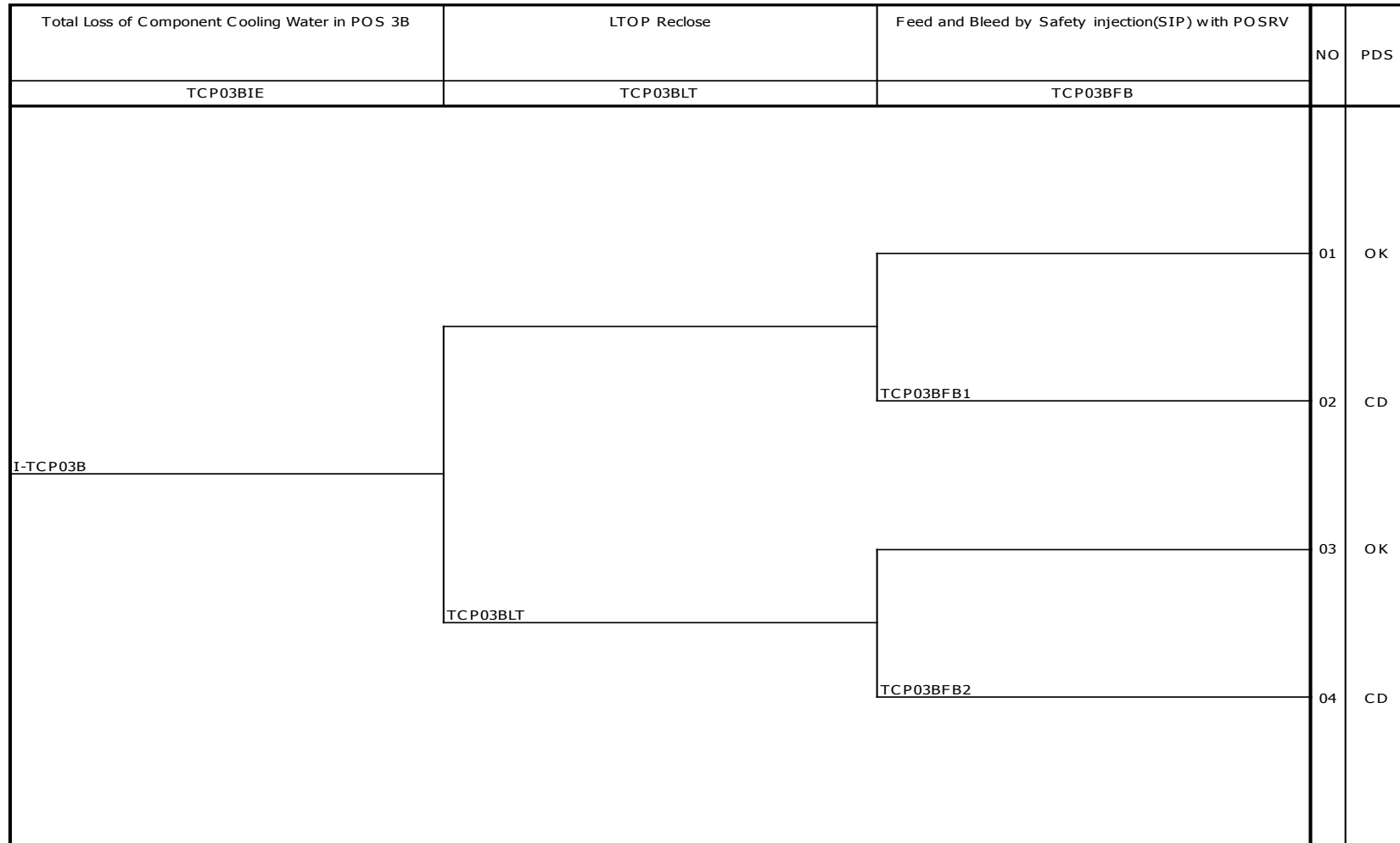


Figure 19.1-92 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 3B

APR1400 DCD TIER 2**Figure 19.1-93 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 3B**

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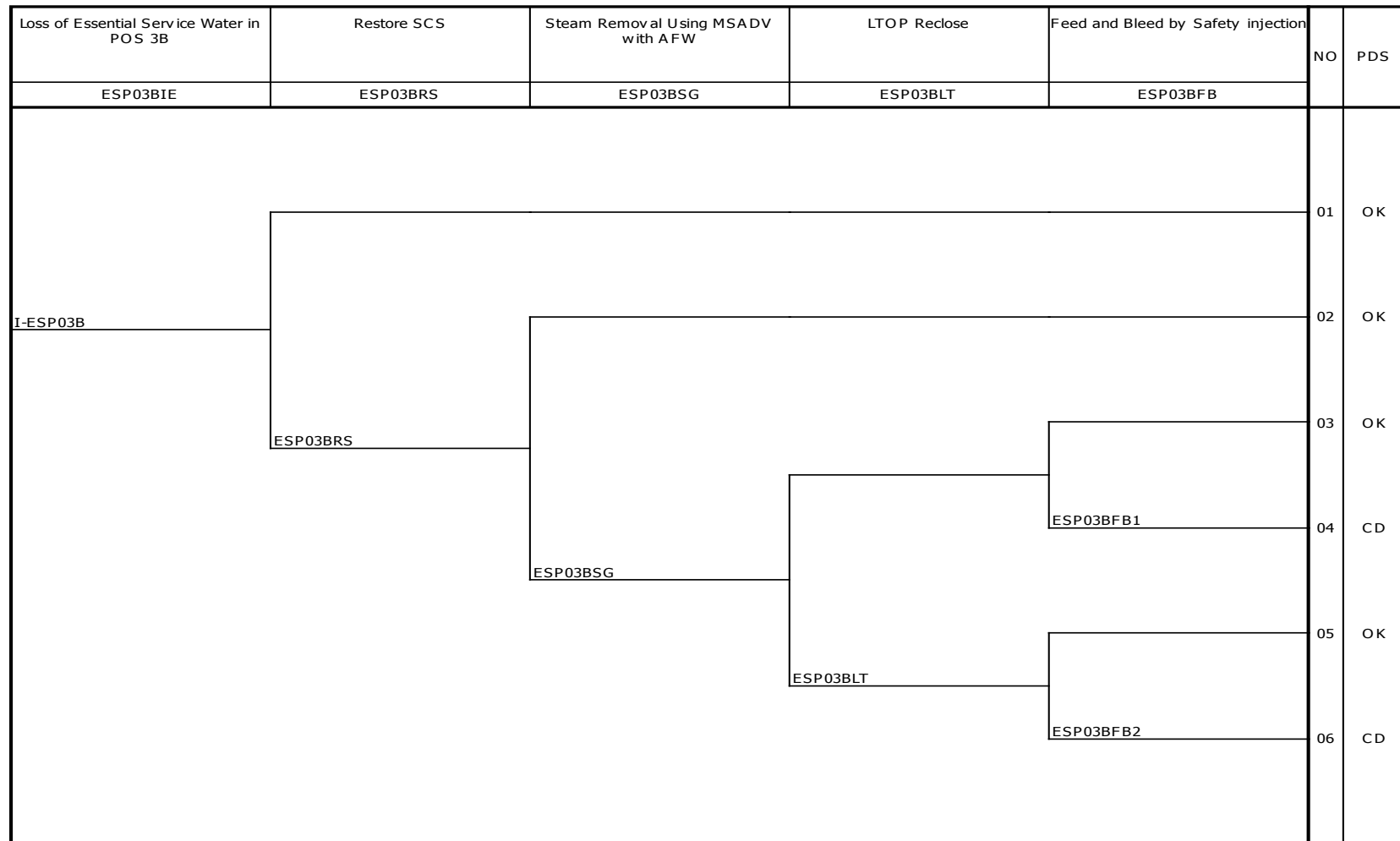
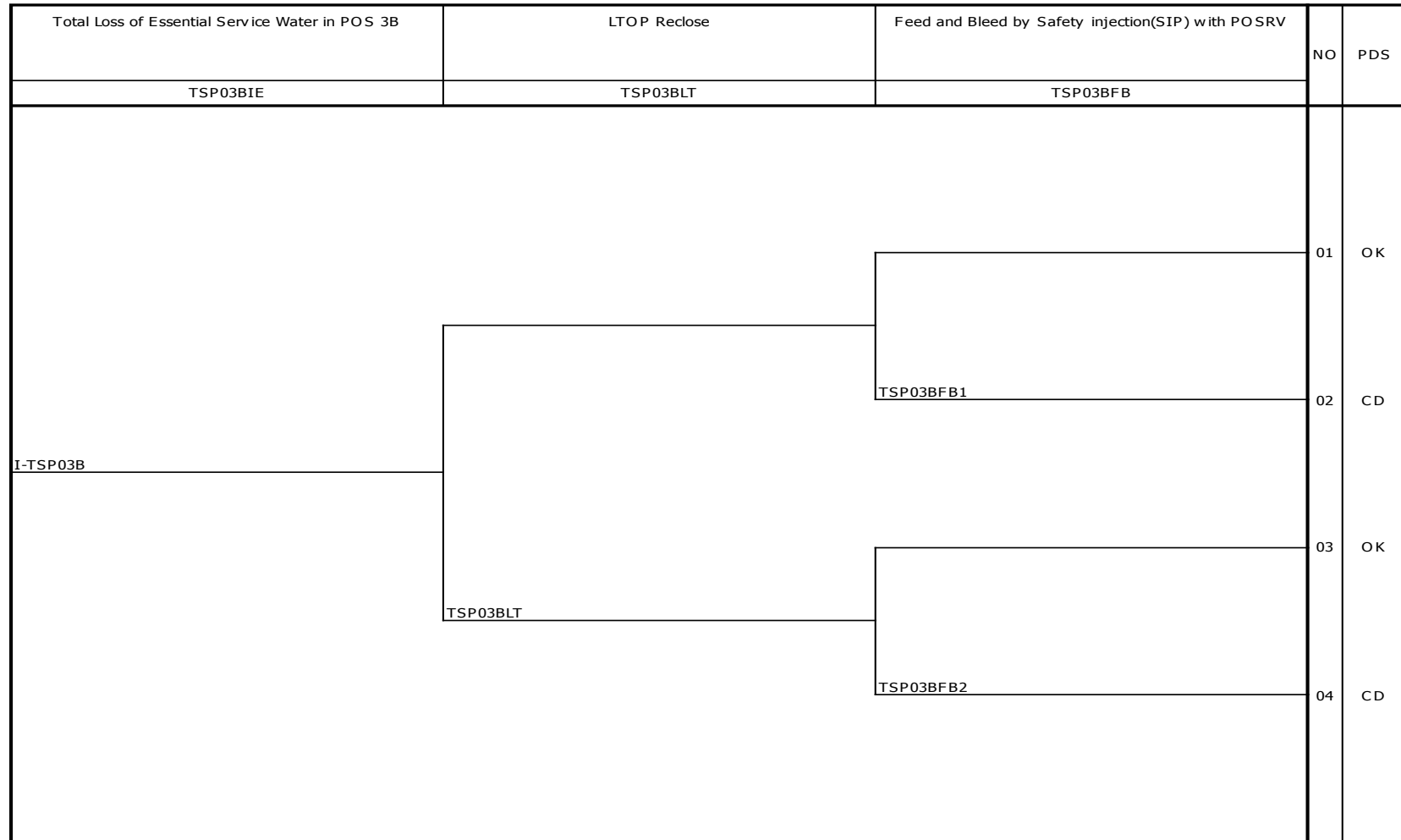


Figure 19.1-94 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 3B

APR1400 DCD TIER 2**Figure 19.1-95 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 3B**

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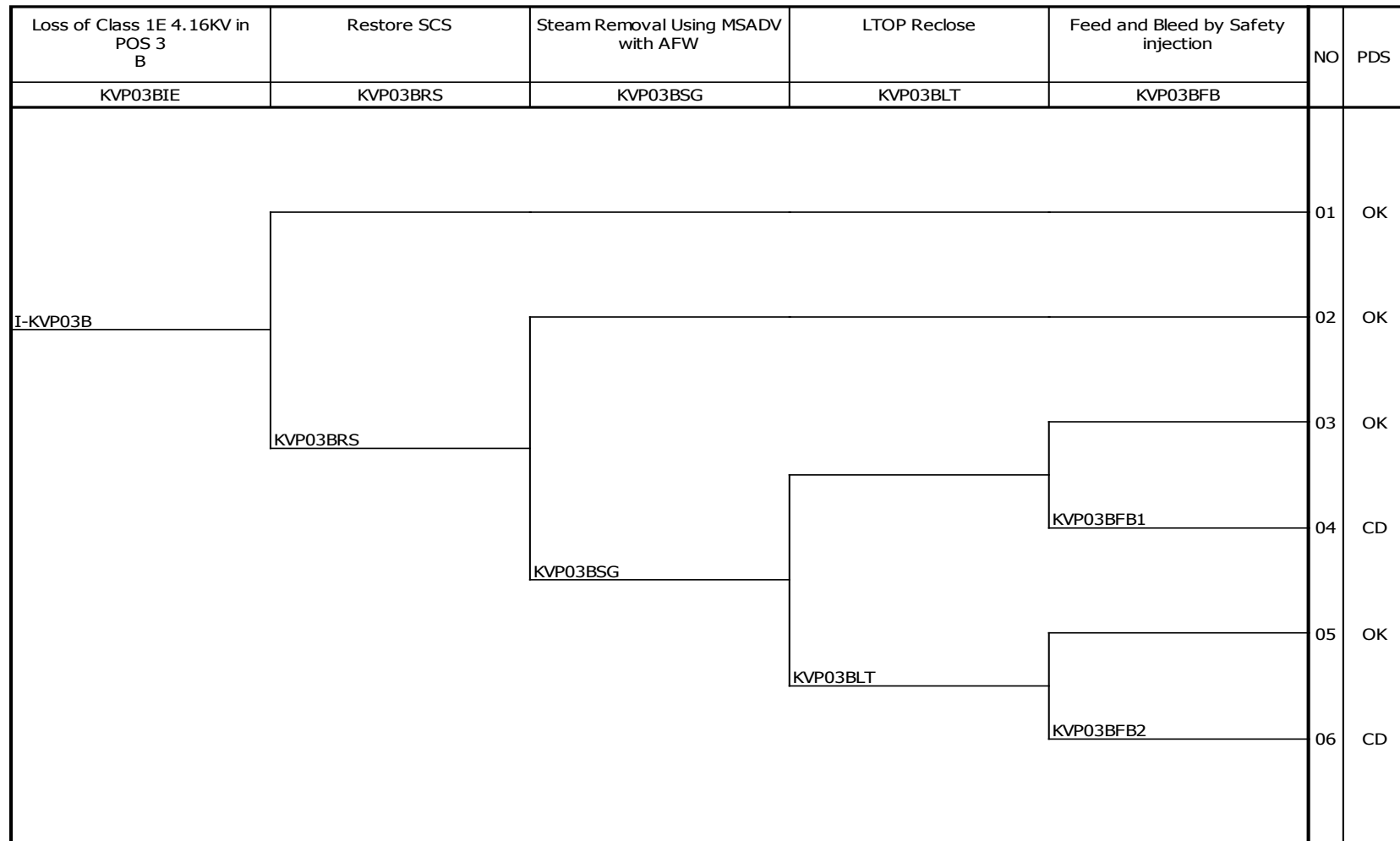


Figure 19.1-96 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 3B

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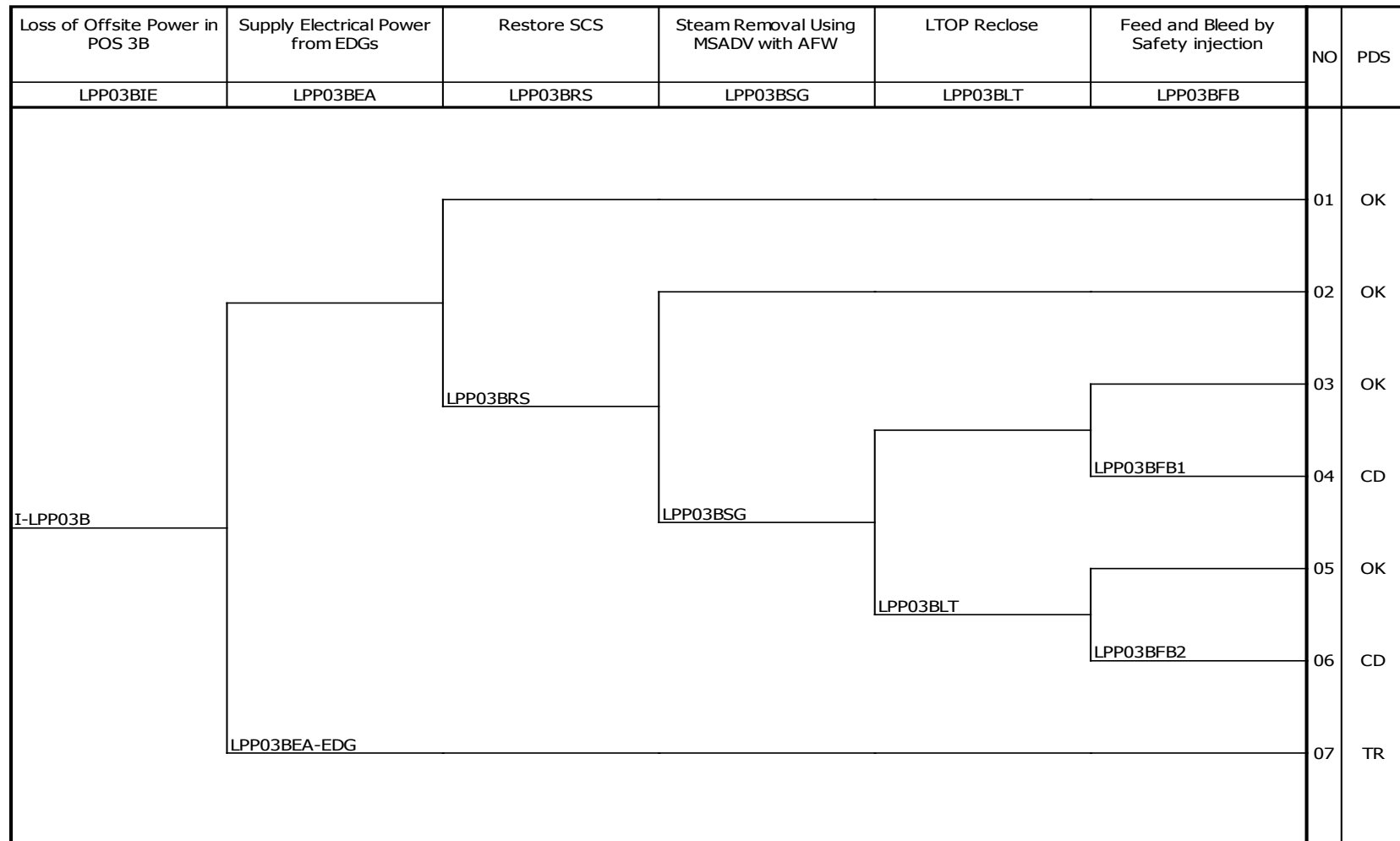
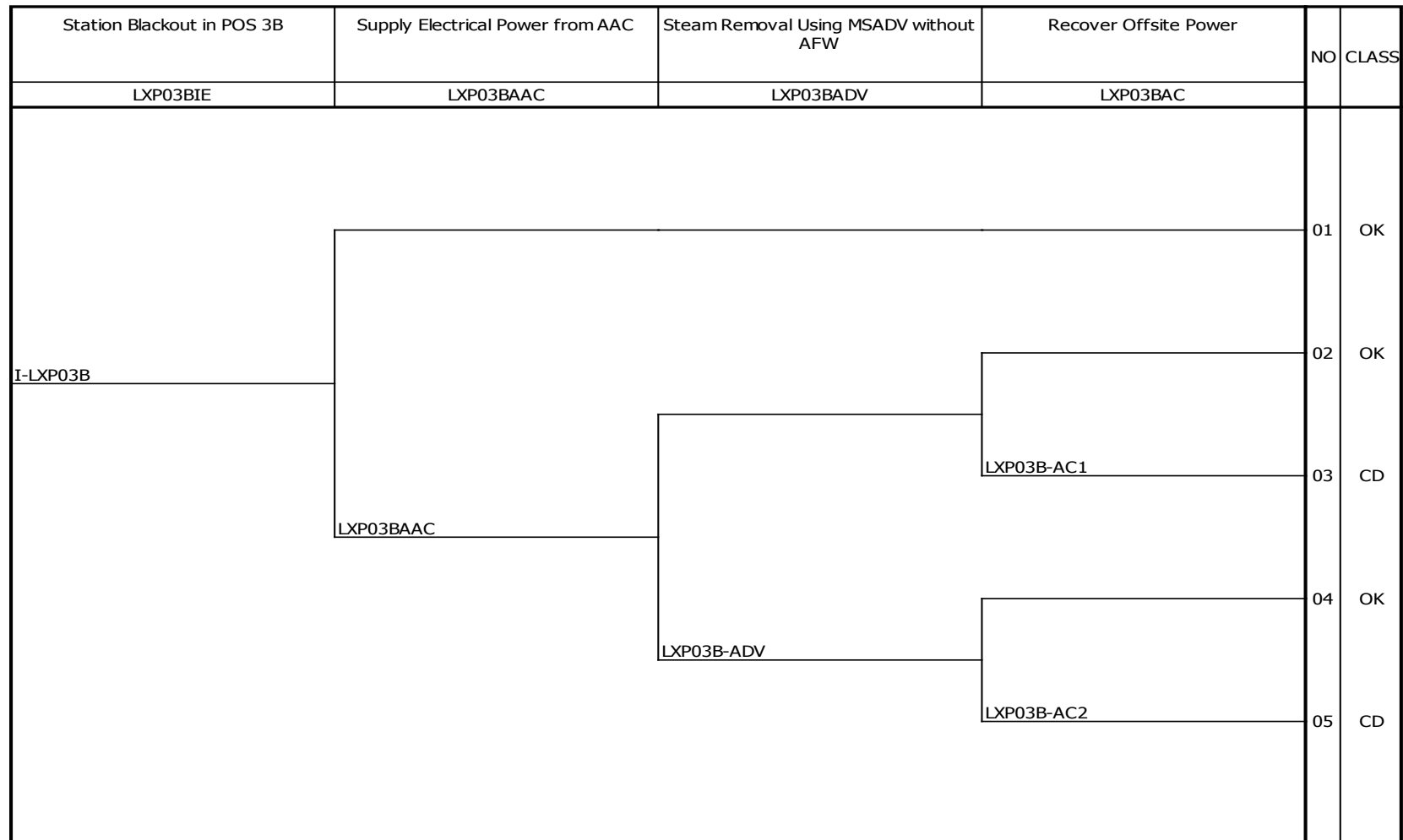


Figure 19.1-97 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 3B

APR1400 DCD TIER 2**Figure 19.1-98 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 3B**

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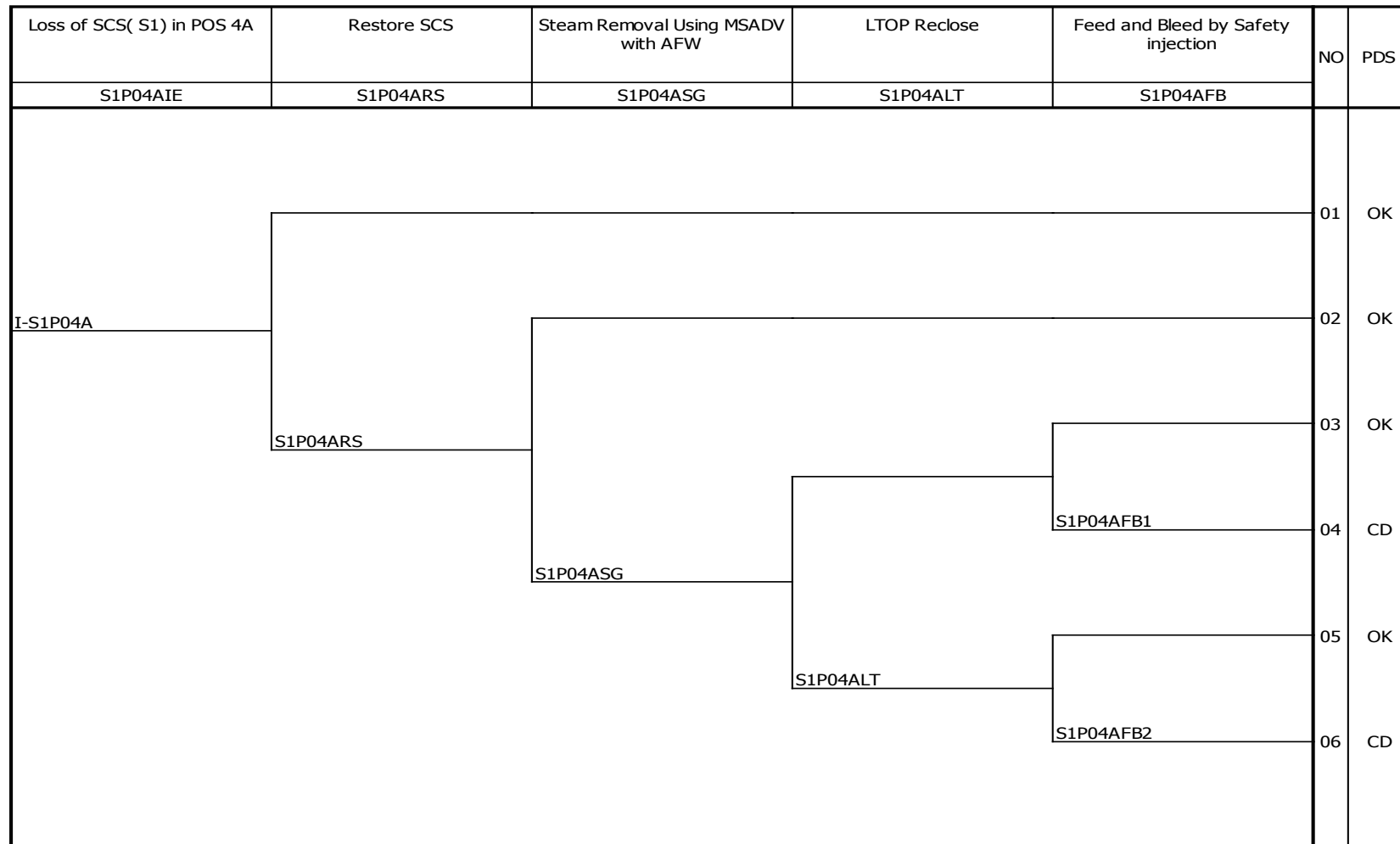


Figure 19.1-99 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 4A

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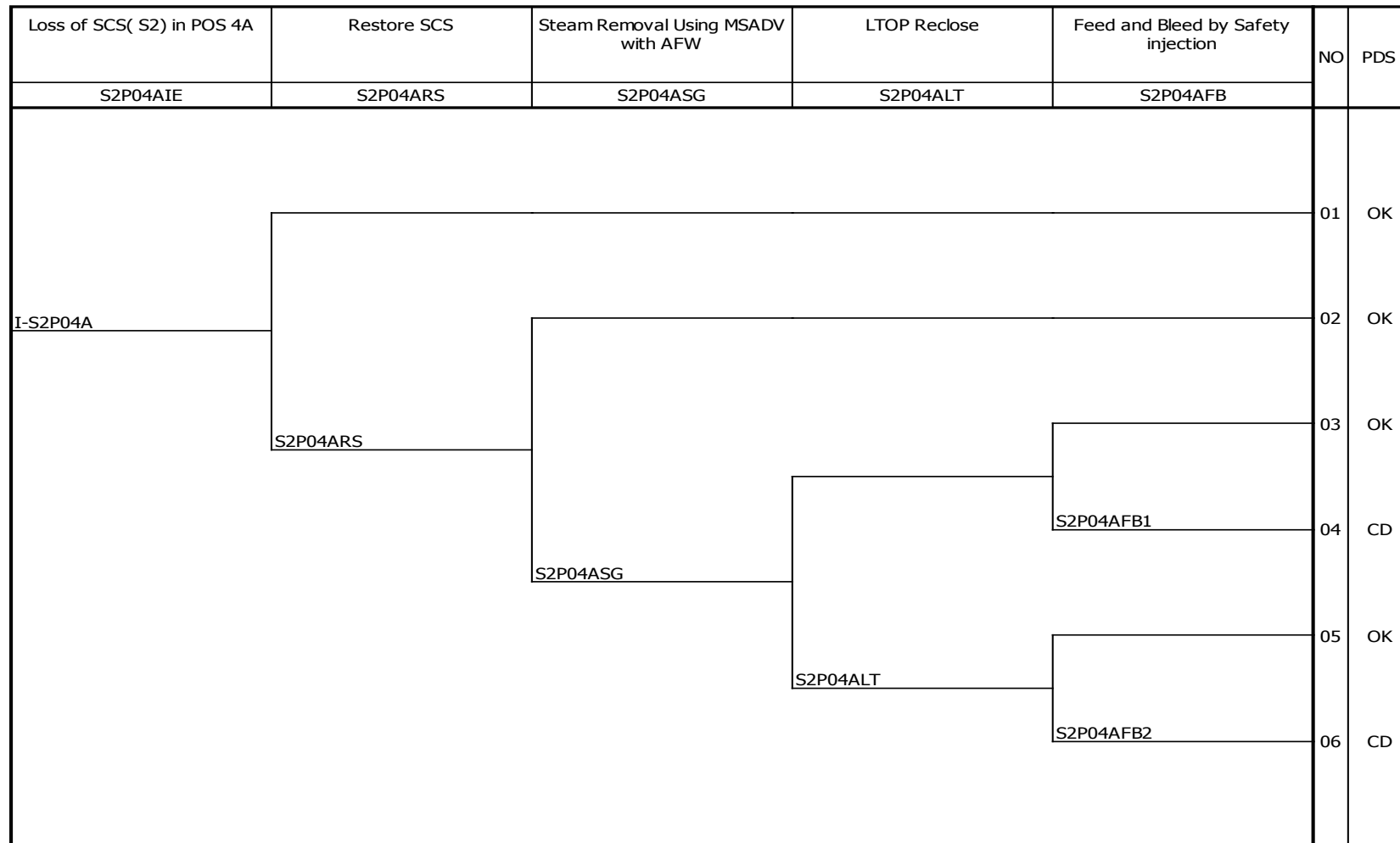


Figure 19.1-100 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 4A

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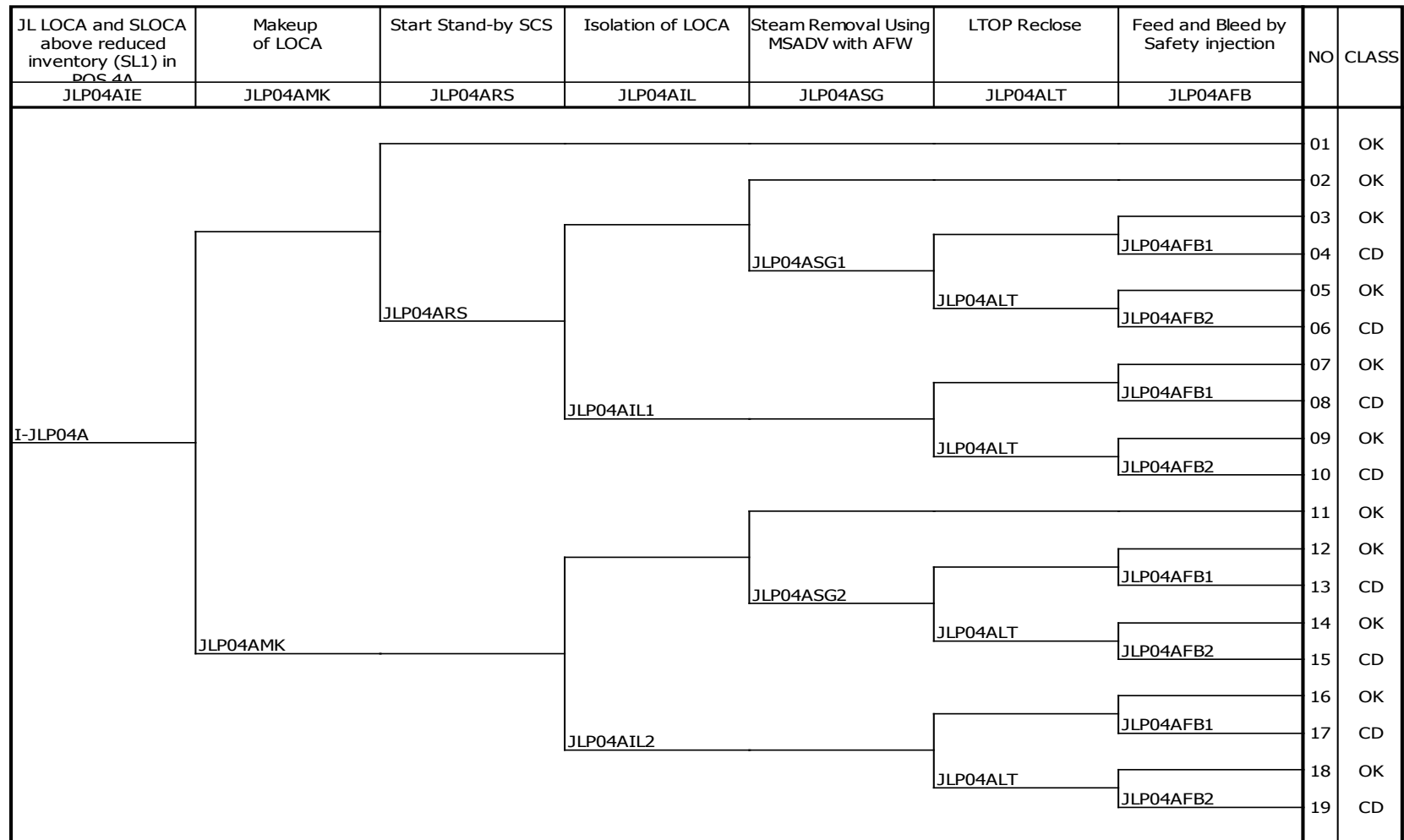


Figure 19.1-101 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 4A

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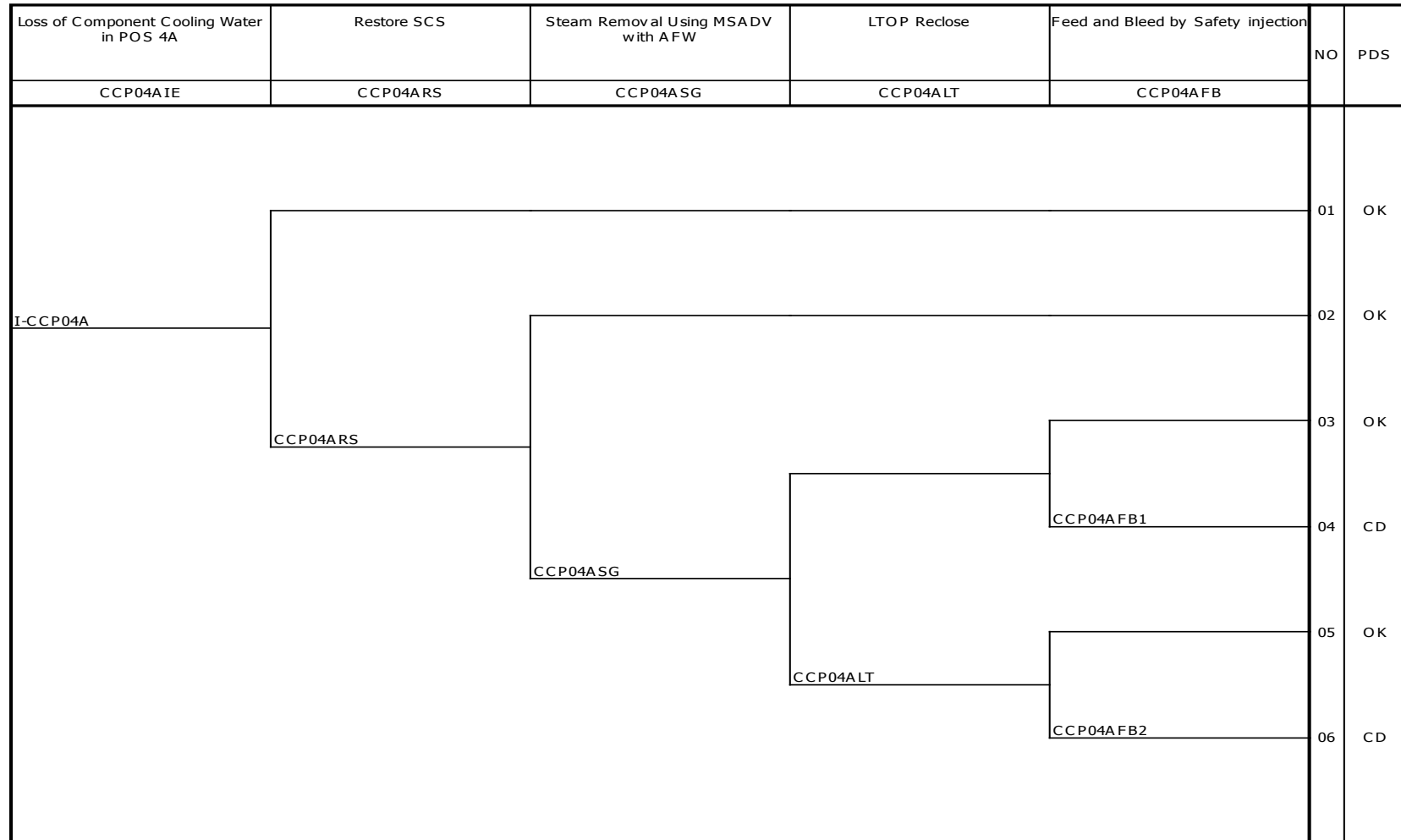
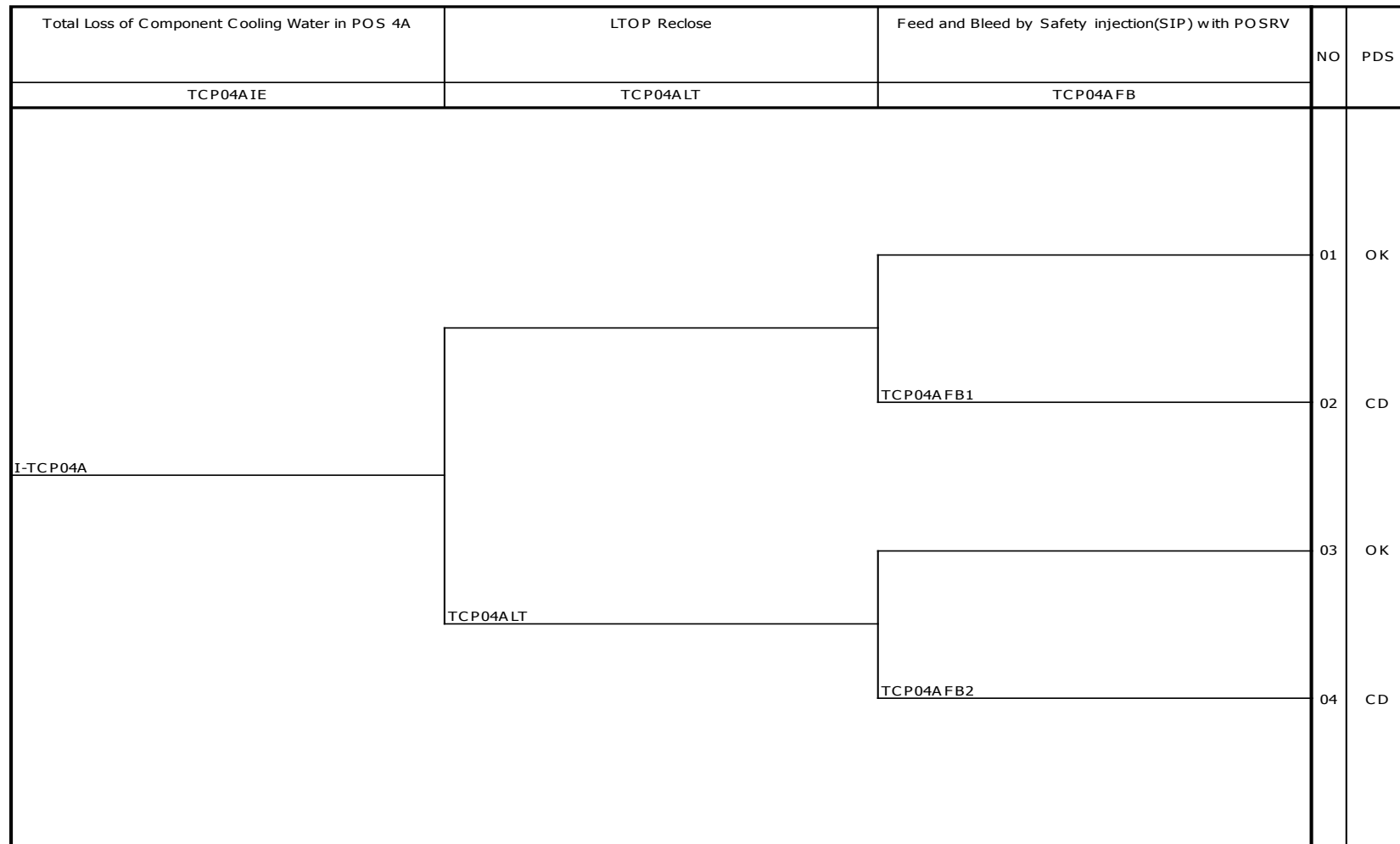


Figure 19.1-102 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 4A

APR1400 DCD TIER 2**Figure 19.1-103 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 4A**

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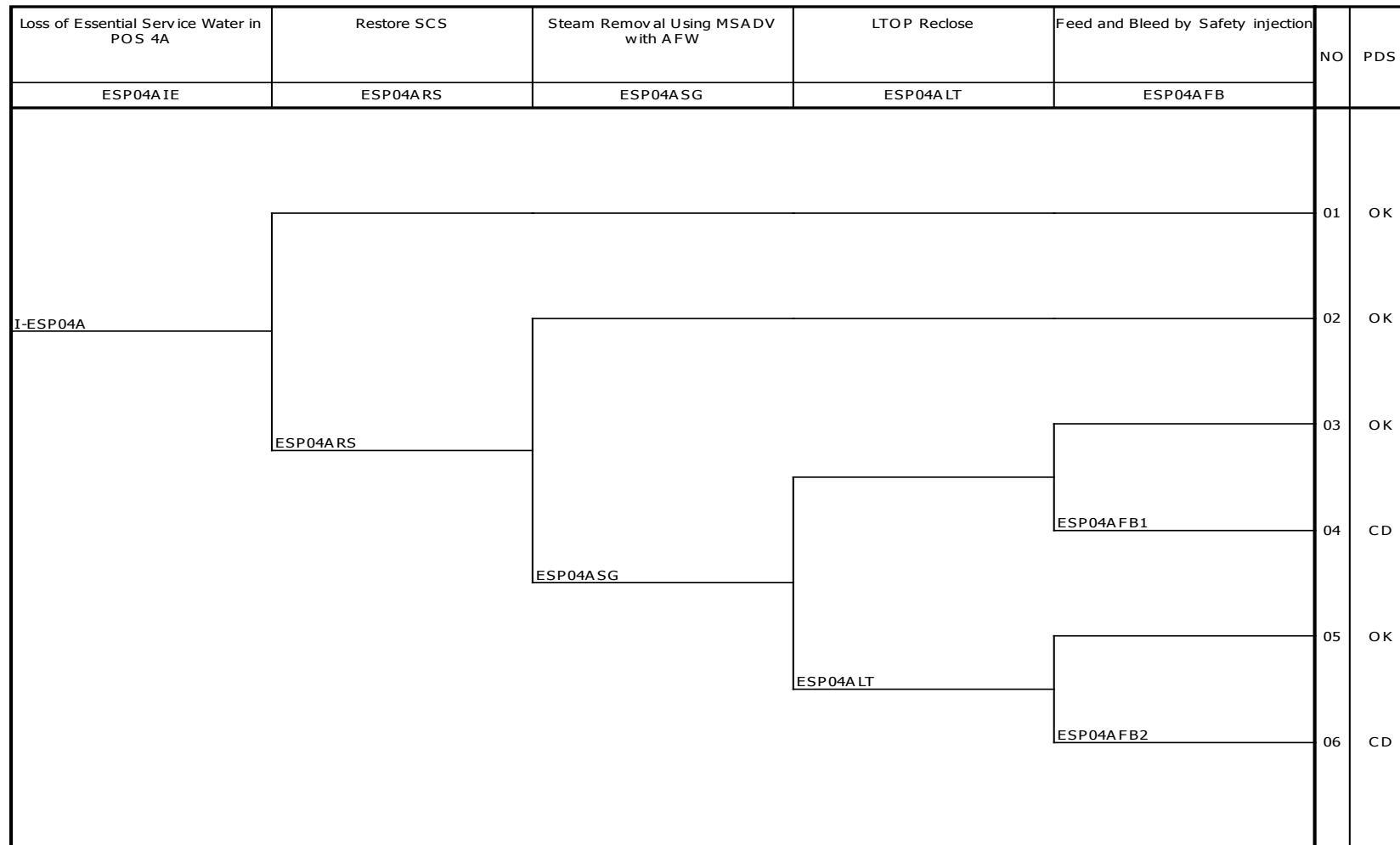


Figure 19.1-104 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 4A

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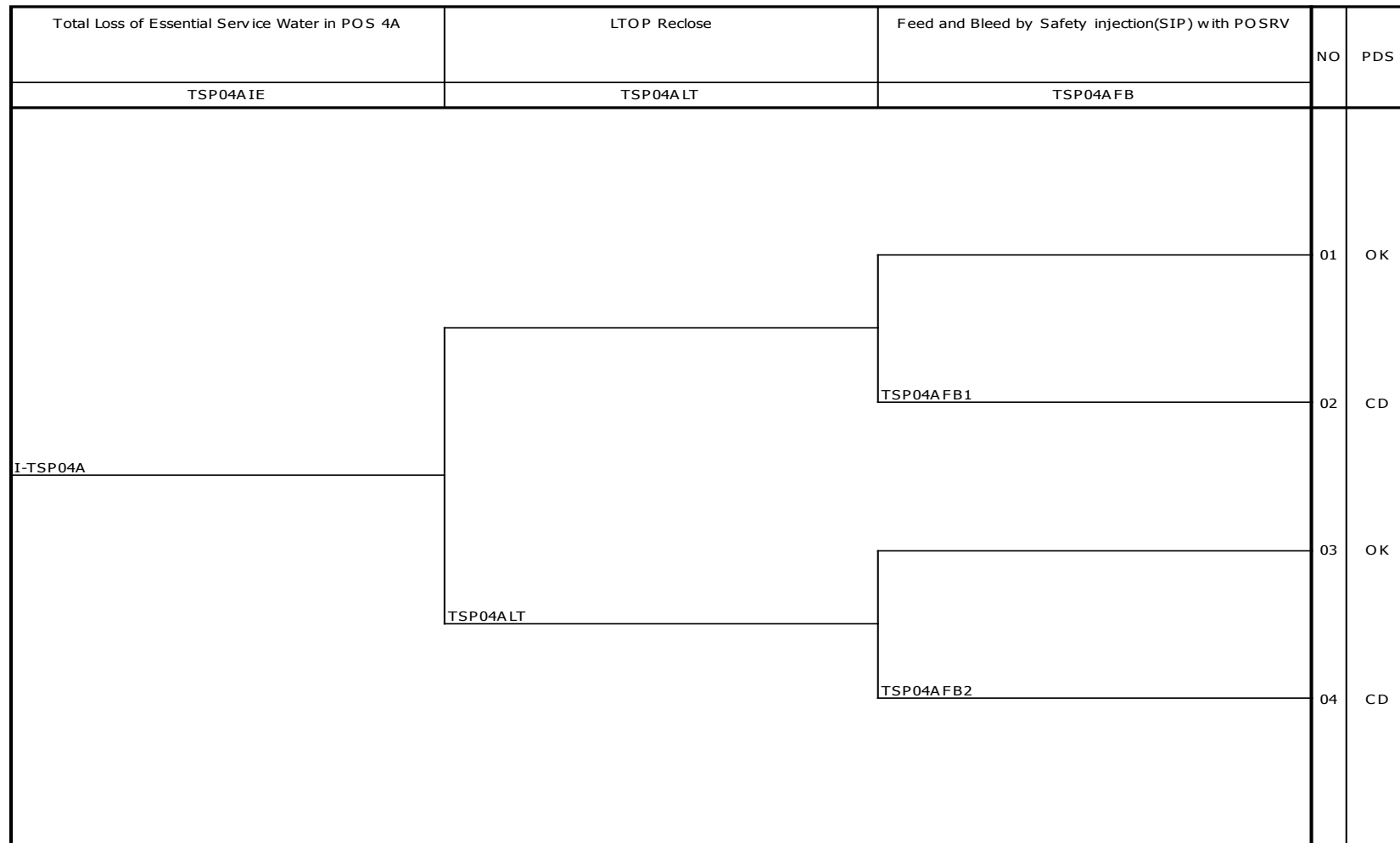


Figure 19.1-105 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 4A

APR1400 DCD TIER 2

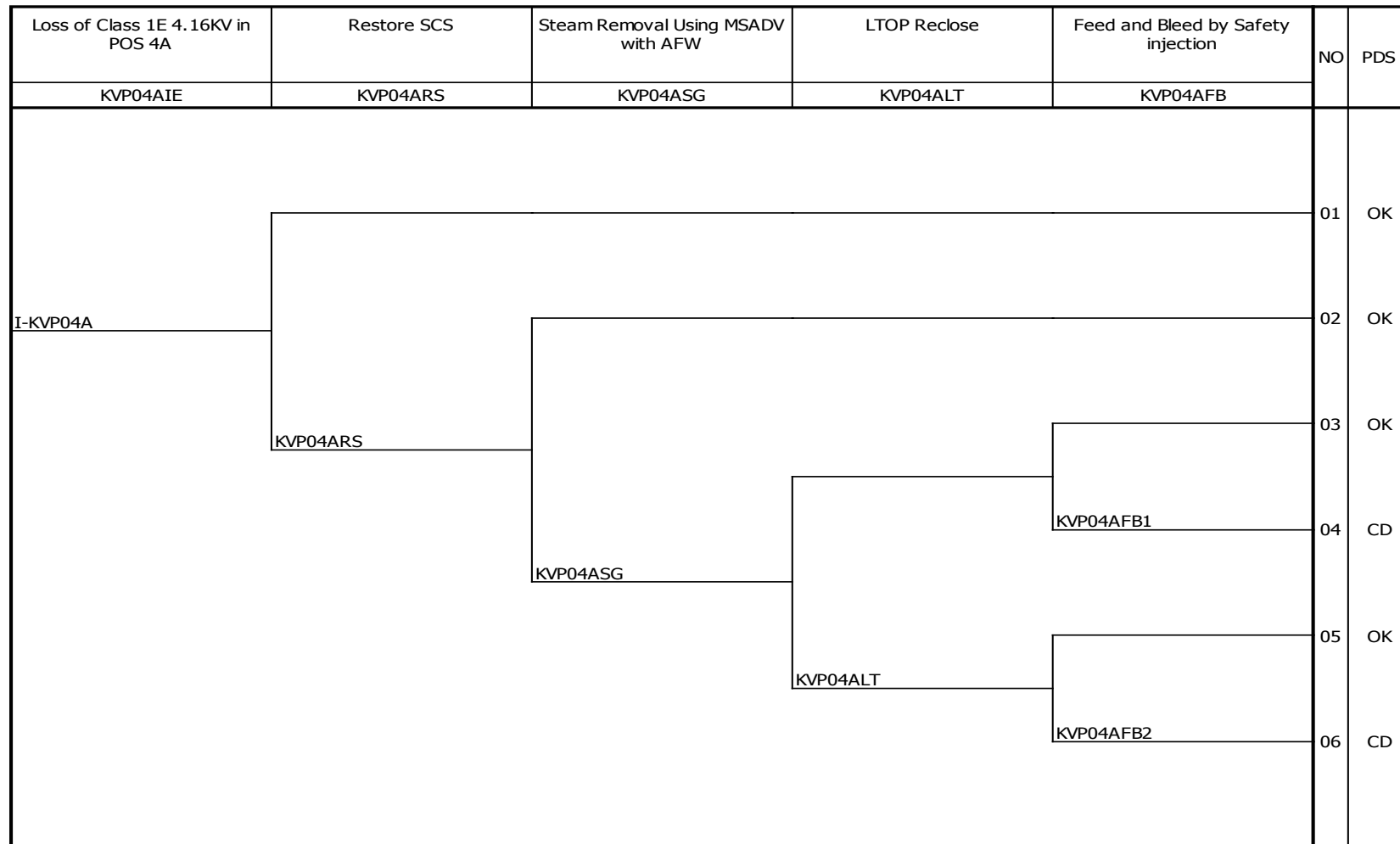


Figure 19.1-106 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 4A

APR1400 DCD TIER 2

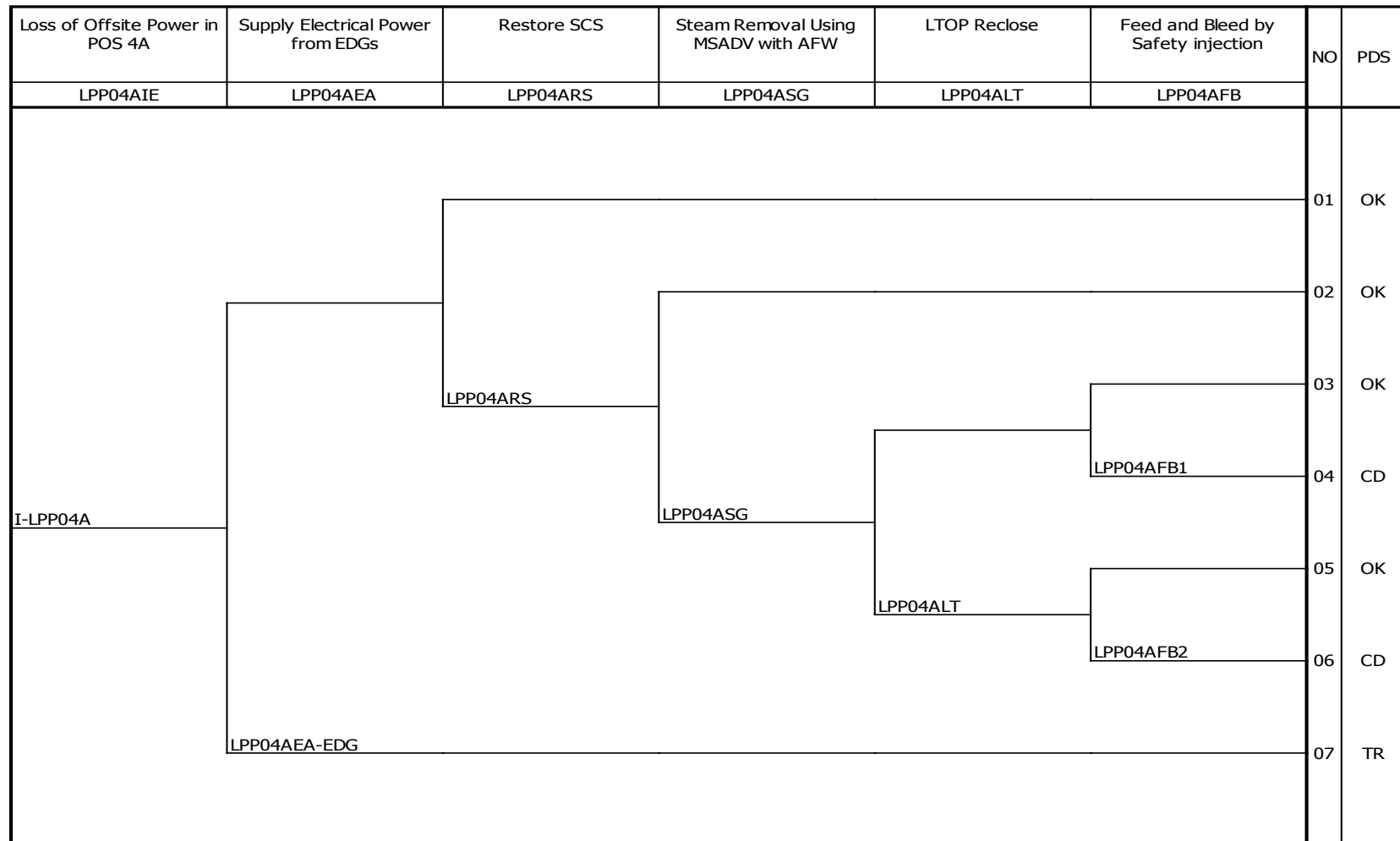
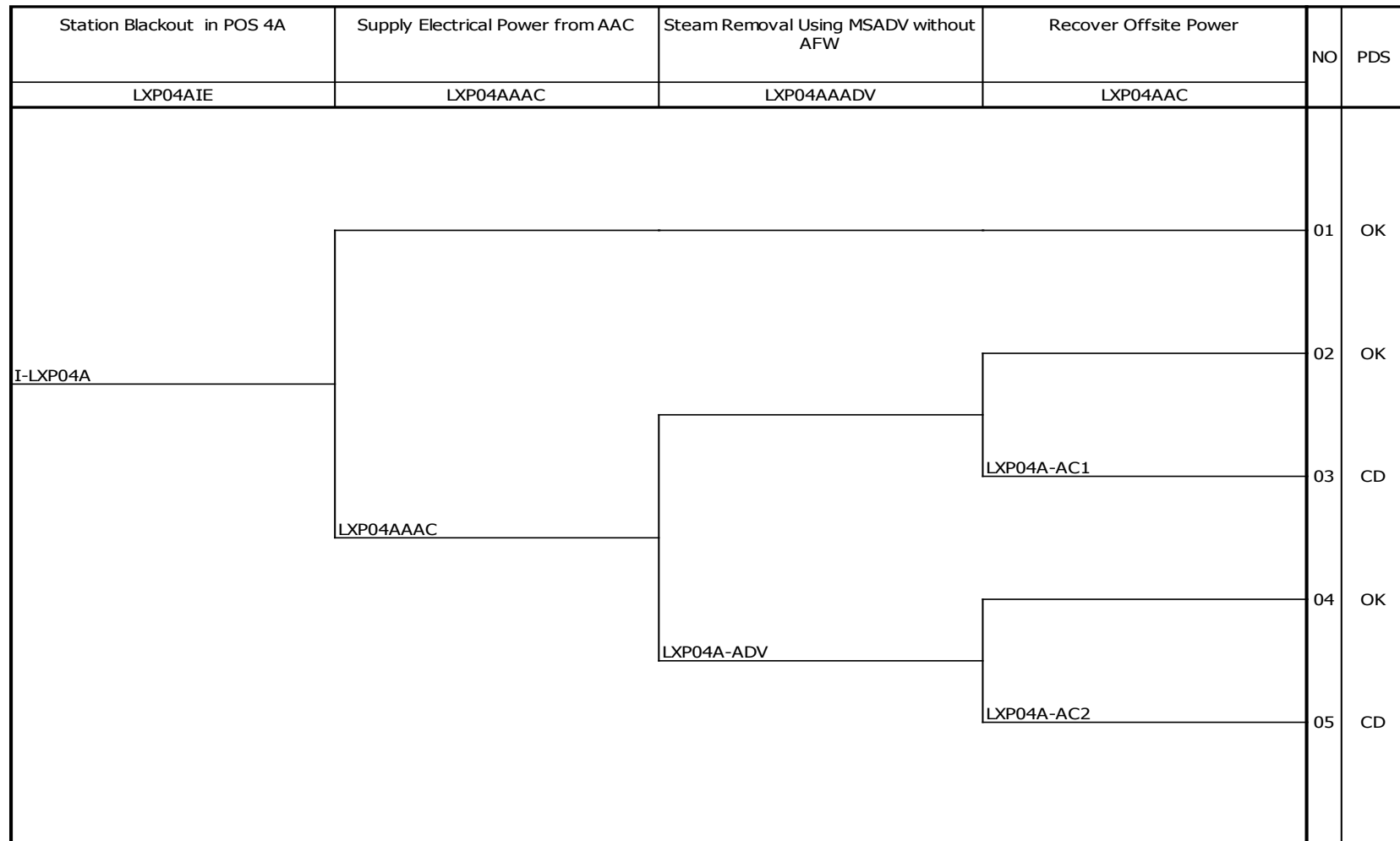
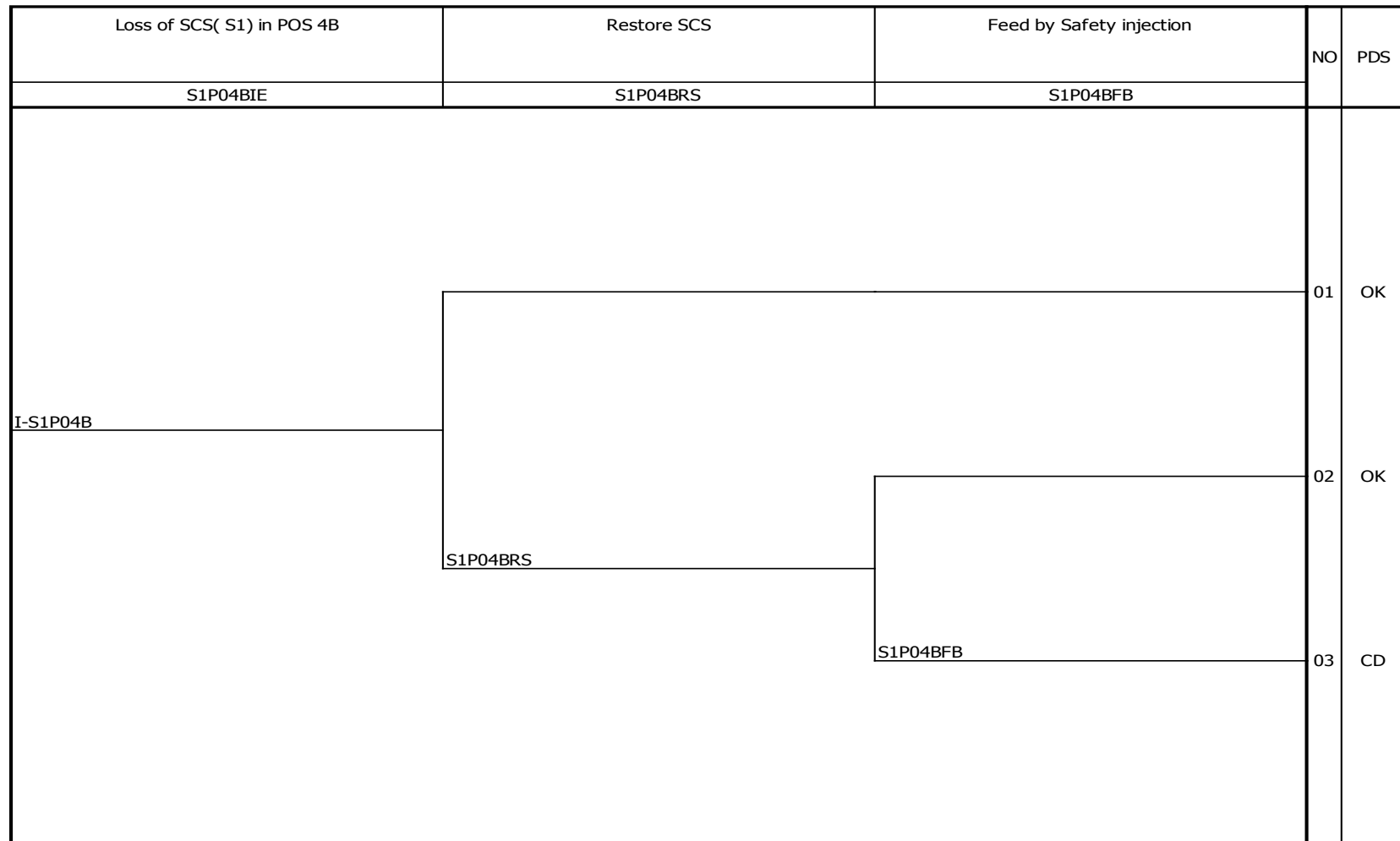


Figure 19.1-107 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 4A

APR1400 DCD TIER 2**Figure 19.1-108 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 4A**

APR1400 DCD TIER 2**Figure 19.1-109 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 4B**

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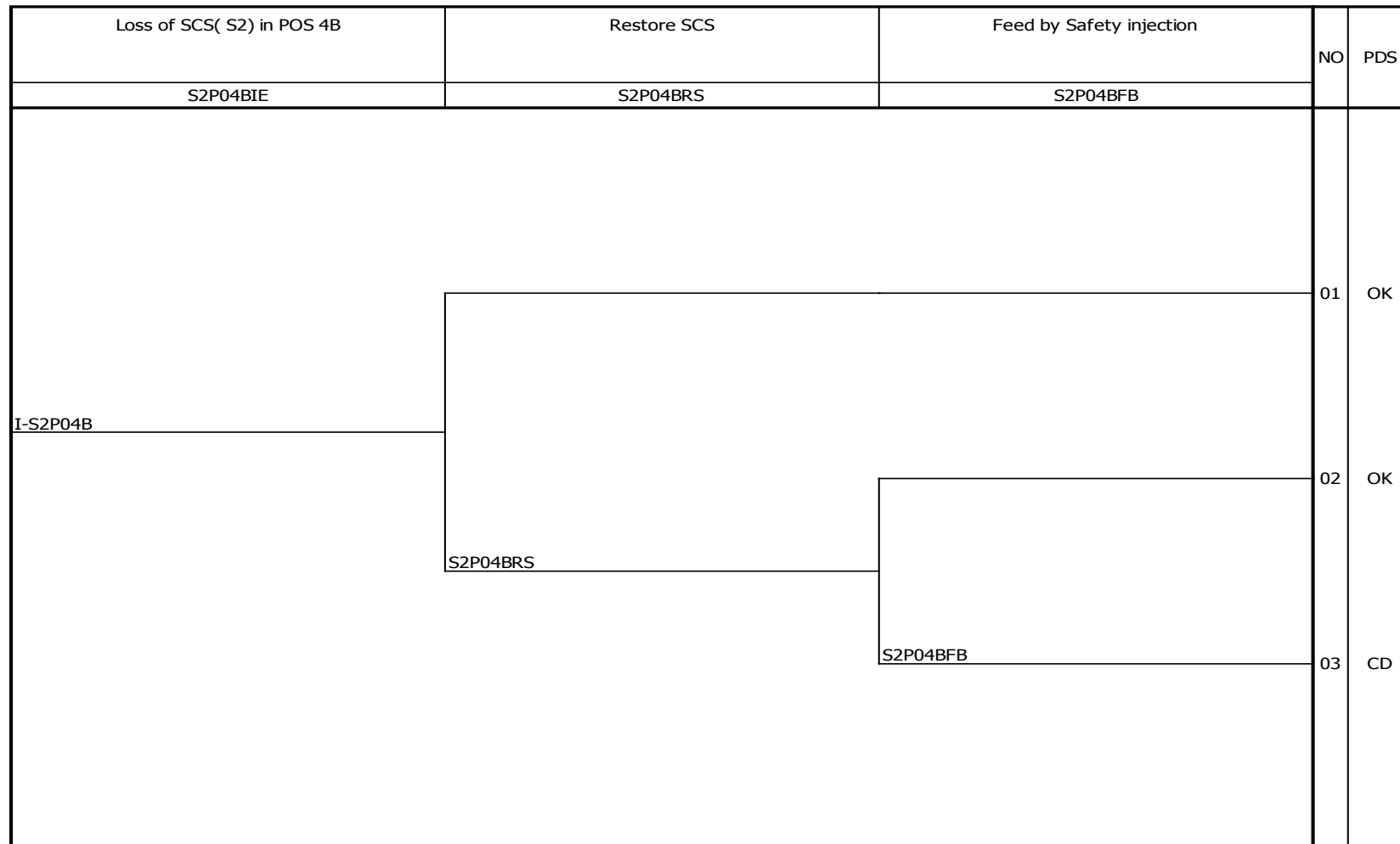


Figure 19.1-110 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 4B

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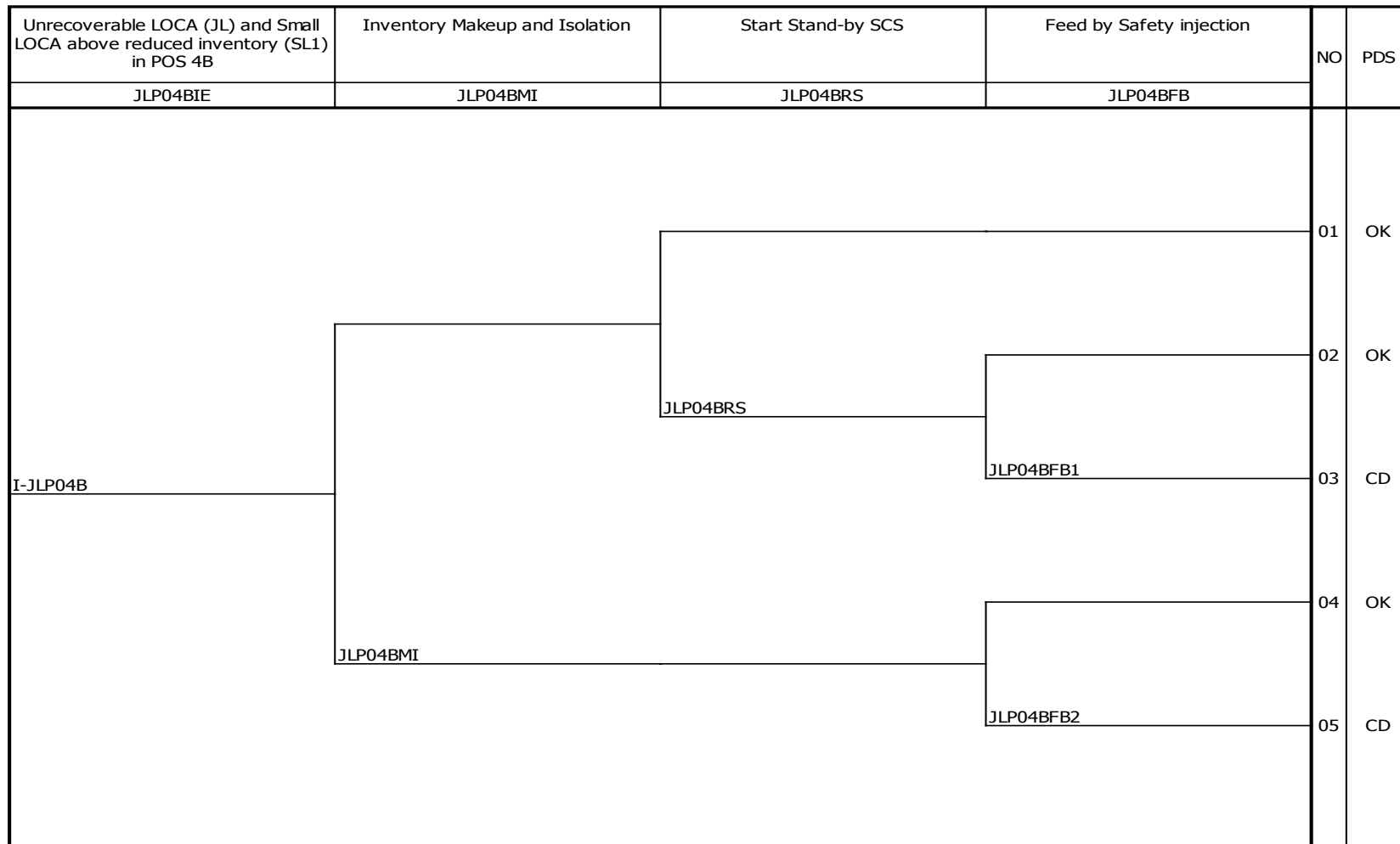


Figure 19.1-111 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 4B

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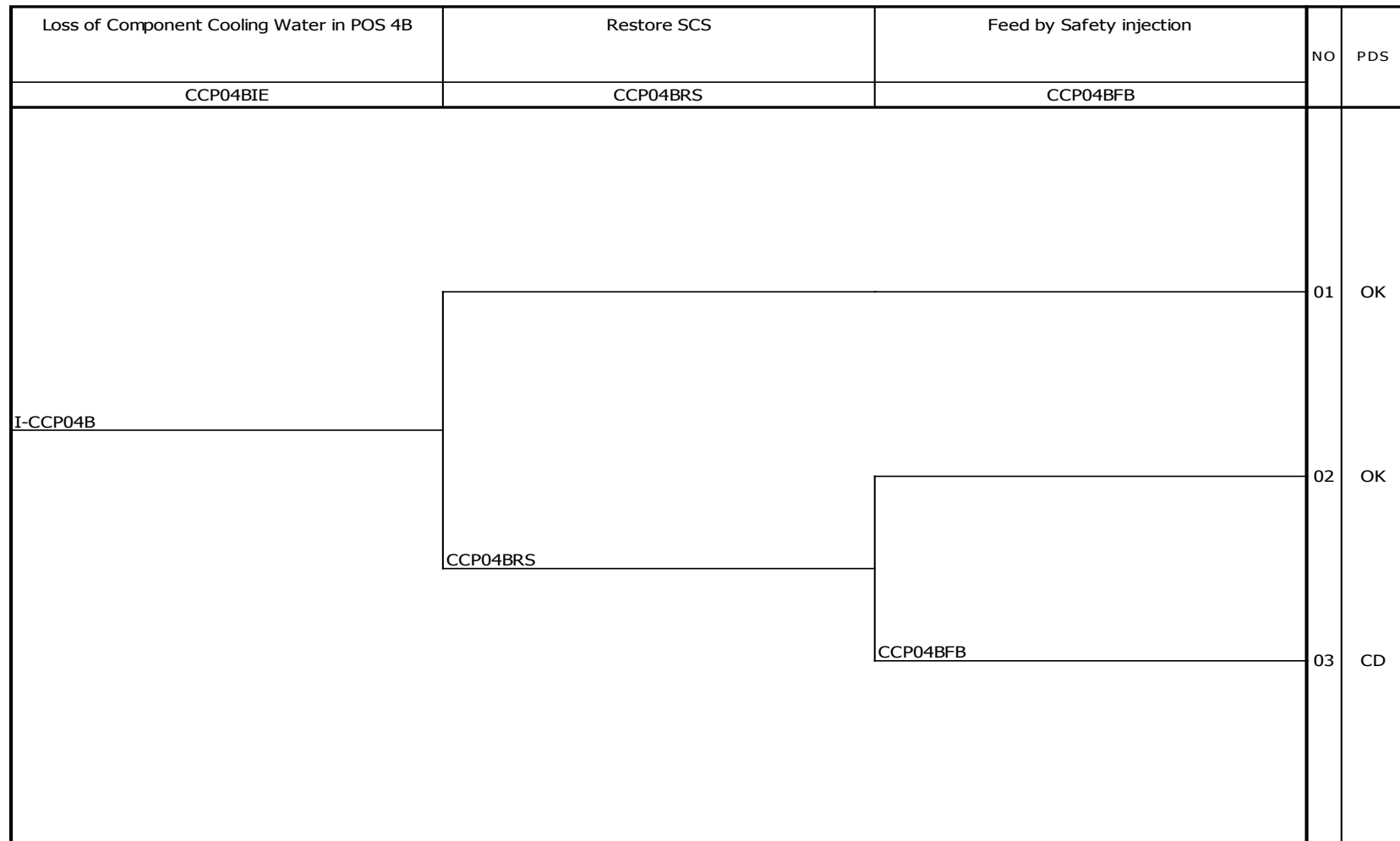
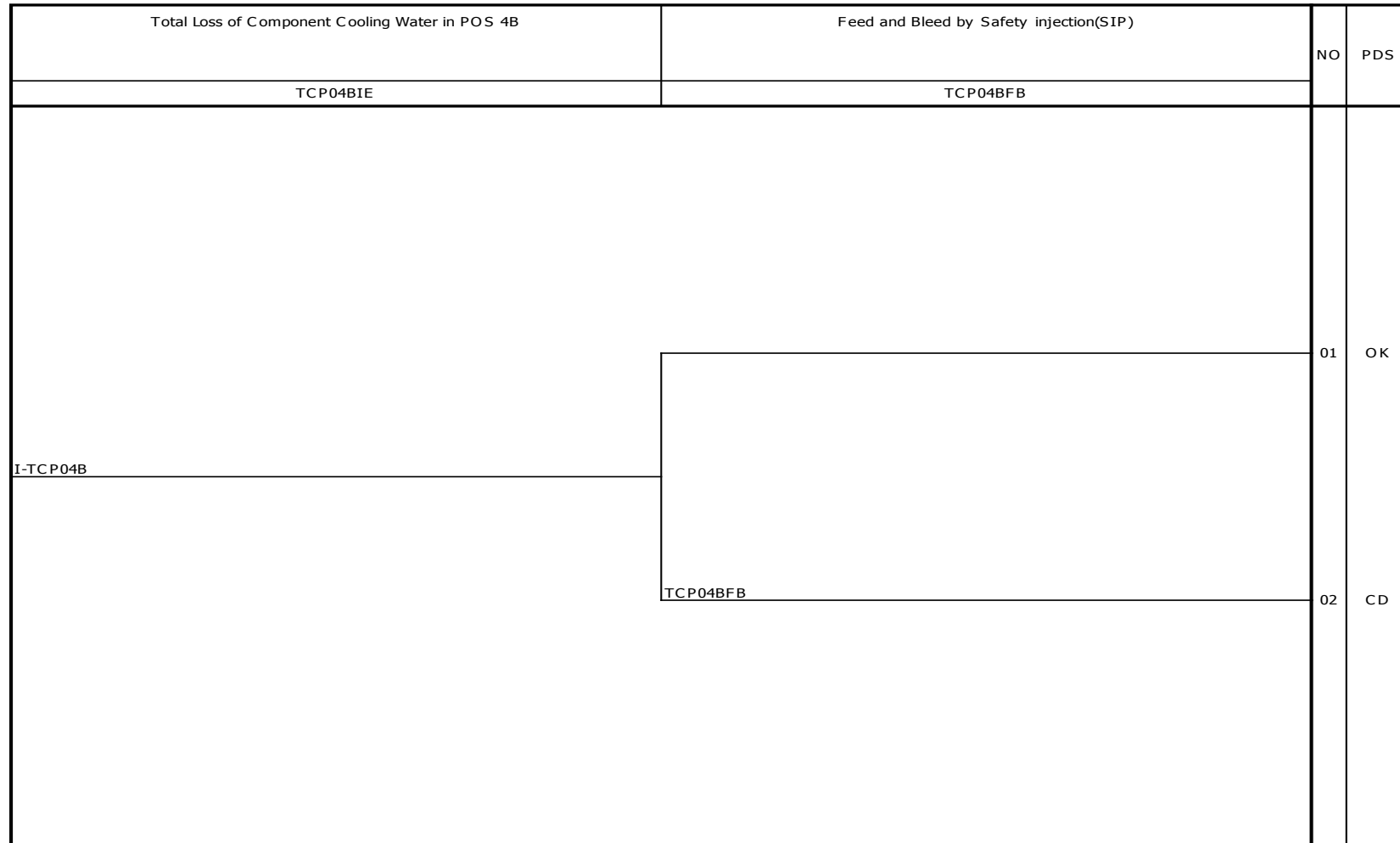


Figure 19.1-112 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 4B

APR1400 DCD TIER 2**Figure 19.1-113 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 4B**

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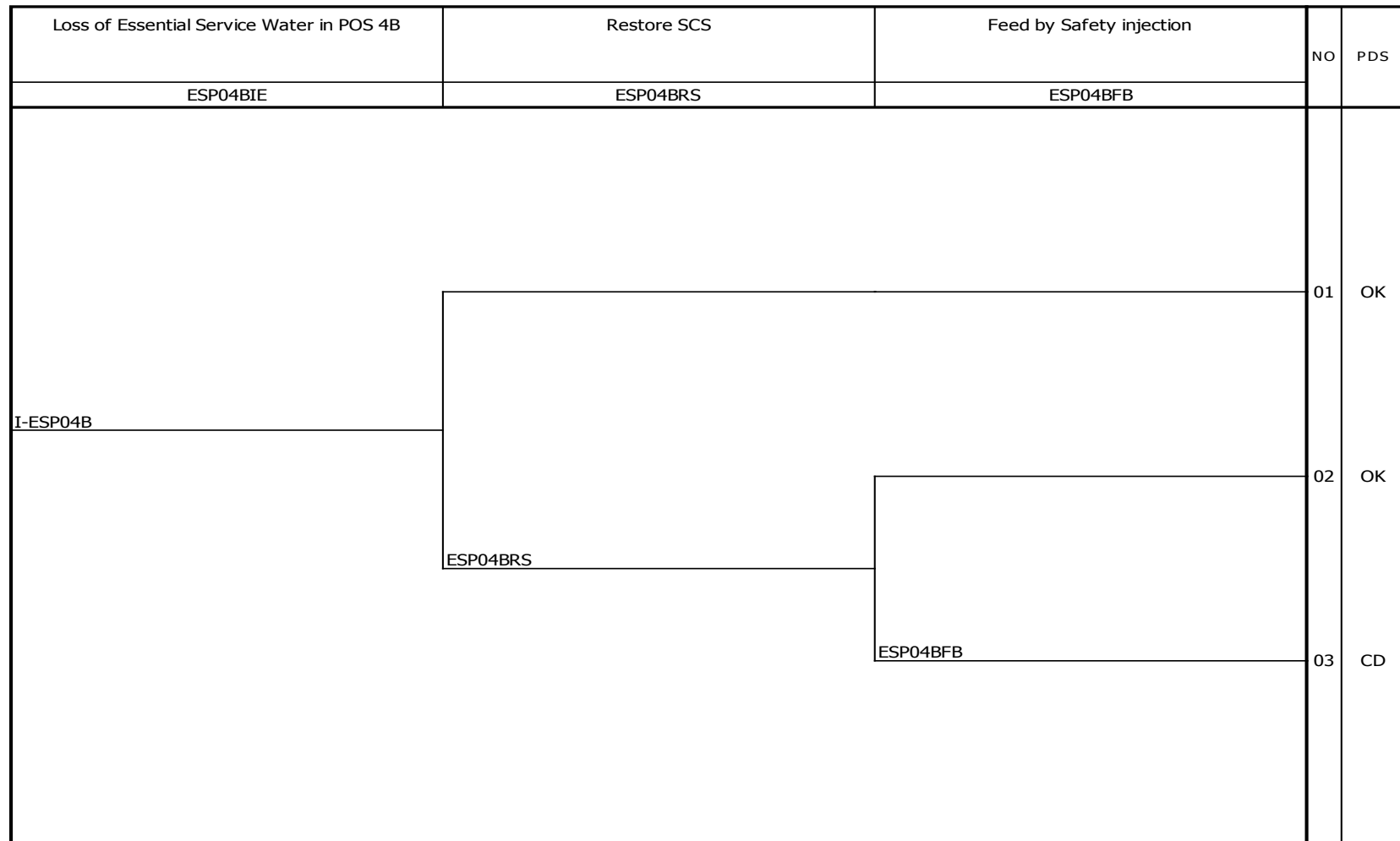


Figure 19.1-114 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 4B

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 4B	Feed and Bleed by Safety injection(SIP)	NO	PDS
TSP04BIE	TSP04BFB		
I-TSP04B		01	OK
	TSP04BFB	02	CD

Figure 19.1-115 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 4B

APR1400 DCD TIER 2

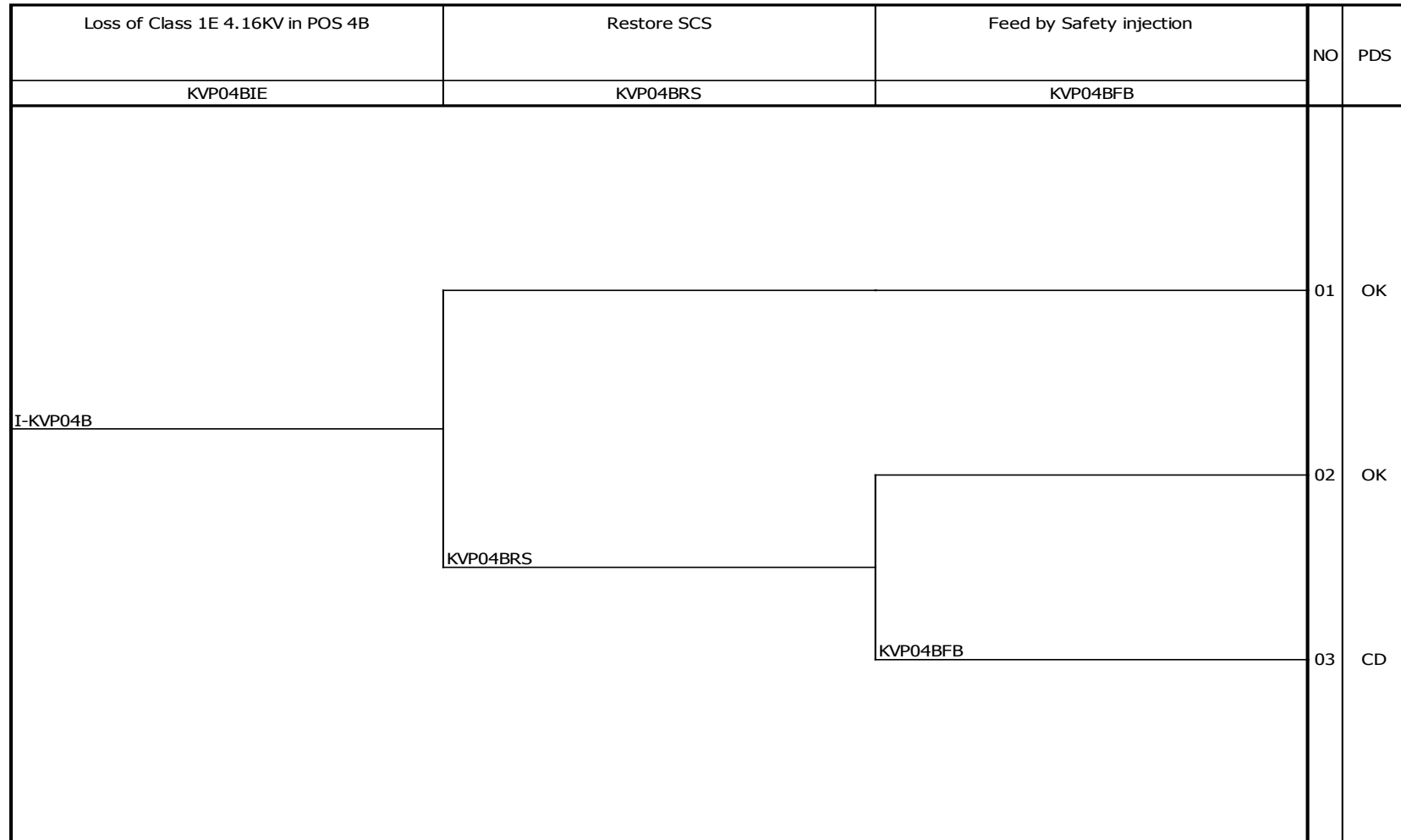


Figure 19.1-116 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 4B

APR1400 DCD TIER 2

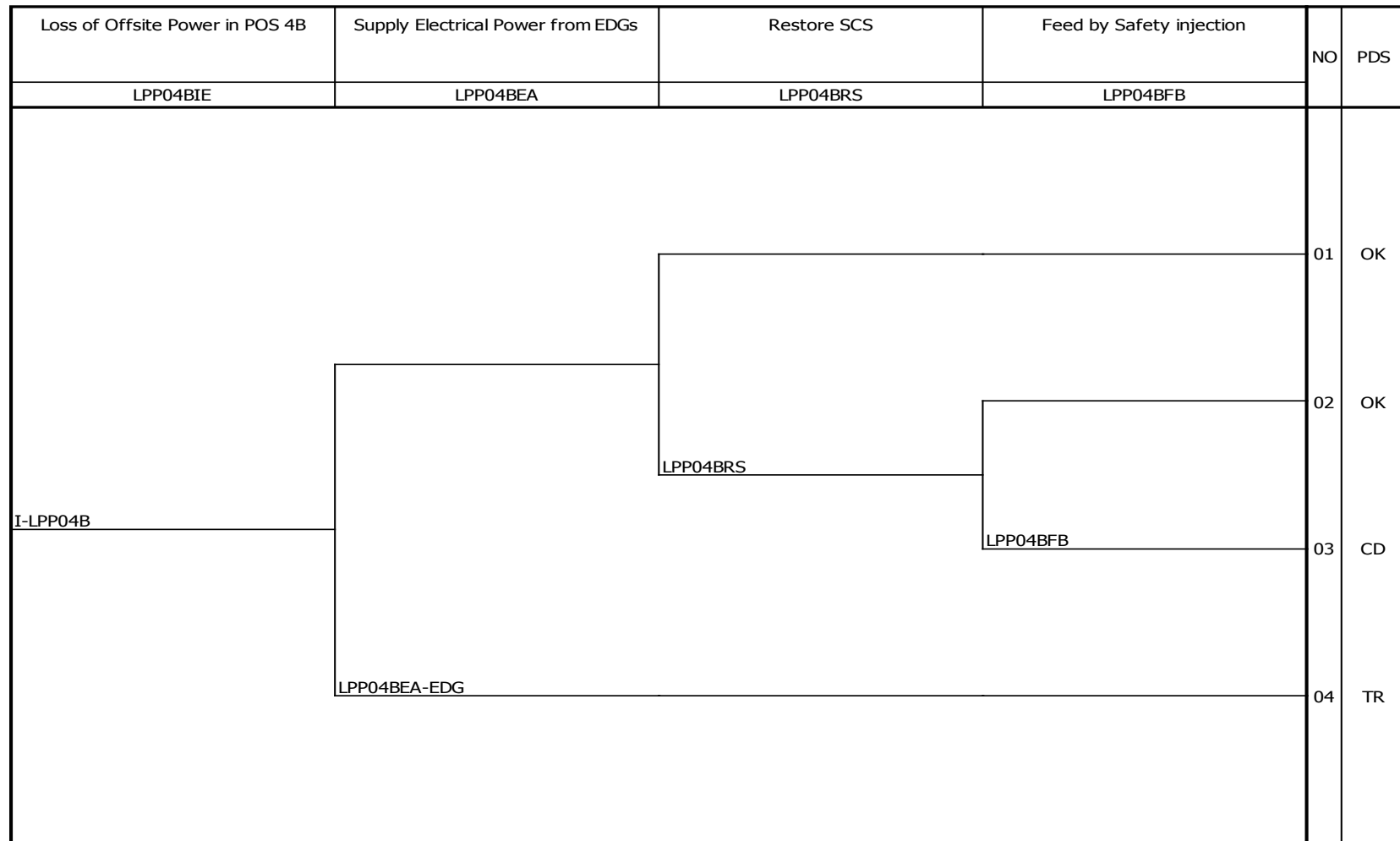
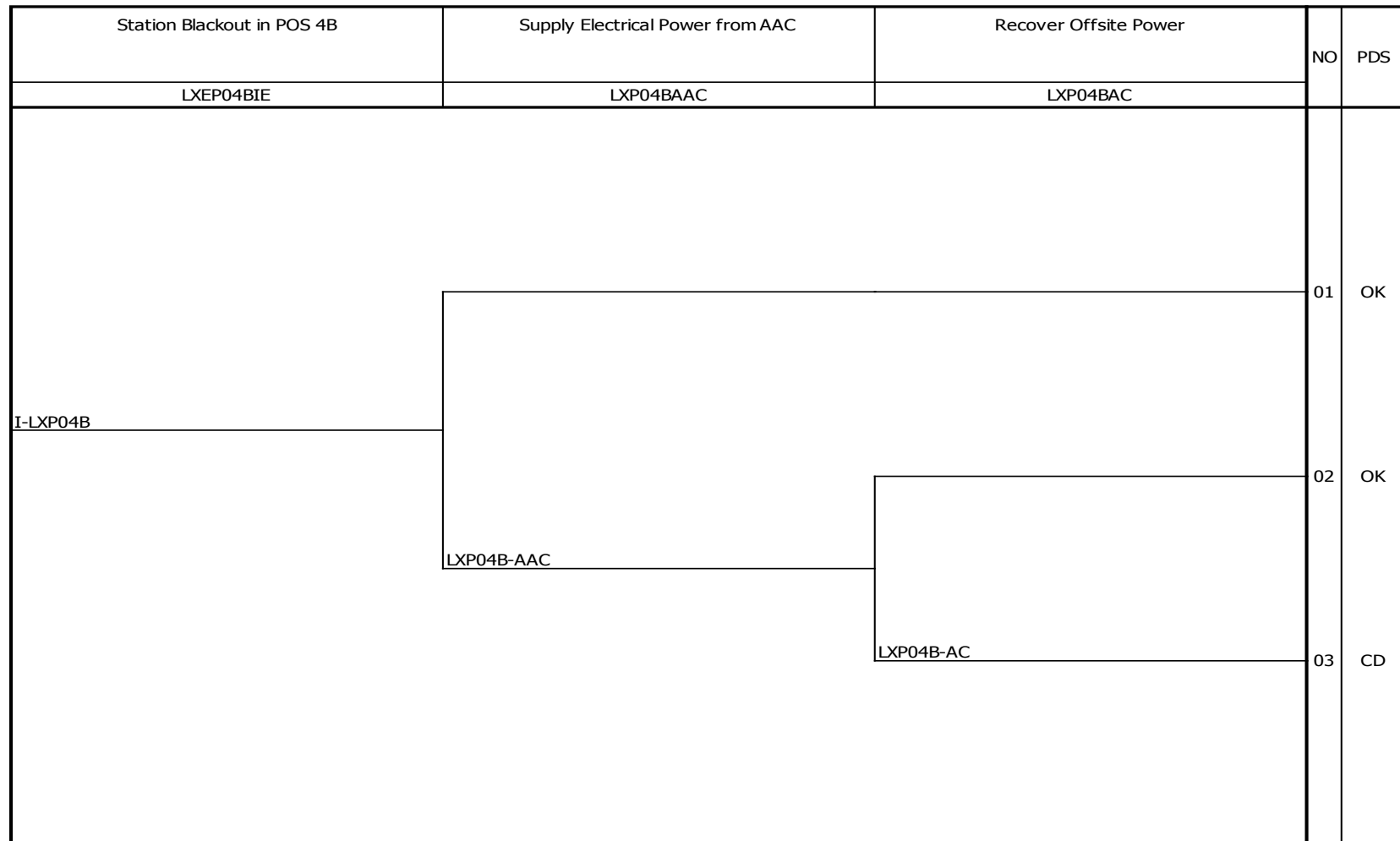


Figure 19.1-117 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 4B

APR1400 DCD TIER 2**Figure 19.1-118 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 4B**

APR1400 DCD TIER 2

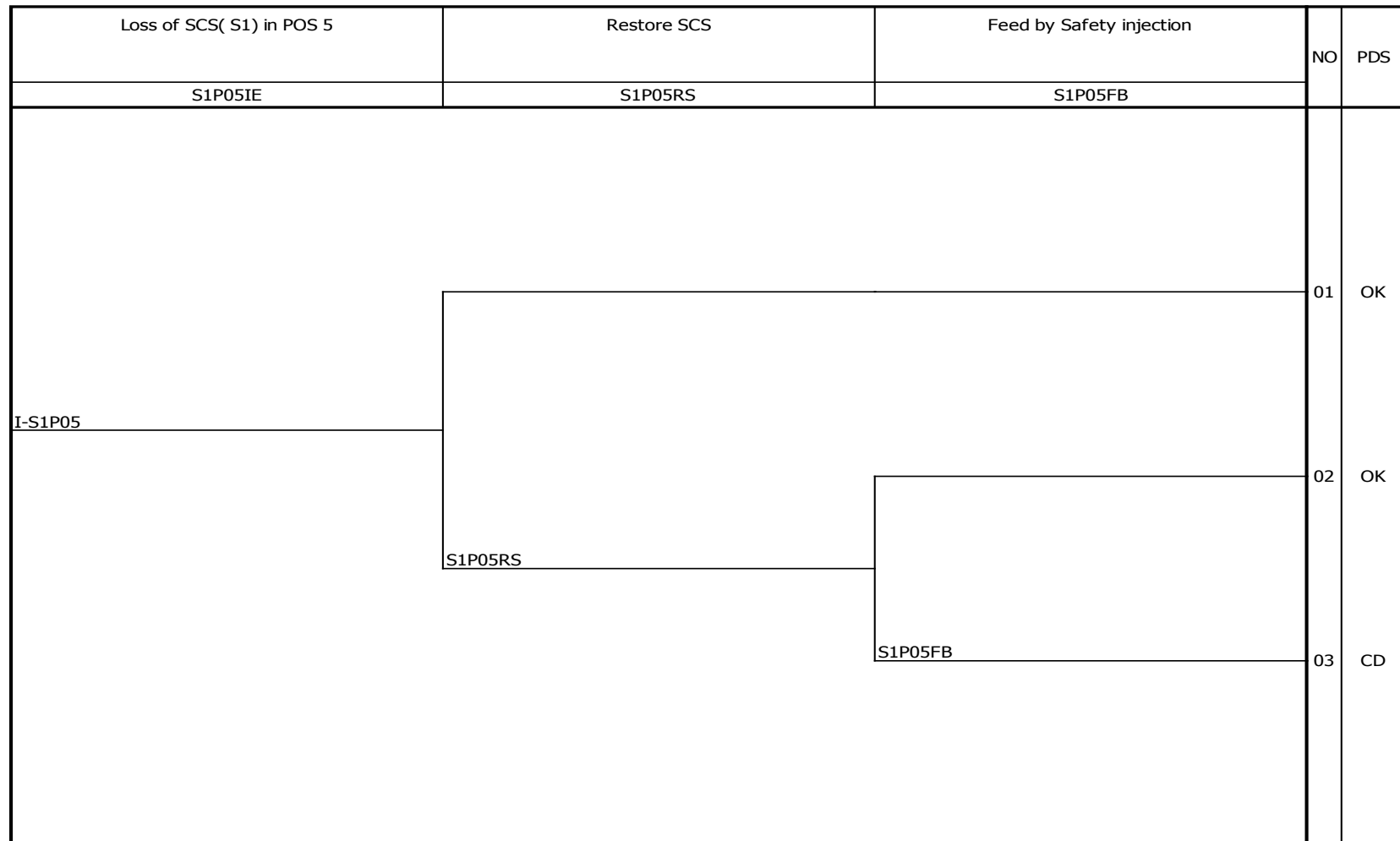


Figure 19.1-119 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 5

APR1400 DCD TIER 2

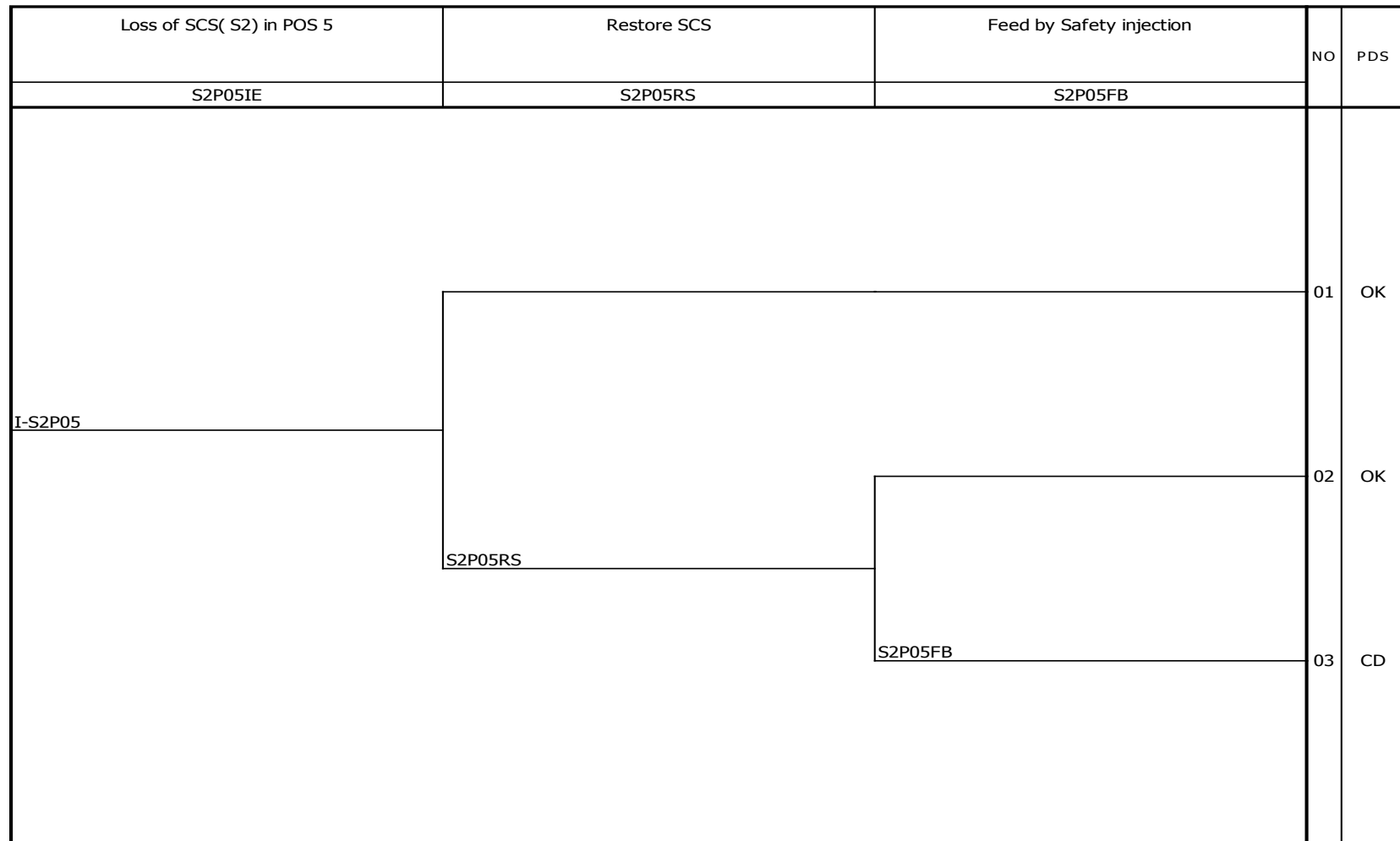


Figure 19.1-120 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 5

APR1400 DCD TIER 2

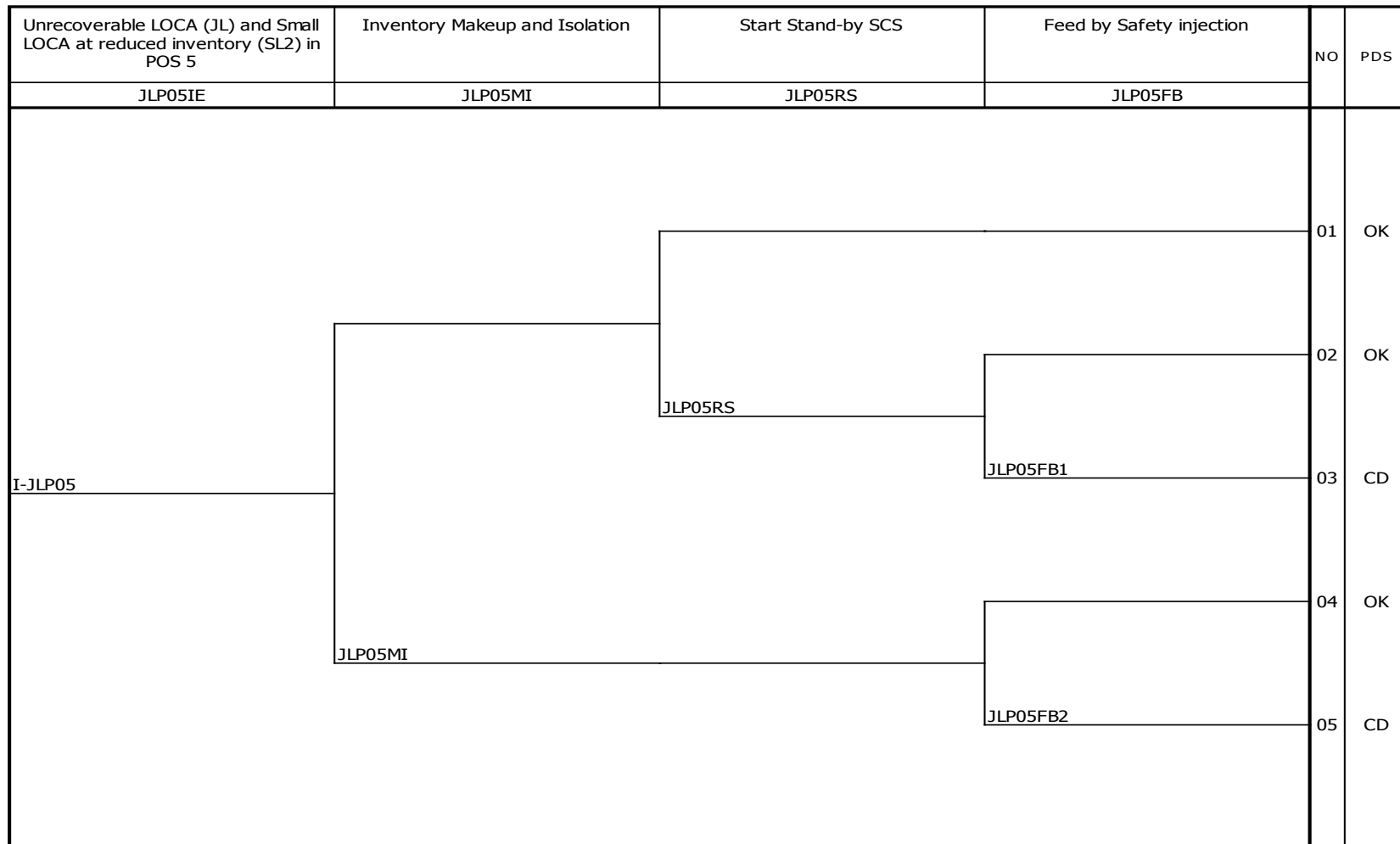
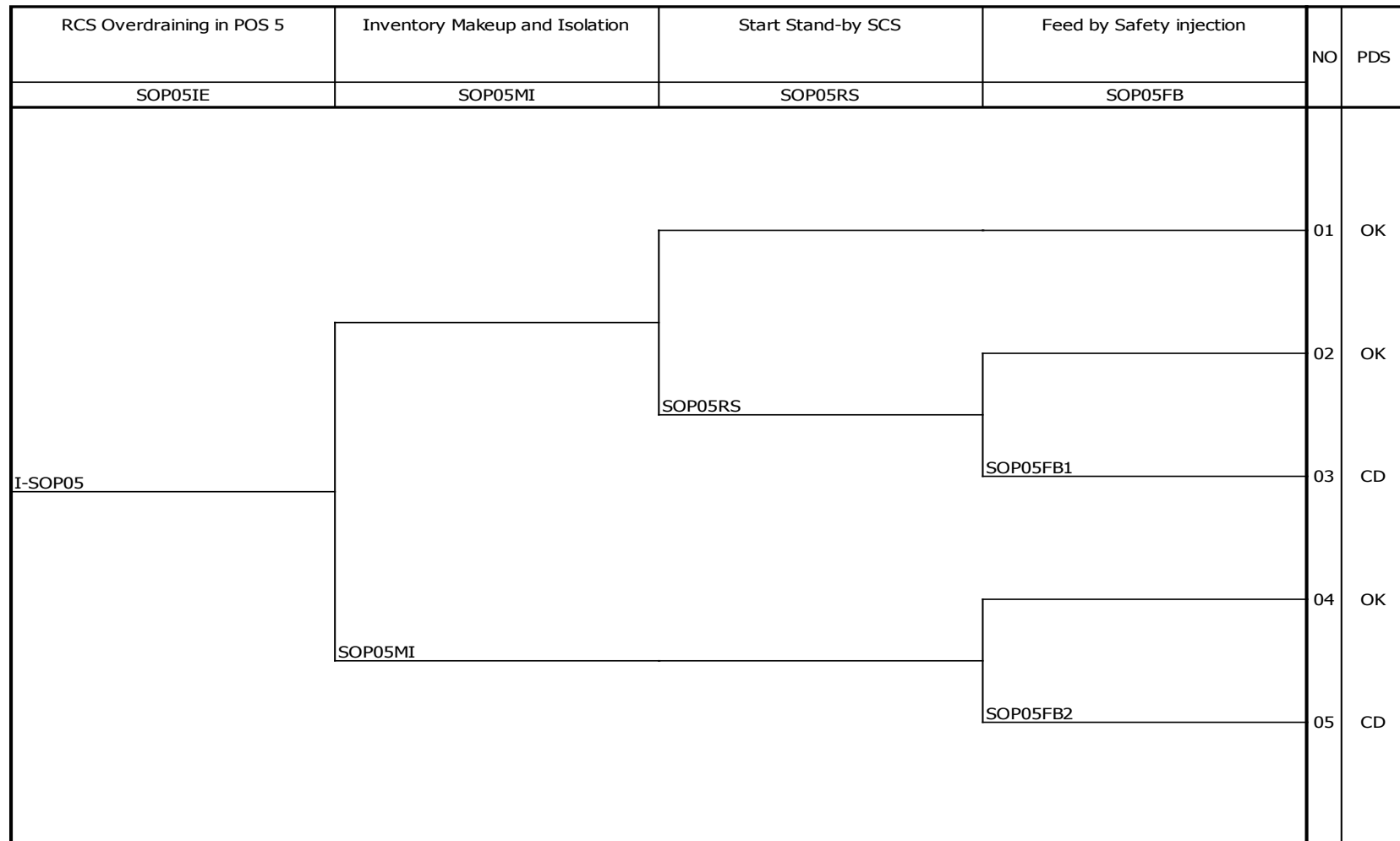


Figure 19.1-121 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 5

APR1400 DCD TIER 2**Figure 19.1-122 LPSD Level 1 Event Tree – Over-drainage During Reduced Inventory Operation (SO) in POS 5**

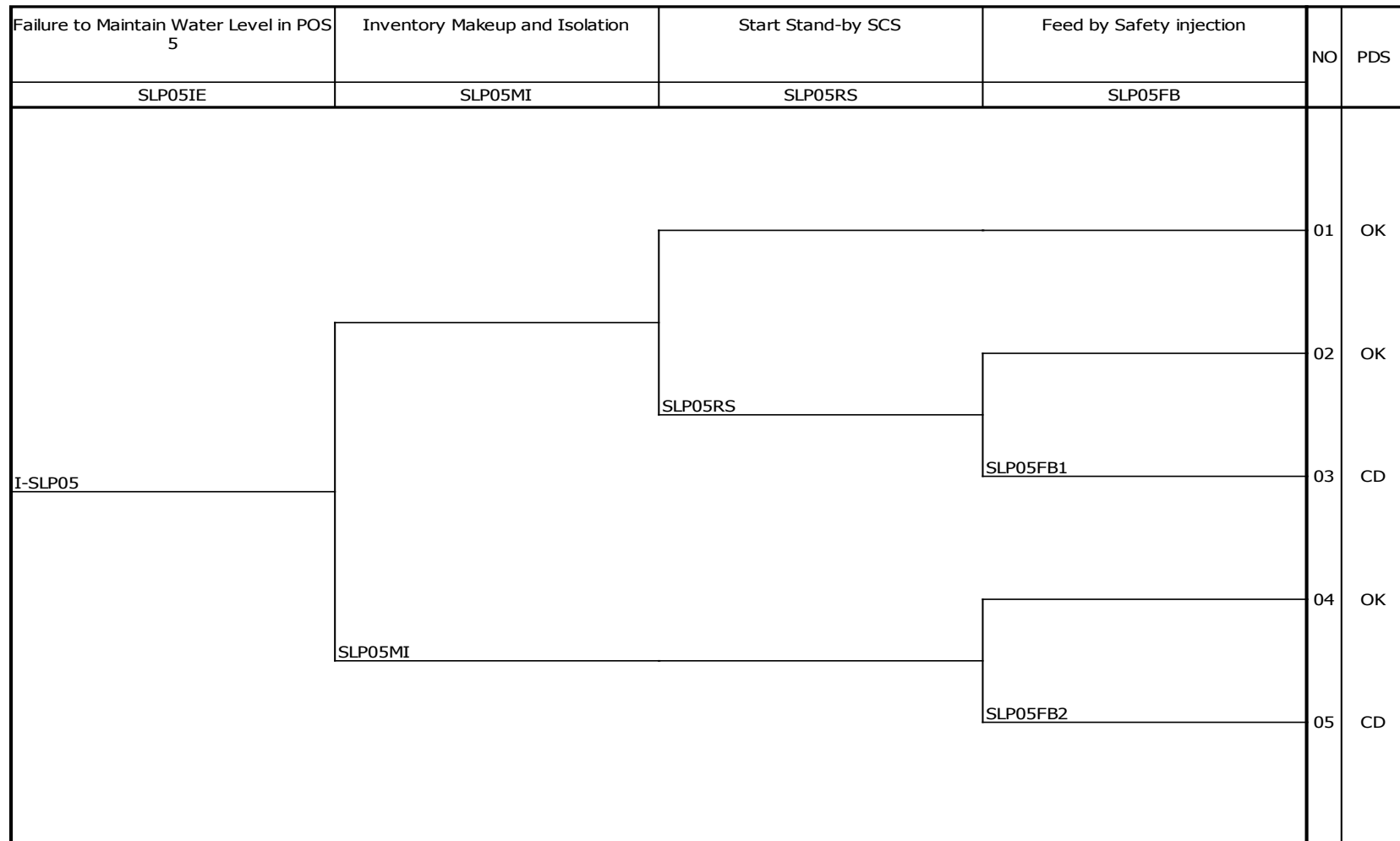
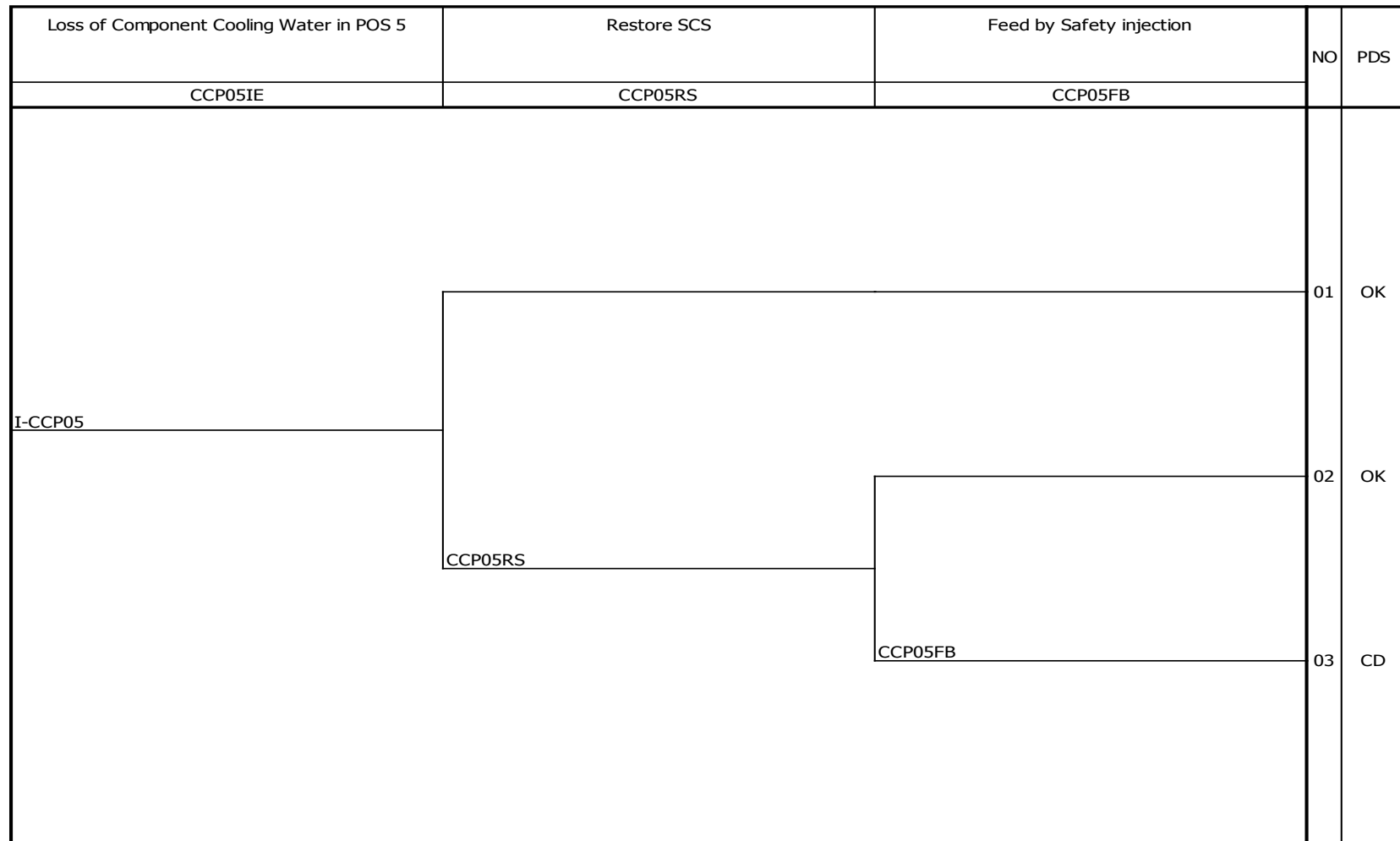
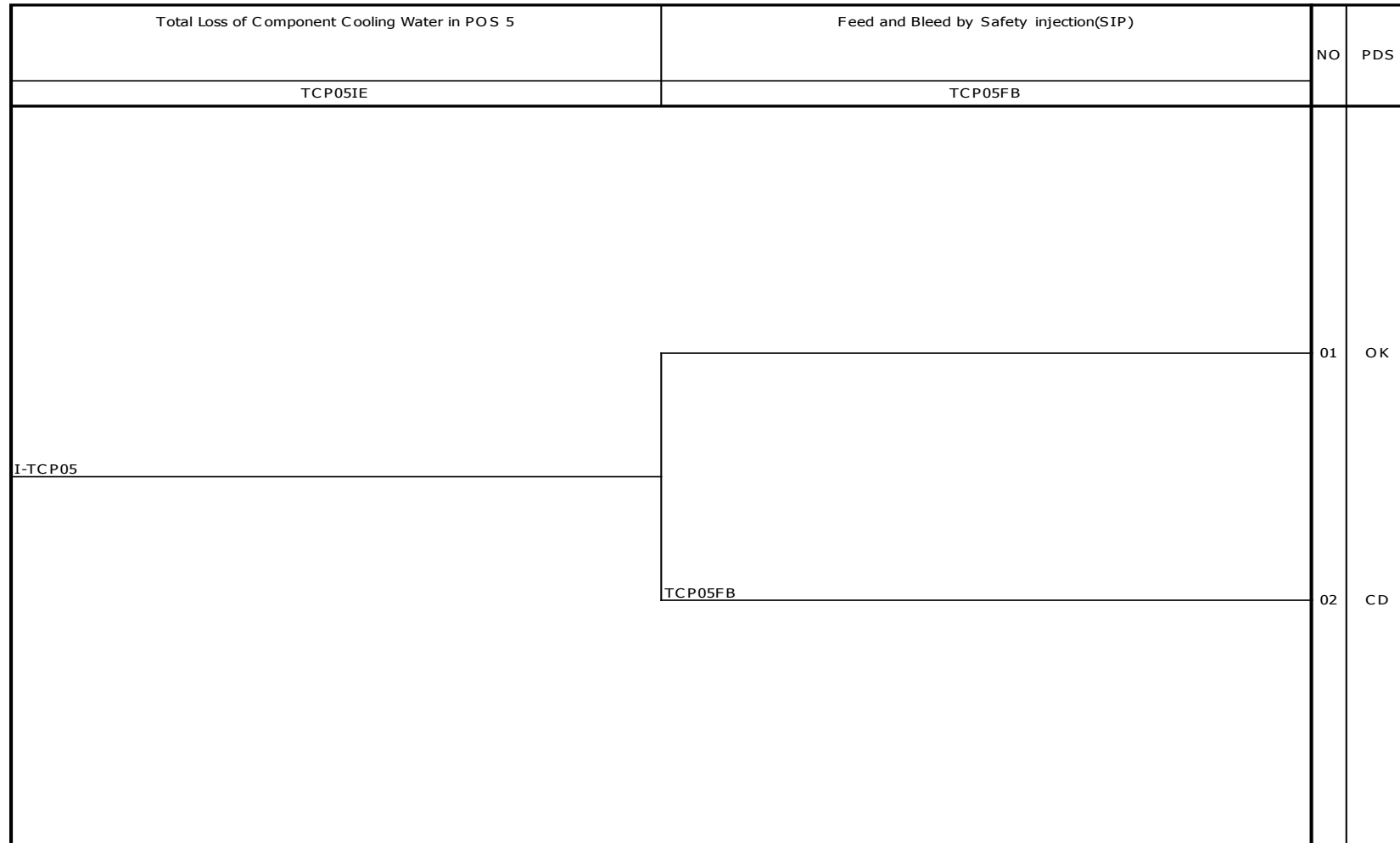
APR1400 DCD TIER 2

Figure 19.1-123 LPSD Level 1 Event Tree - Failure to Maintain Water Level During Reduced Inventory Operation (SL) in POS 5

APR1400 DCD TIER 2**Figure 19.1-124 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 5**

APR1400 DCD TIER 2**Figure 19.1-125 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 5**

APR1400 DCD TIER 2

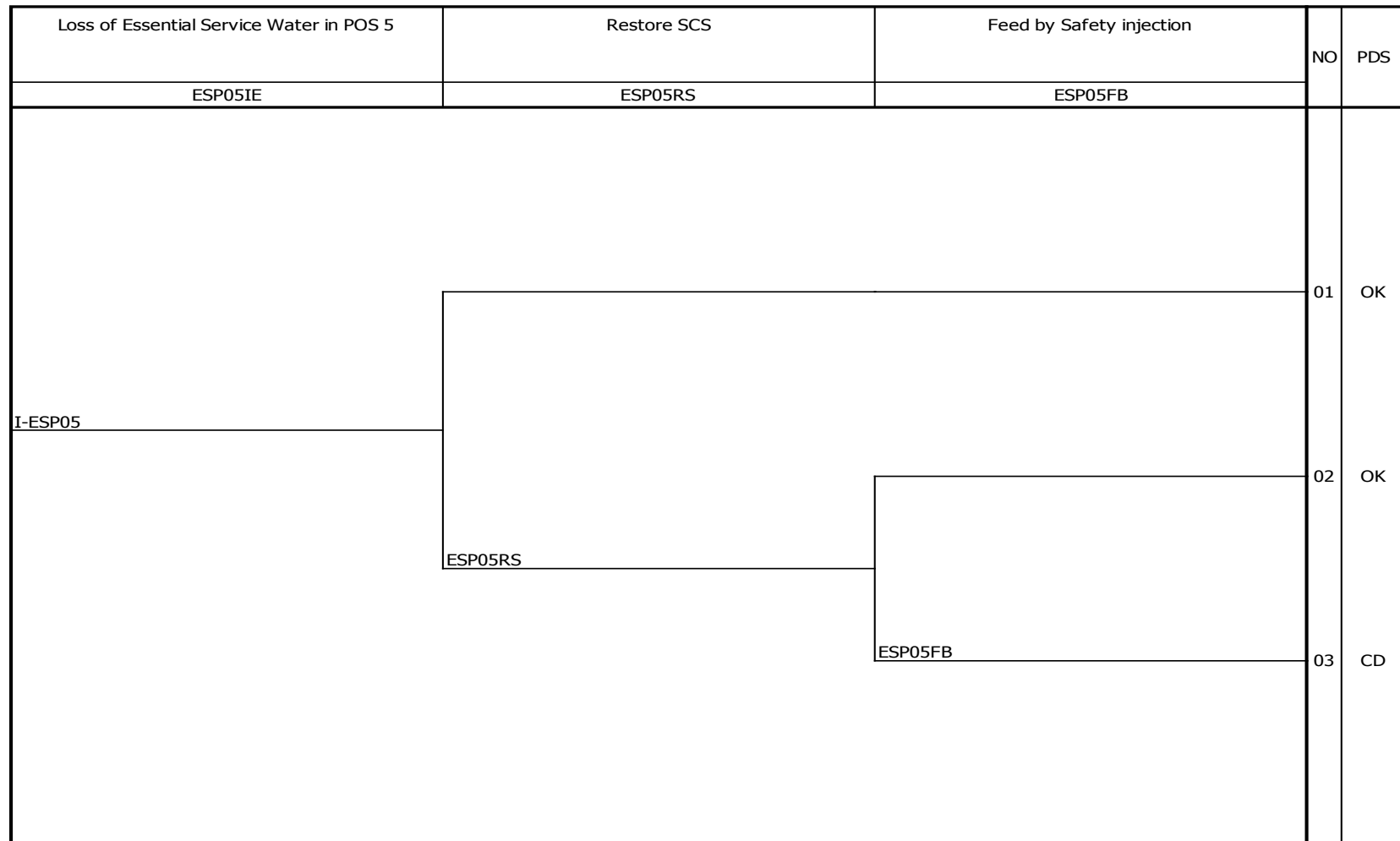
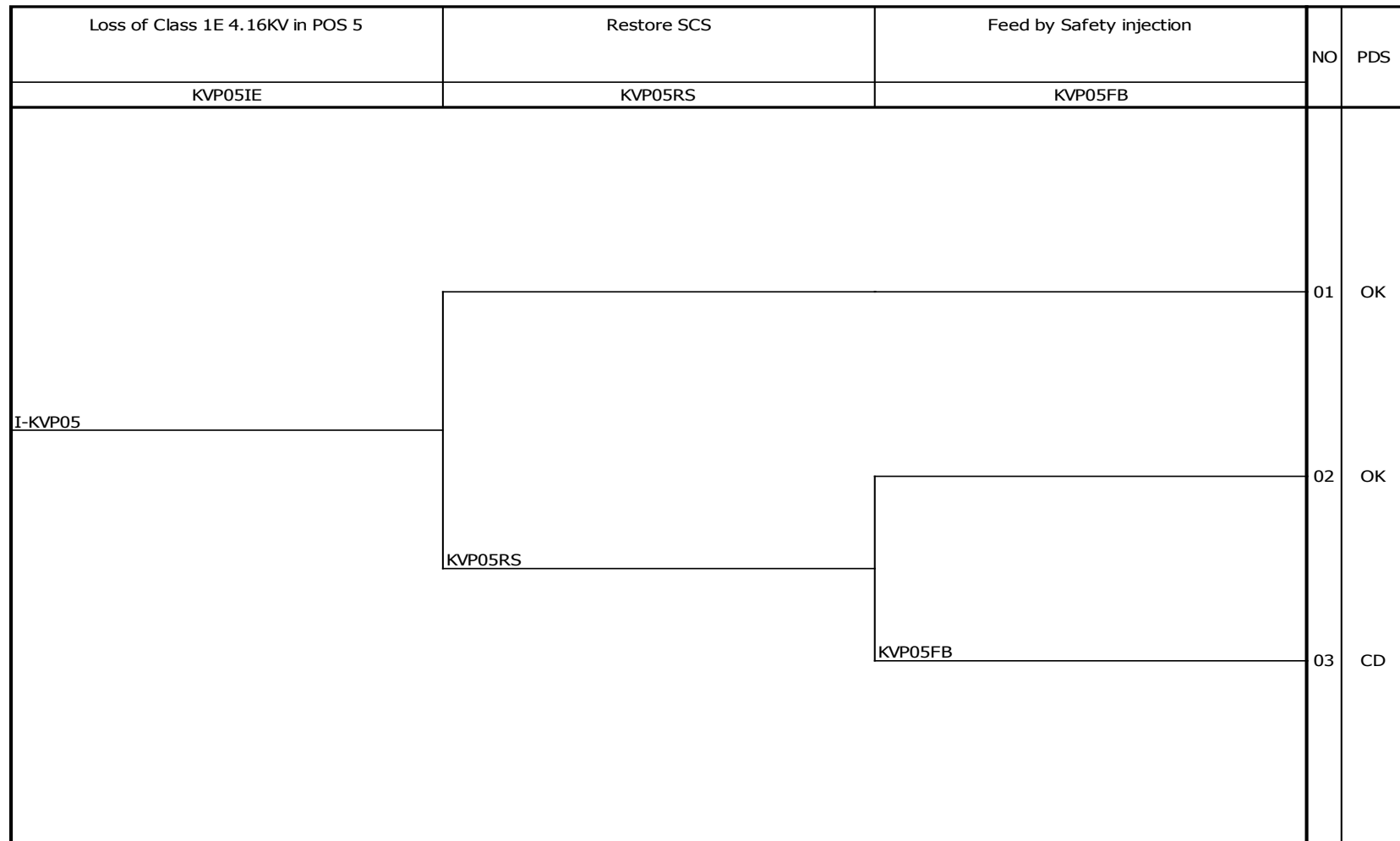


Figure 19.1-126 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 5

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 5	Feed and Bleed by Safety injection(SIP)	NO	PDS
TSP05IE	TSP05FB		
I-TSP05		01	OK
	TSP05FB	02	CD

Figure 19.1-127 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 5

APR1400 DCD TIER 2**Figure 19.1-128 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 5**

APR1400 DCD TIER 2

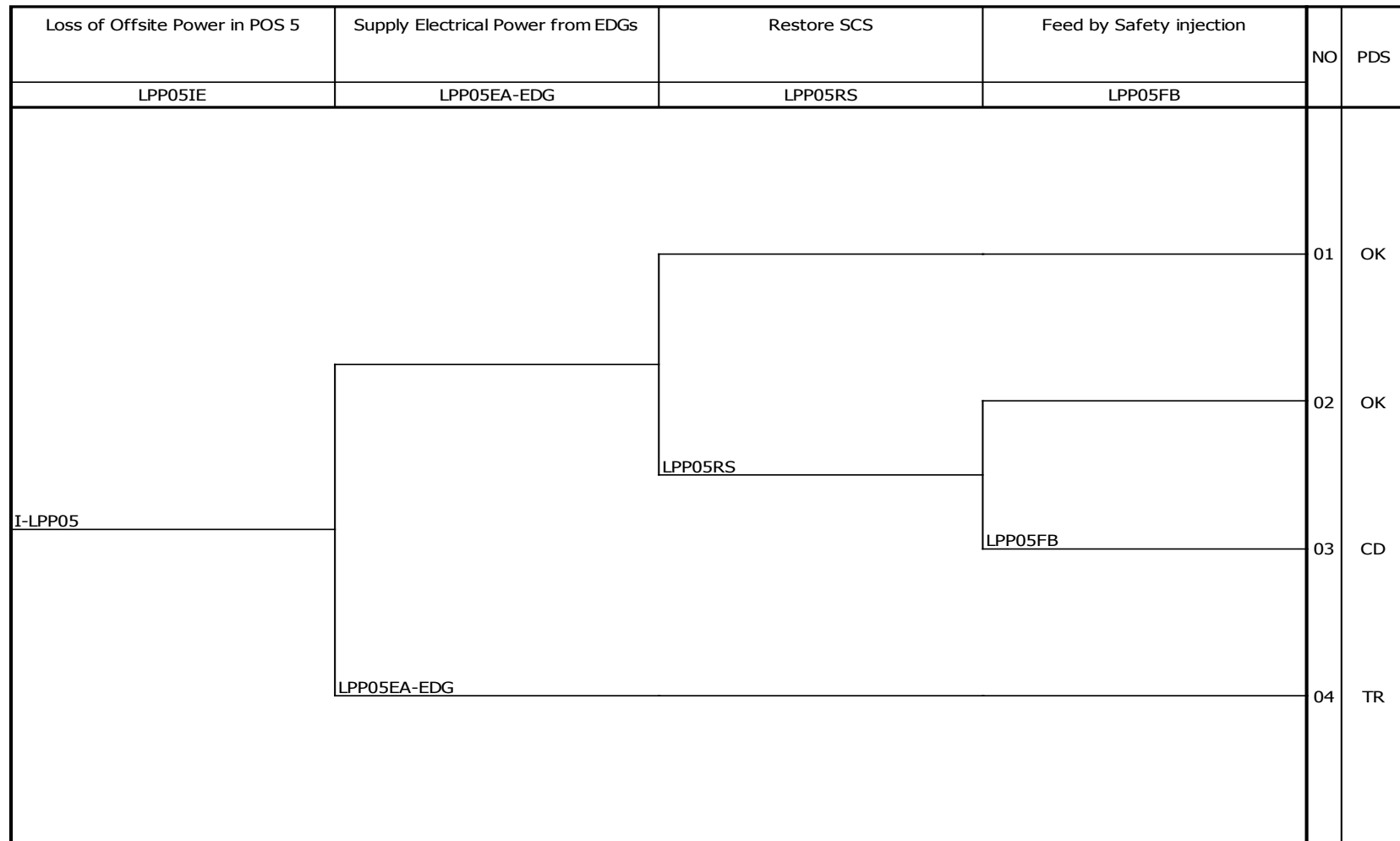
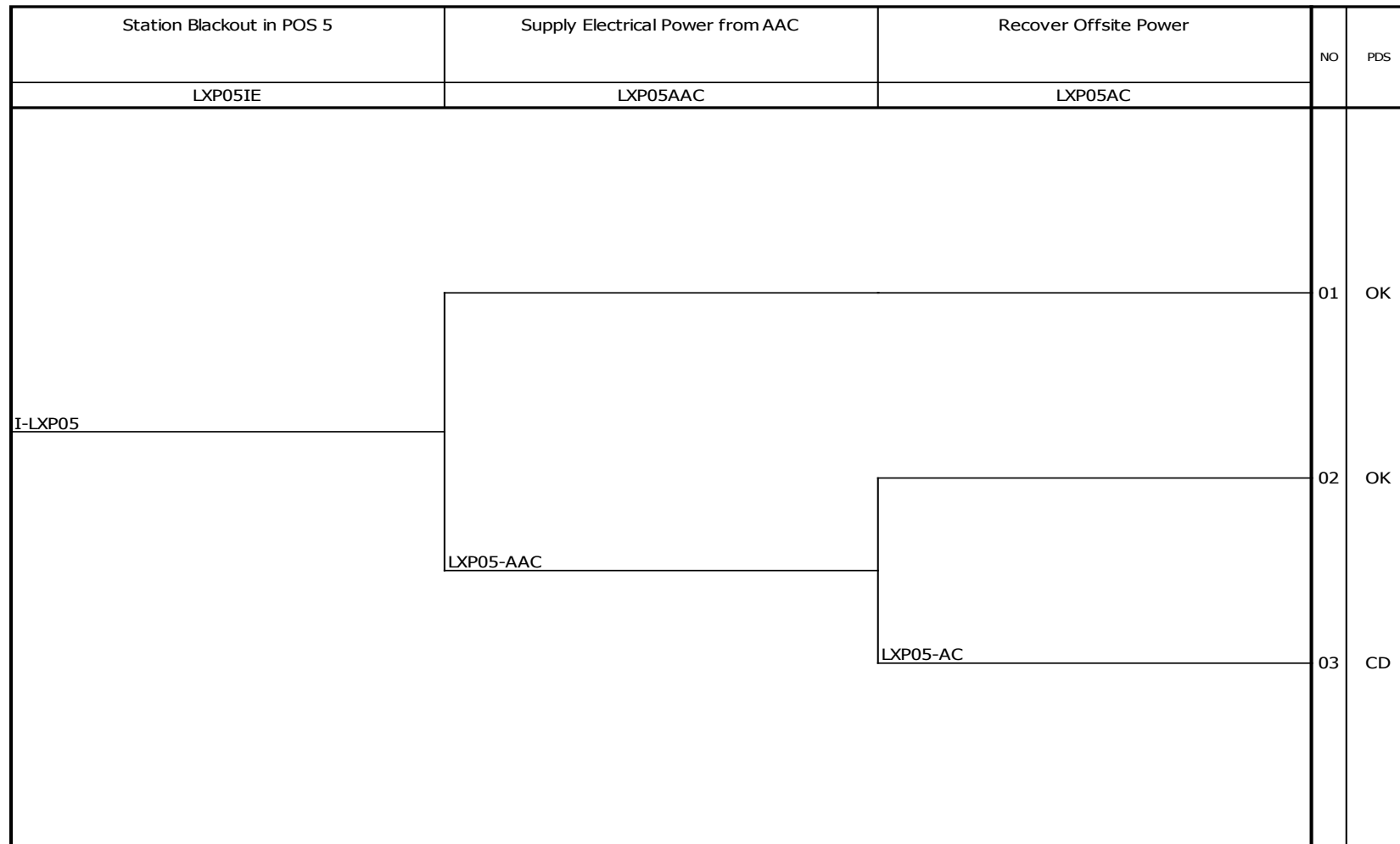
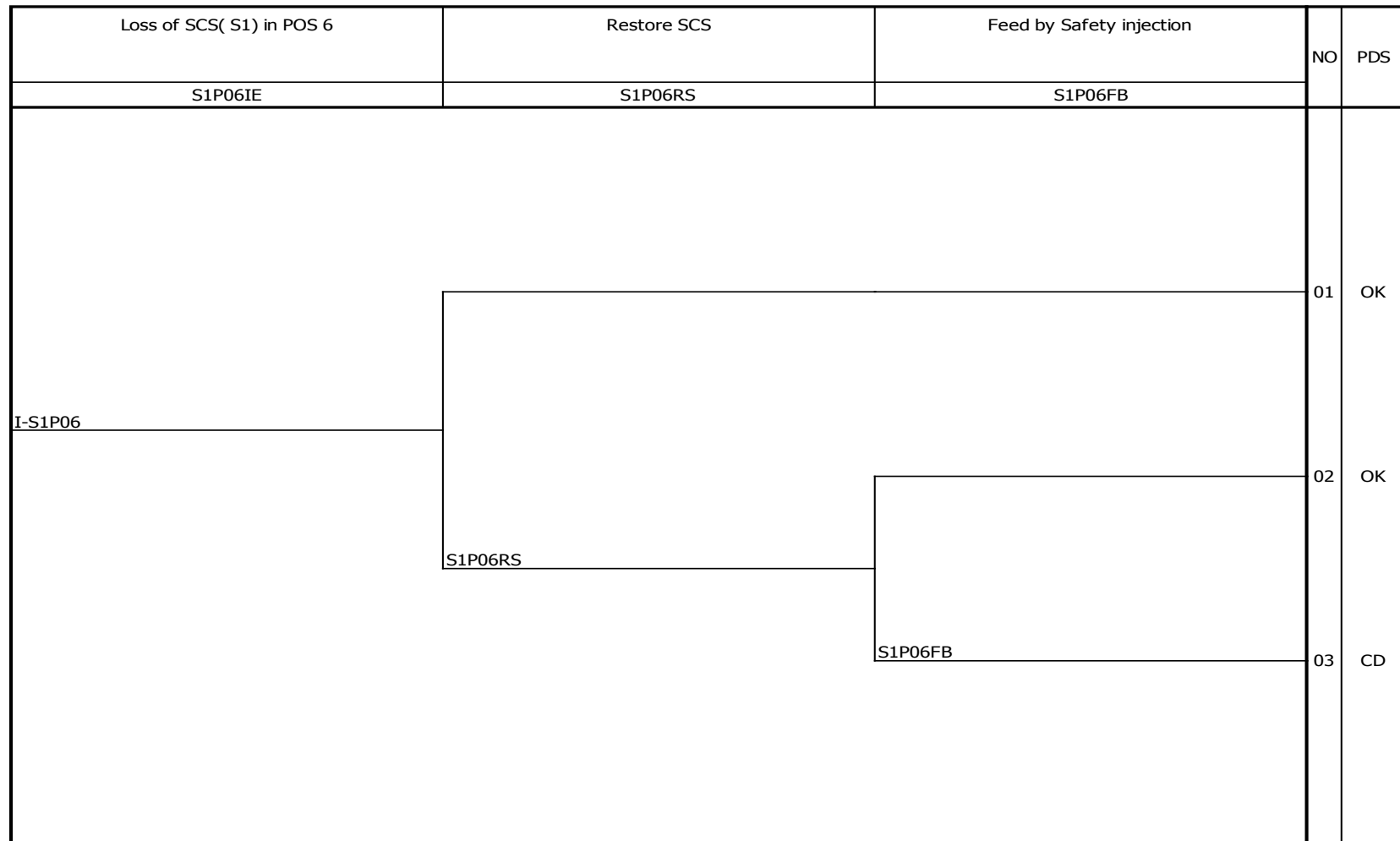


Figure 19.1-129 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 5

APR1400 DCD TIER 2**Figure 19.1-130 LPSD Level 1 Event Tree - Statation Blackout (LX) in POS 5**

APR1400 DCD TIER 2**Figure 19.1-131 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 6**

APR1400 DCD TIER 2

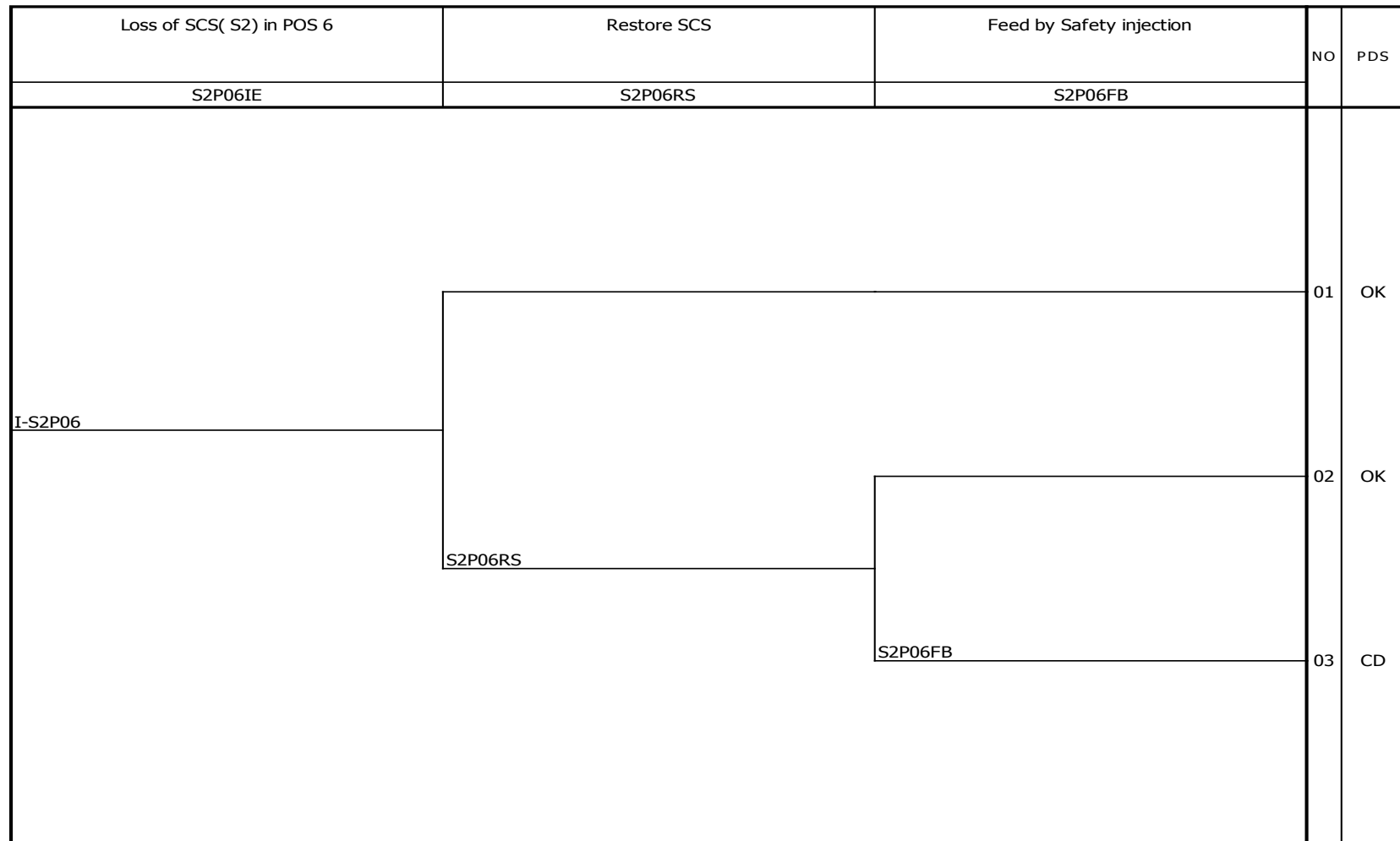


Figure 19.1-132 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 6

APR1400 DCD TIER 2

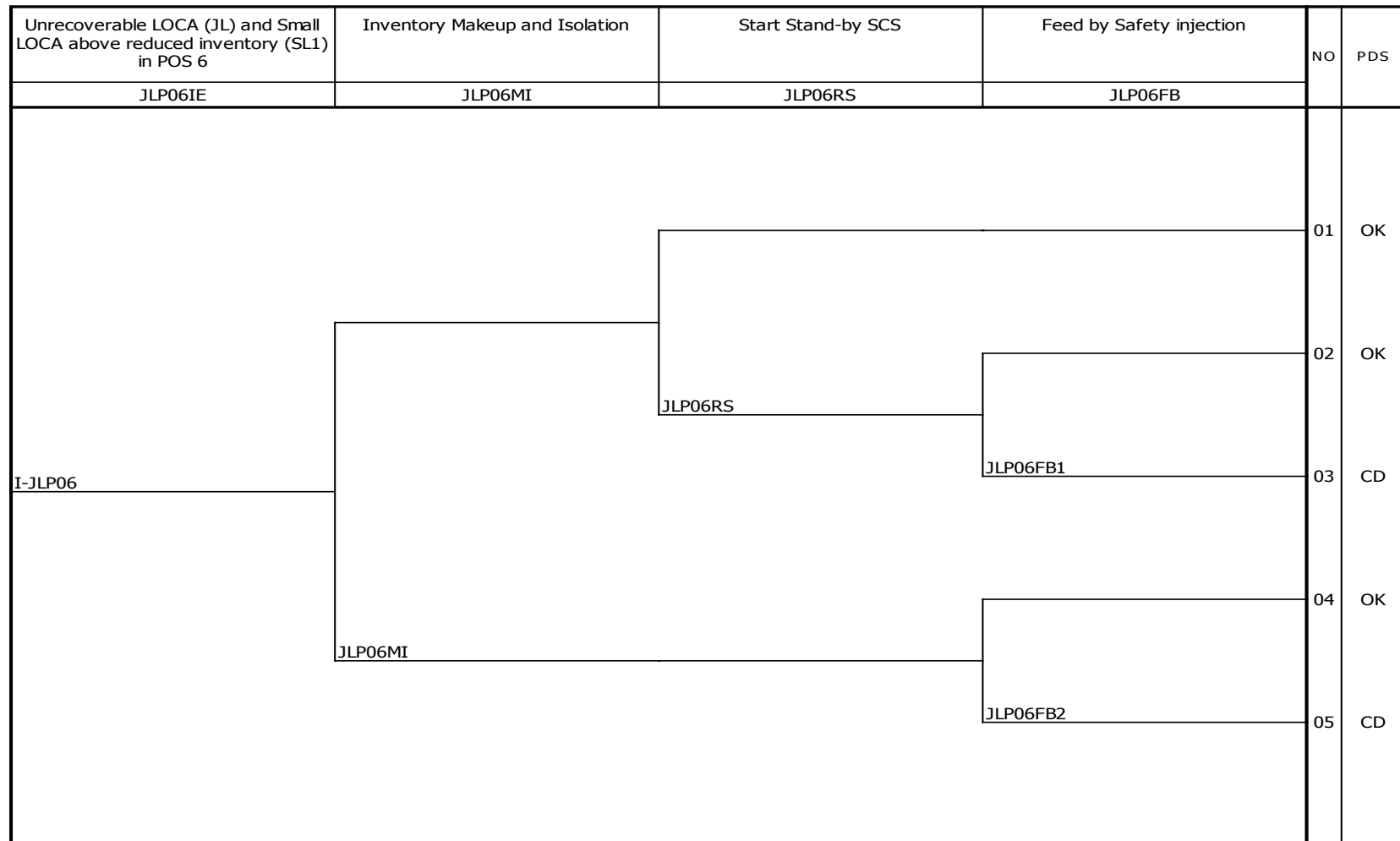


Figure 19.1-133 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 6

APR1400 DCD TIER 2

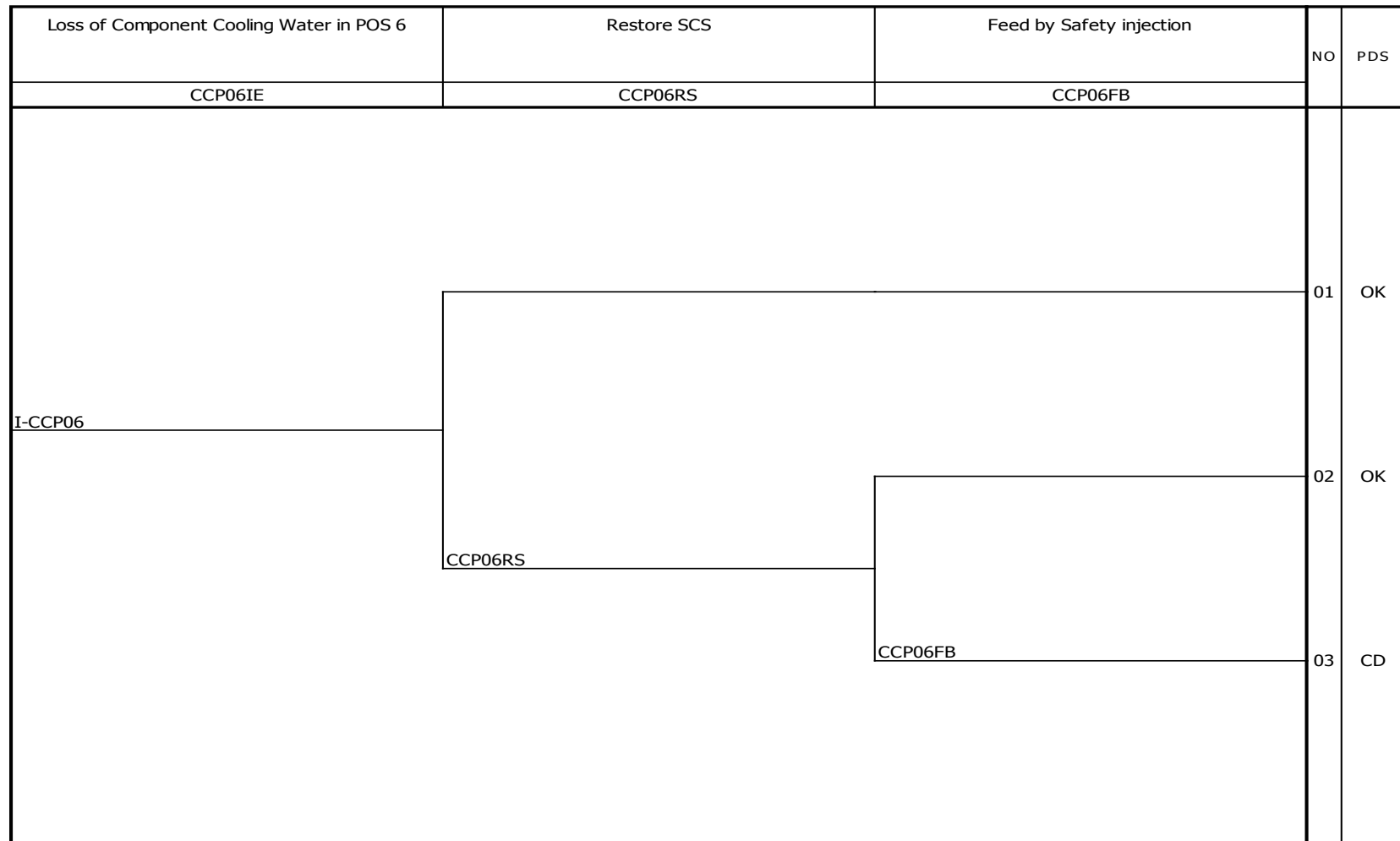
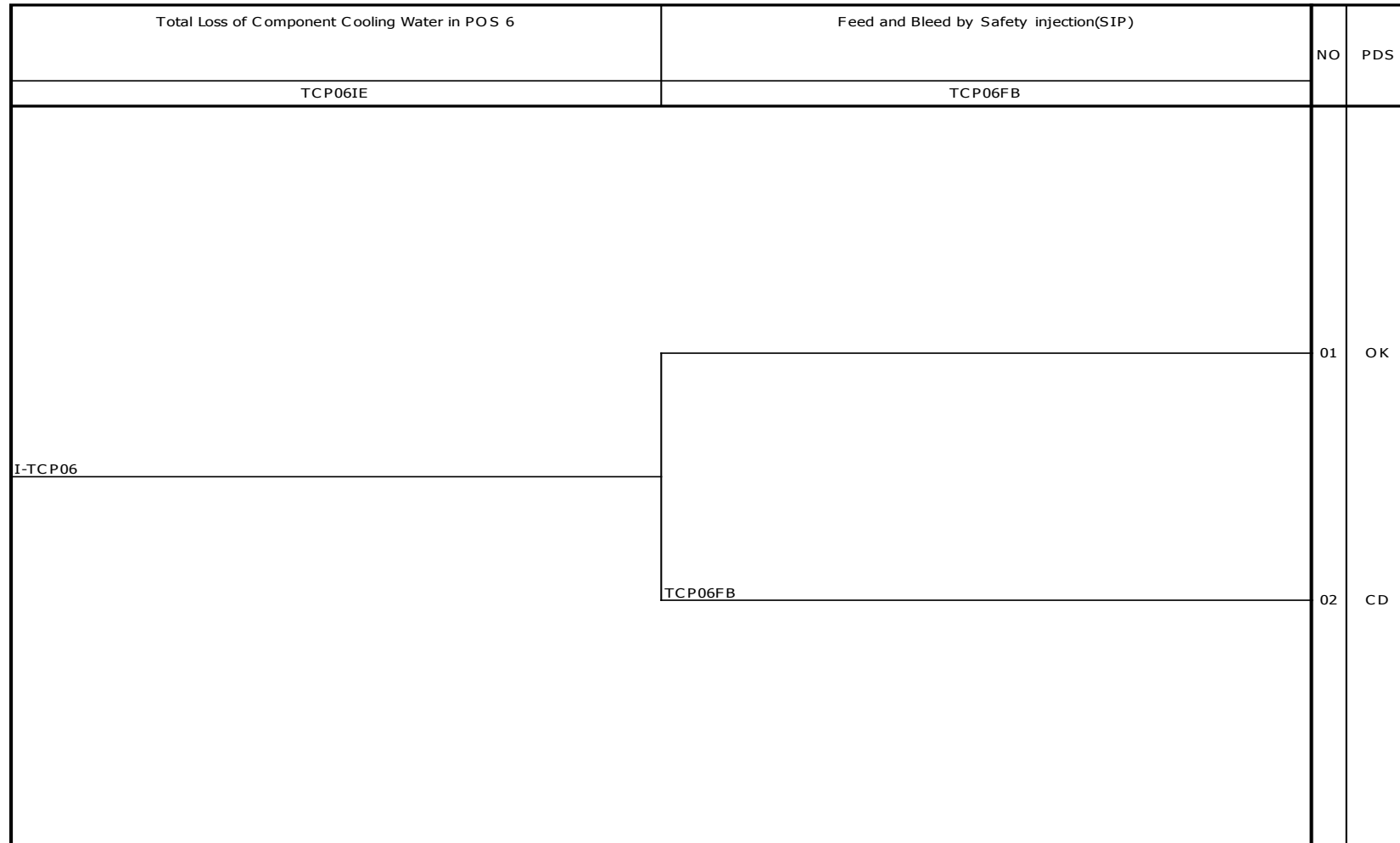


Figure 19.1-134 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 6

APR1400 DCD TIER 2**Figure 19.1-135 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 6**

APR1400 DCD TIER 2

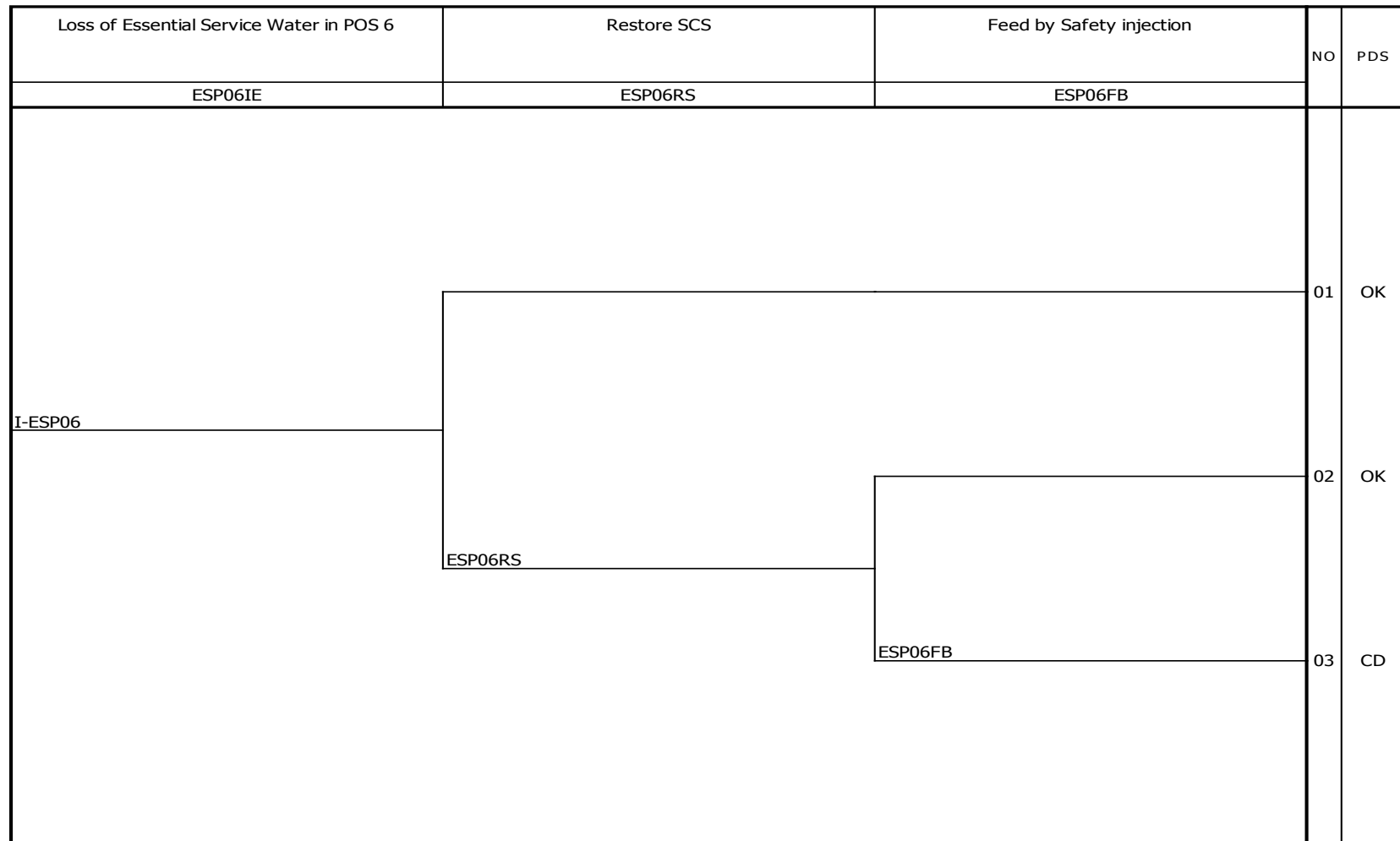
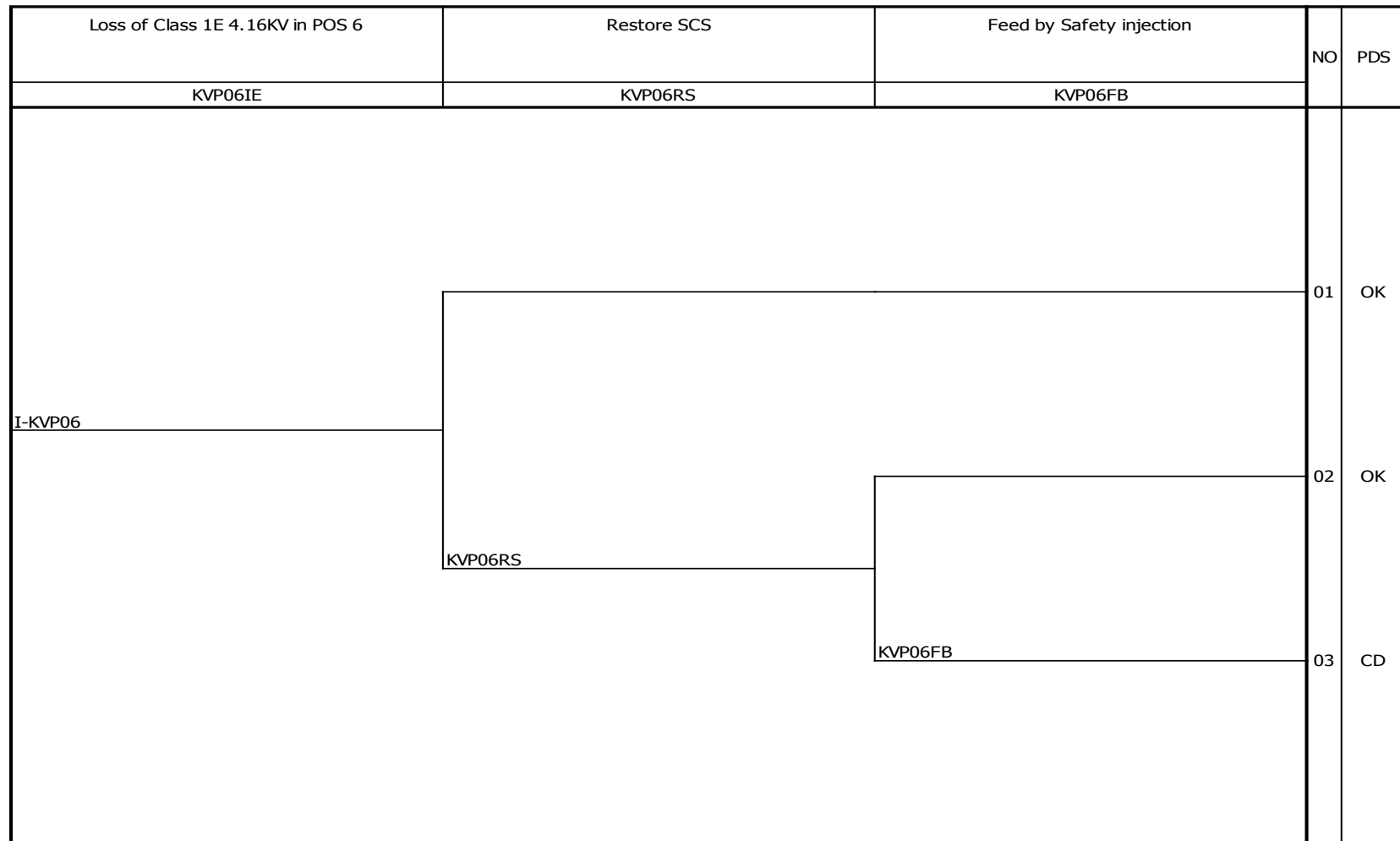


Figure 19.1-136 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 6

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 6	Feed and Bleed by Safety injection(SIP)	NO	PDS
TSP06IE	TSP06FB		
I-TSP06		01	OK
	TSP06FB	02	CD

Figure 19.1-137 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 6

APR1400 DCD TIER 2**Figure 19.1-138 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 6**

APR1400 DCD TIER 2

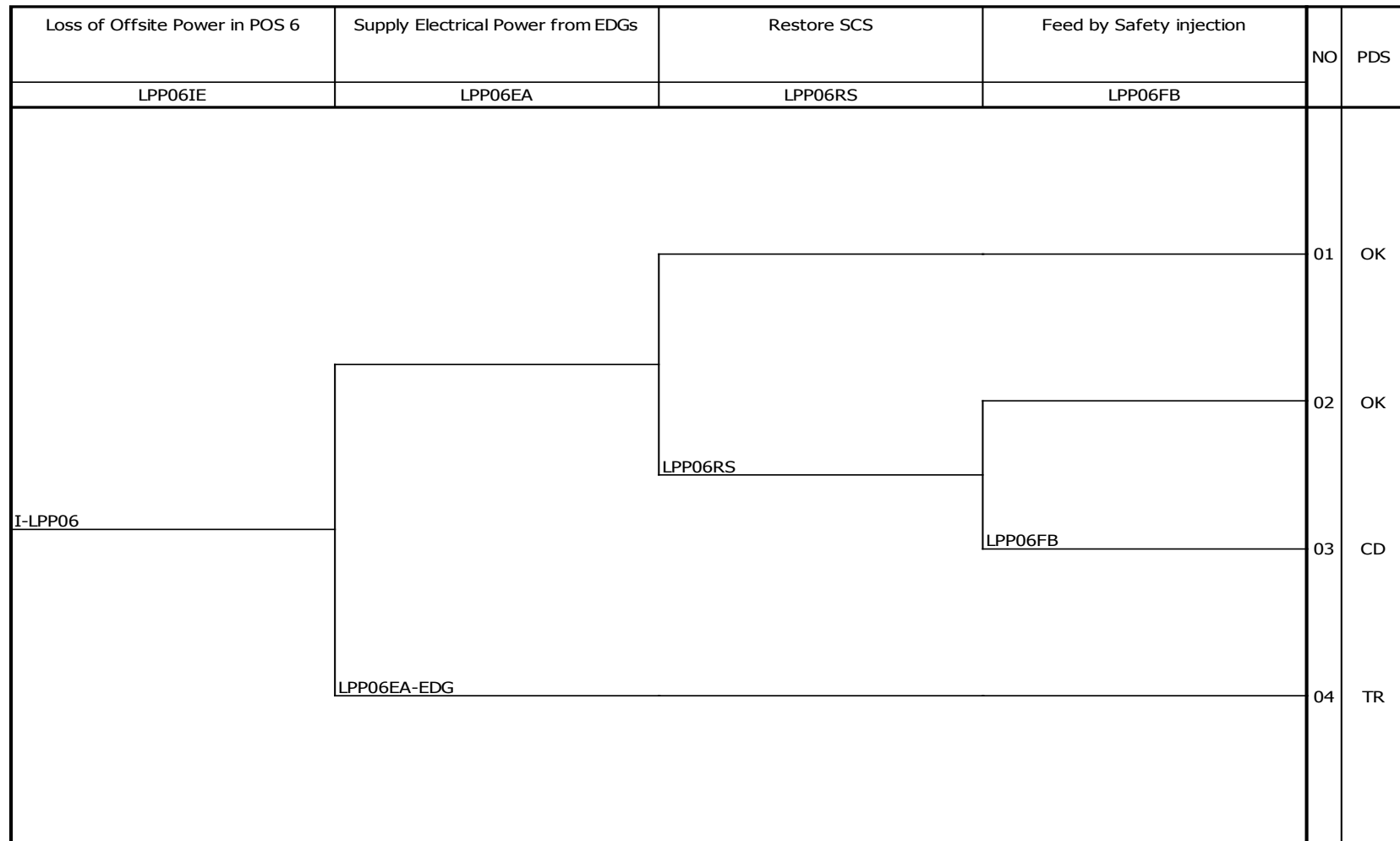
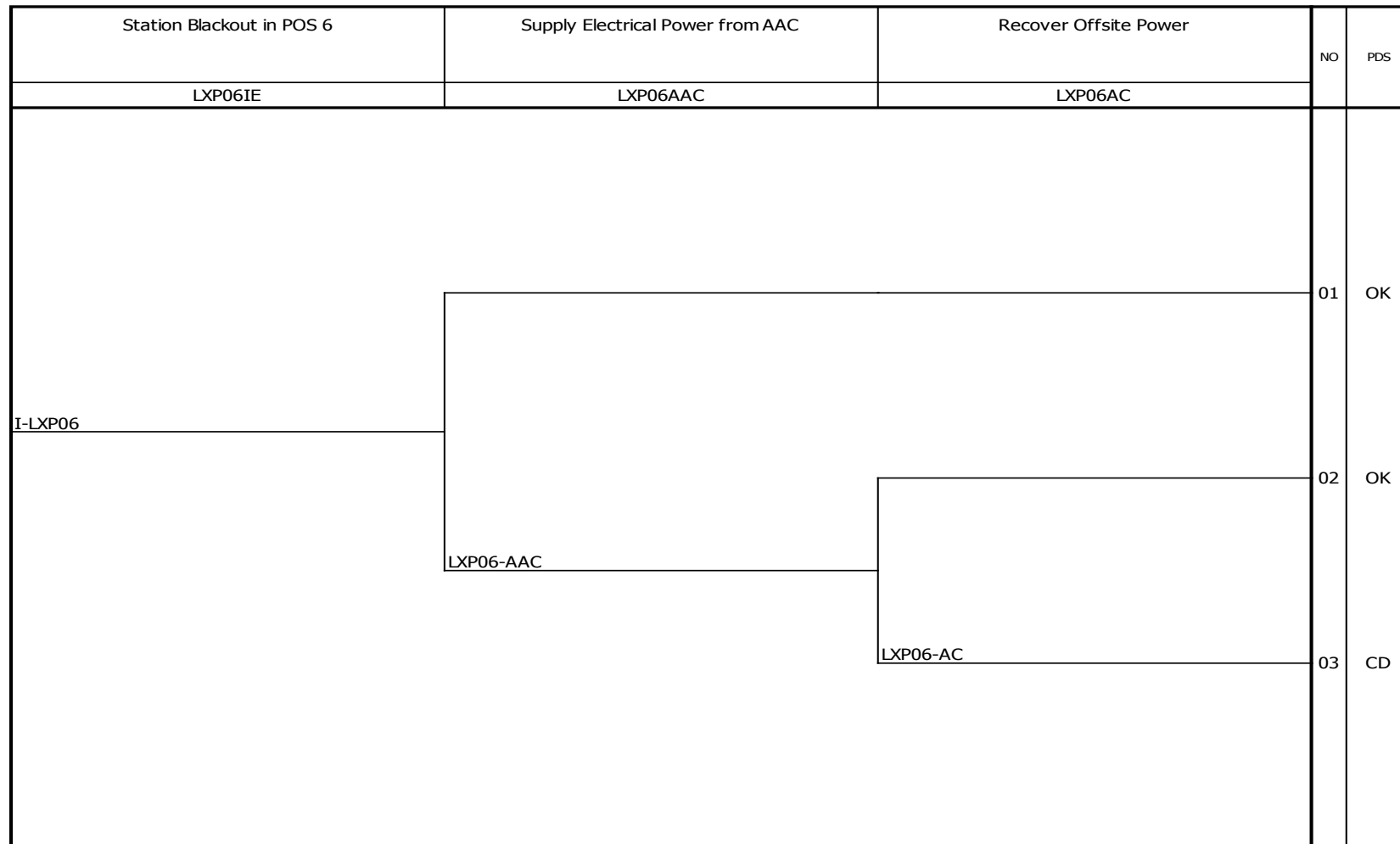


Figure 19.1-139 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 6

APR1400 DCD TIER 2**Figure 19.1-140 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 6**

APR1400 DCD TIER 2

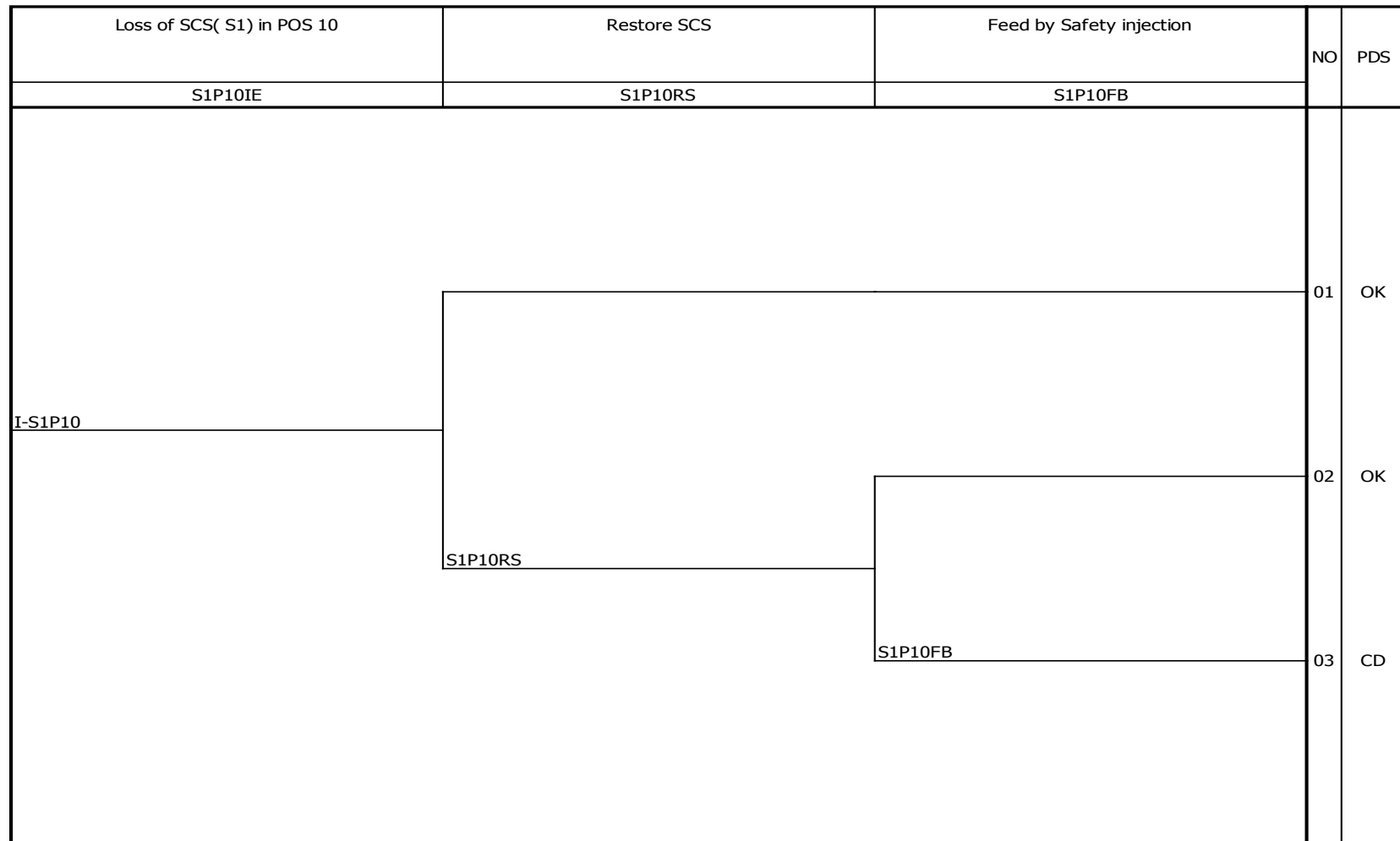
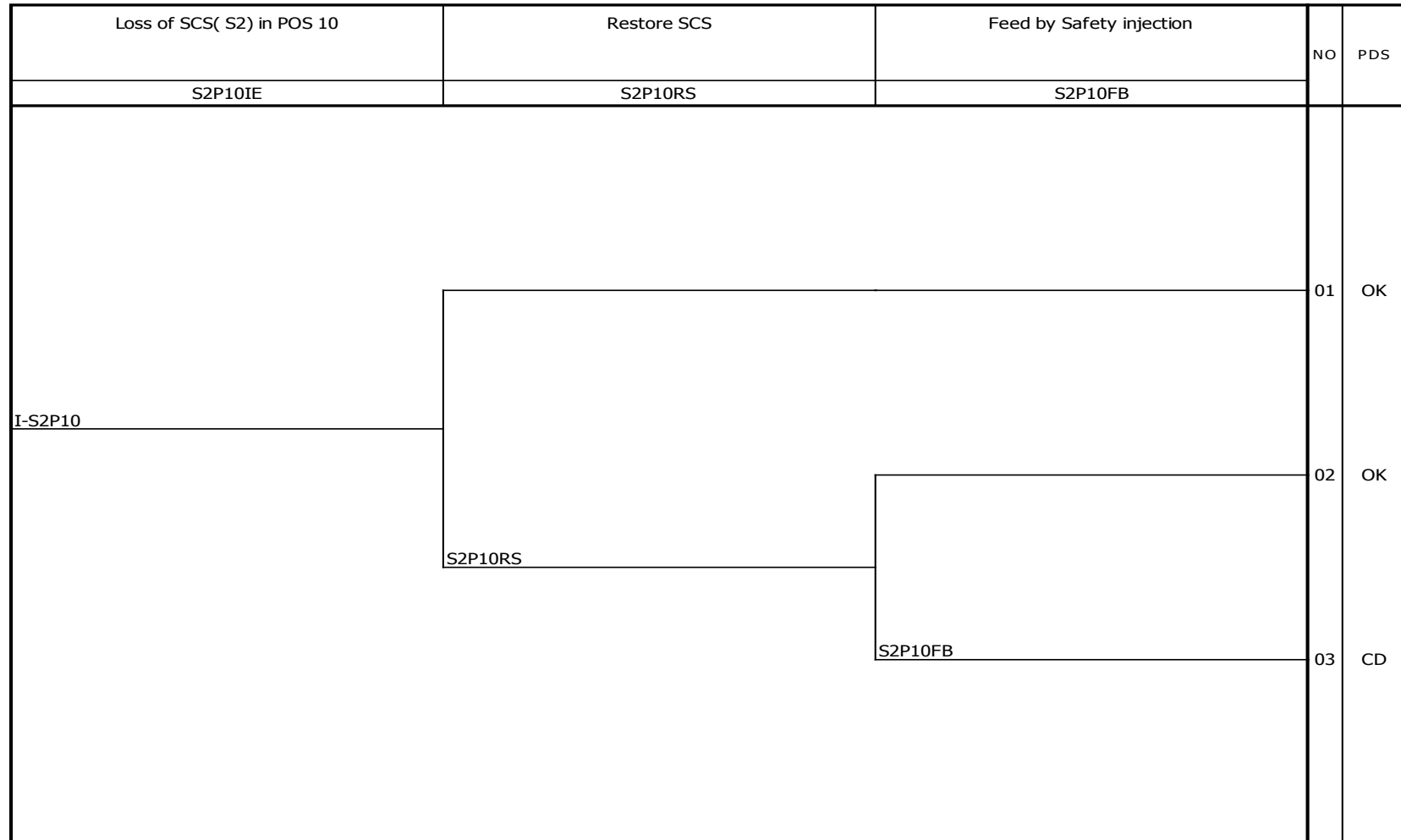
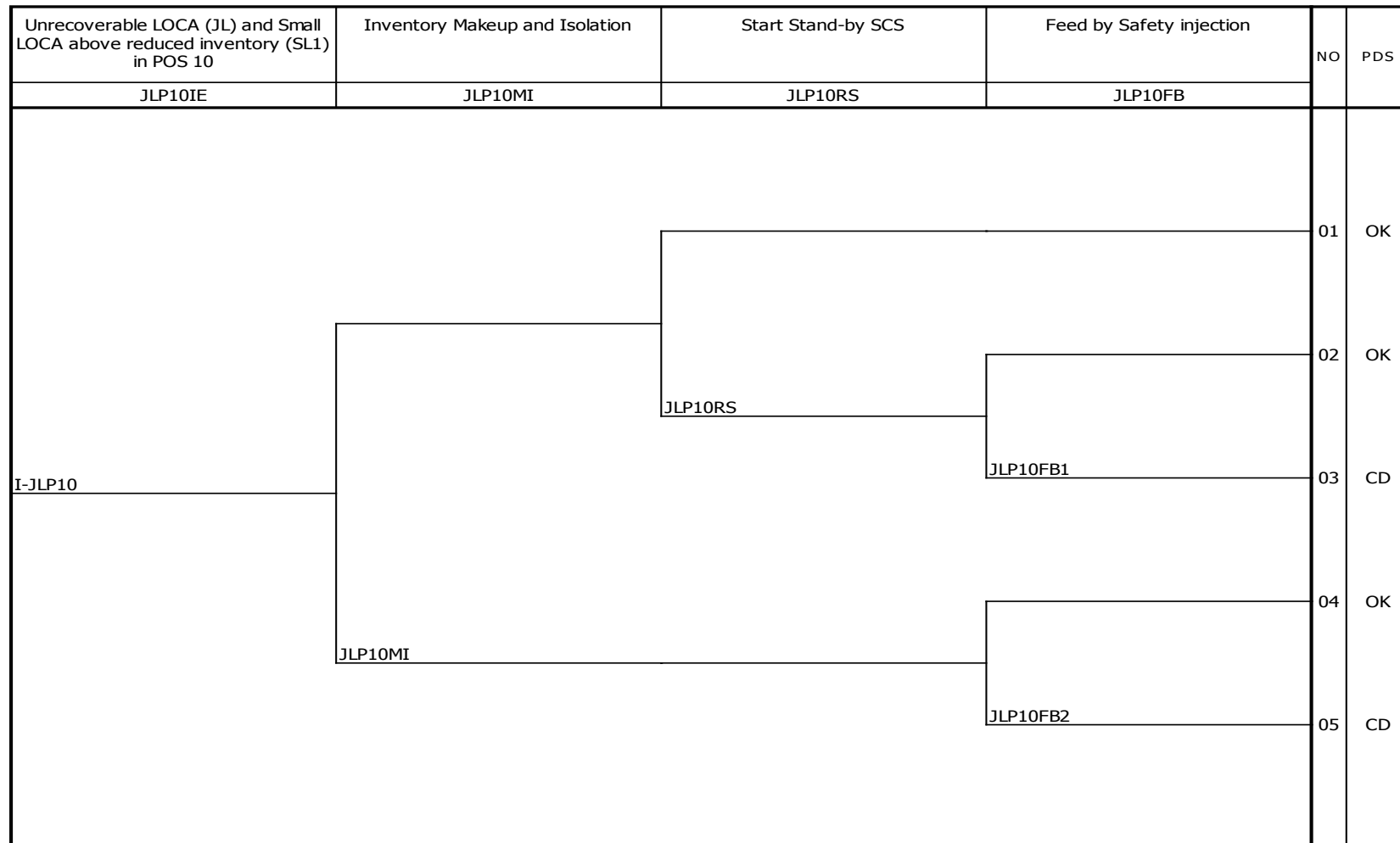
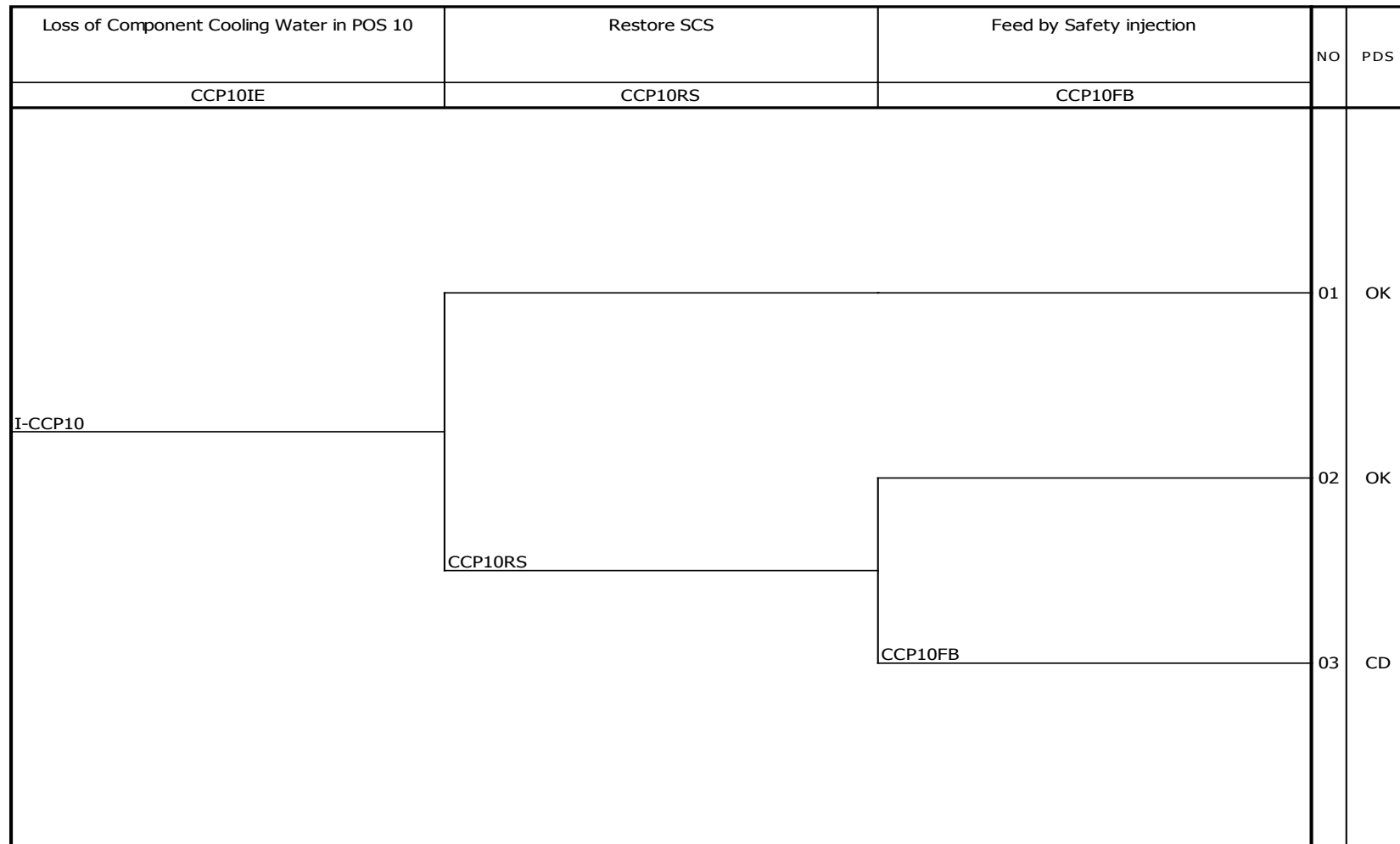
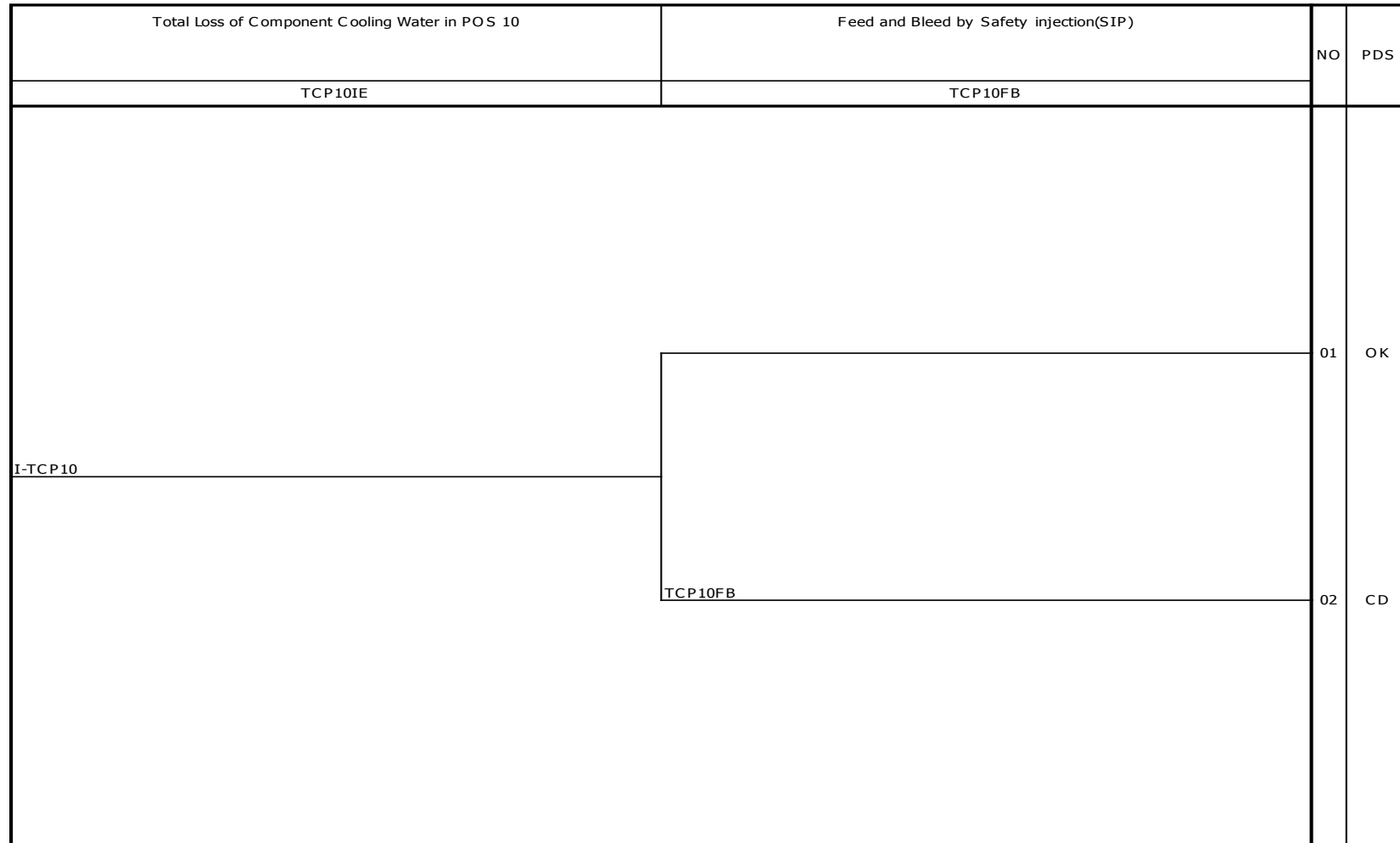


Figure 19.1-141 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 10

APR1400 DCD TIER 2**Figure 19.1-142 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 10**

APR1400 DCD TIER 2**Figure 19.1-143 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 10**

APR1400 DCD TIER 2**Figure 19.1-144 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 10**

APR1400 DCD TIER 2**Figure 19.1-145 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 10**

APR1400 DCD TIER 2

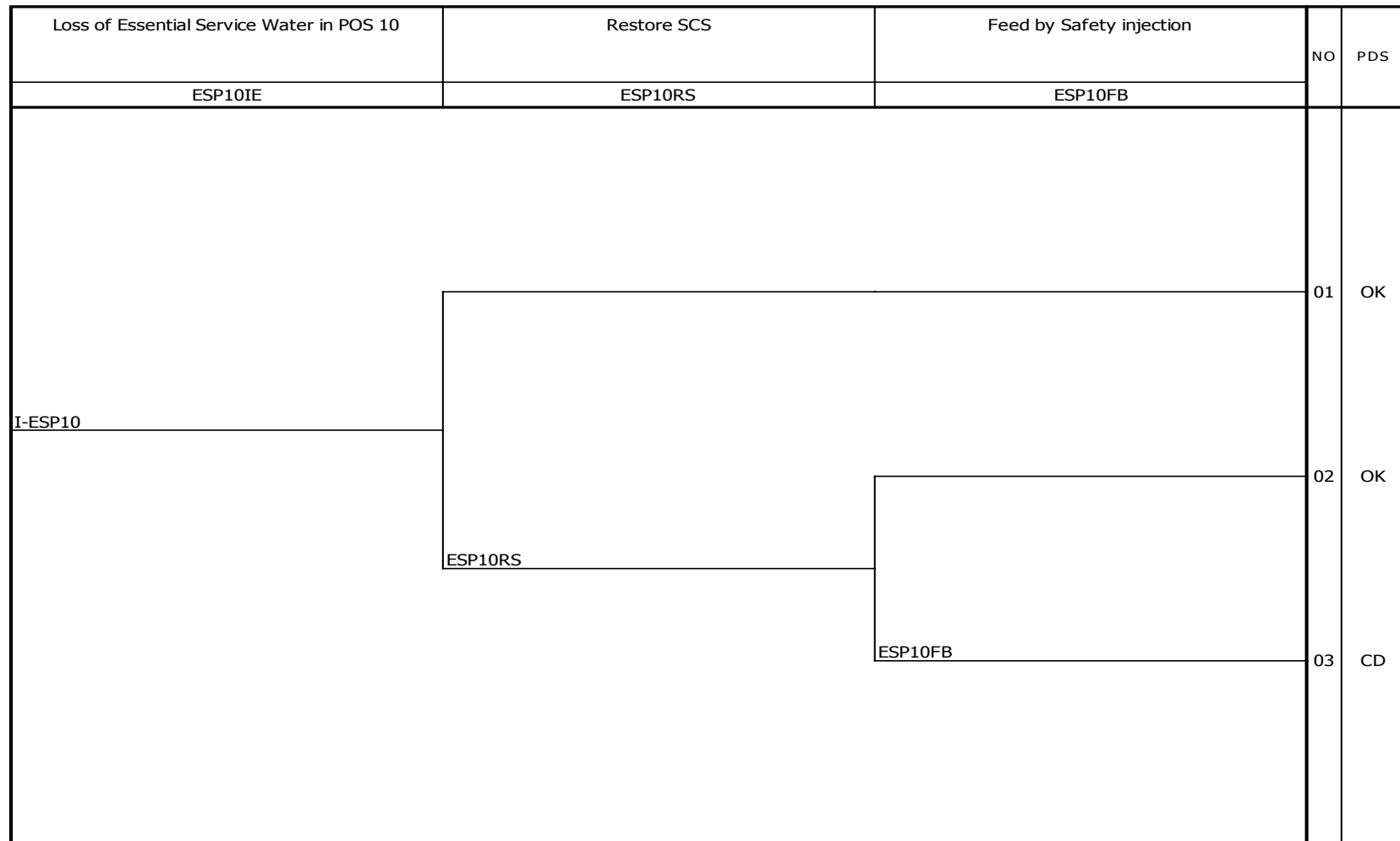


Figure 19.1-146 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 10

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 10	Feed and Bleed by Safety injection(SIP)	NO	PDS
TSP10IE	TSP10FB		
I-TSP10		01	OK
	TSP10FB	02	CD

Figure 19.1-147 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 10

APR1400 DCD TIER 2

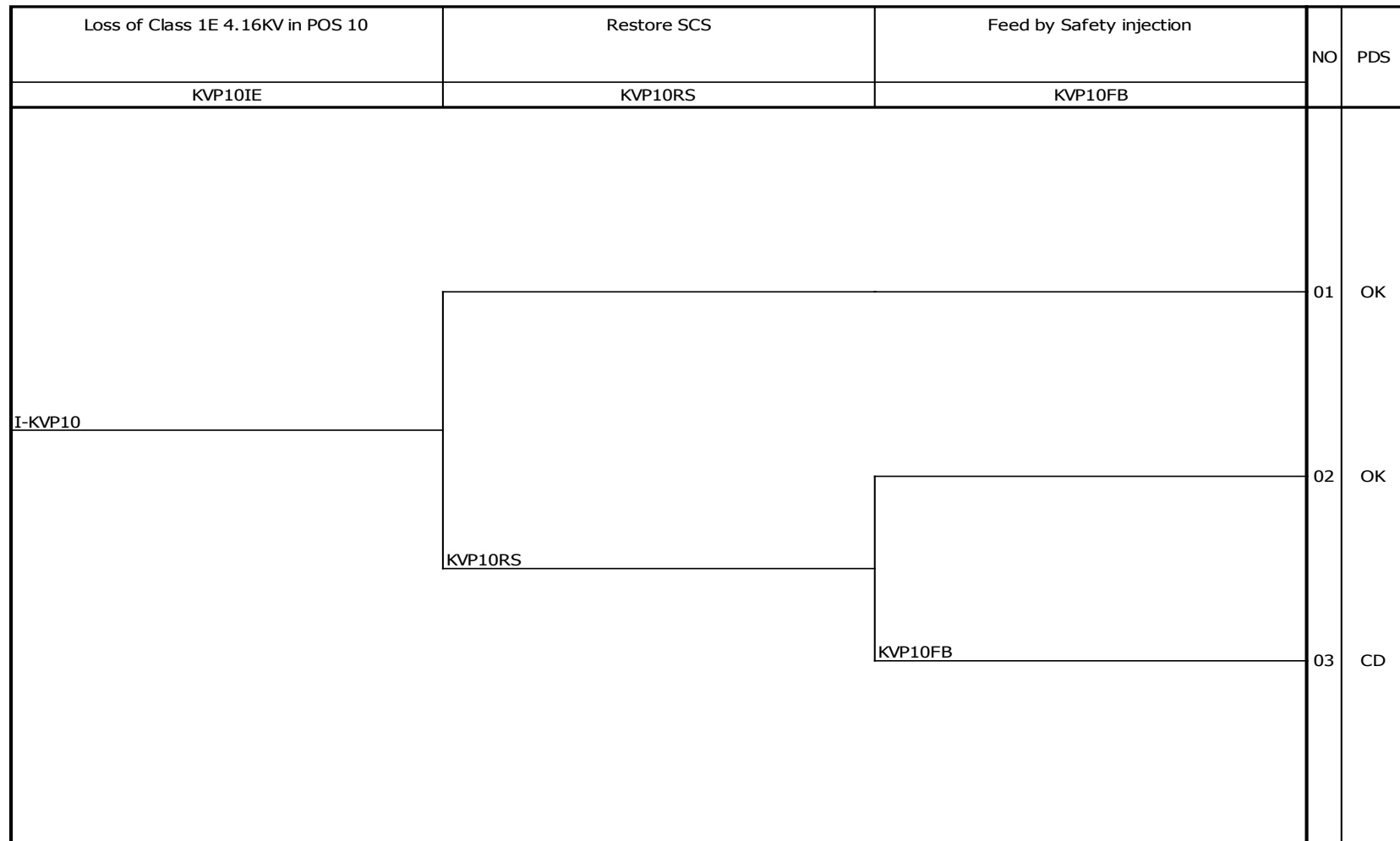


Figure 19.1-148 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 10

APR1400 DCD TIER 2

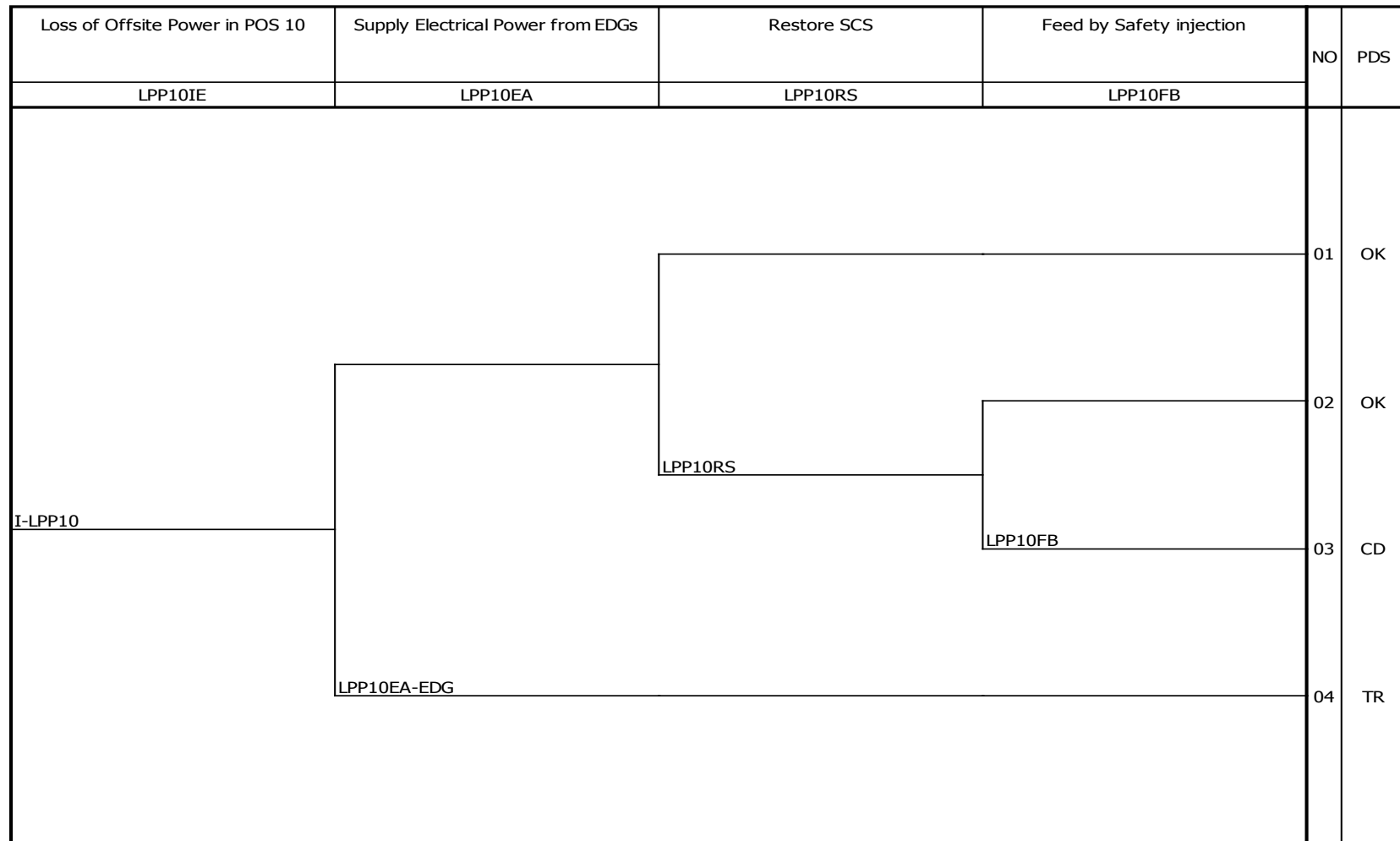
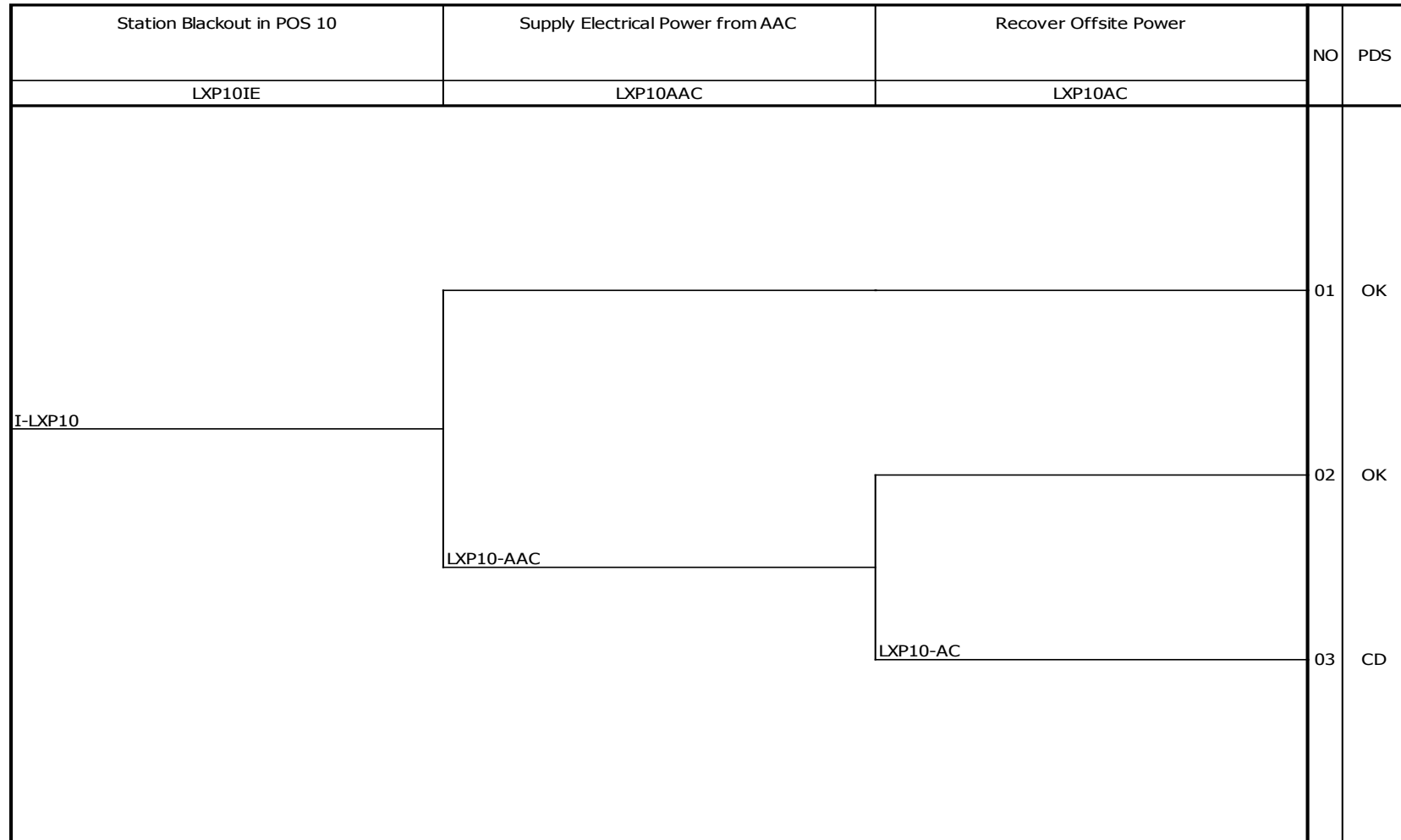


Figure 19.1-149 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 10

APR1400 DCD TIER 2**Figure 19.1-150 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 10**

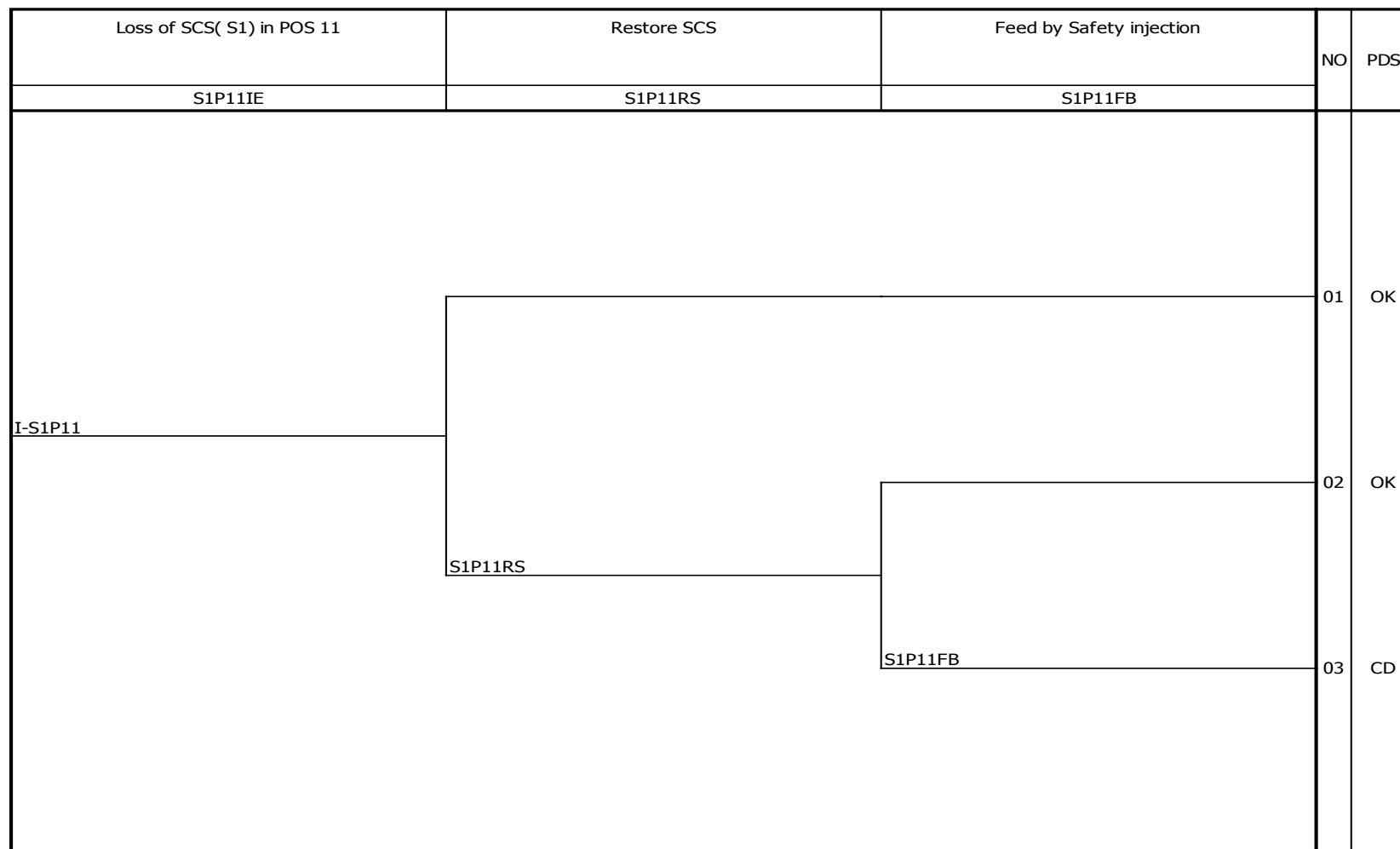
APR1400 DCD TIER 2

Figure 19.1-151 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 11

APR1400 DCD TIER 2

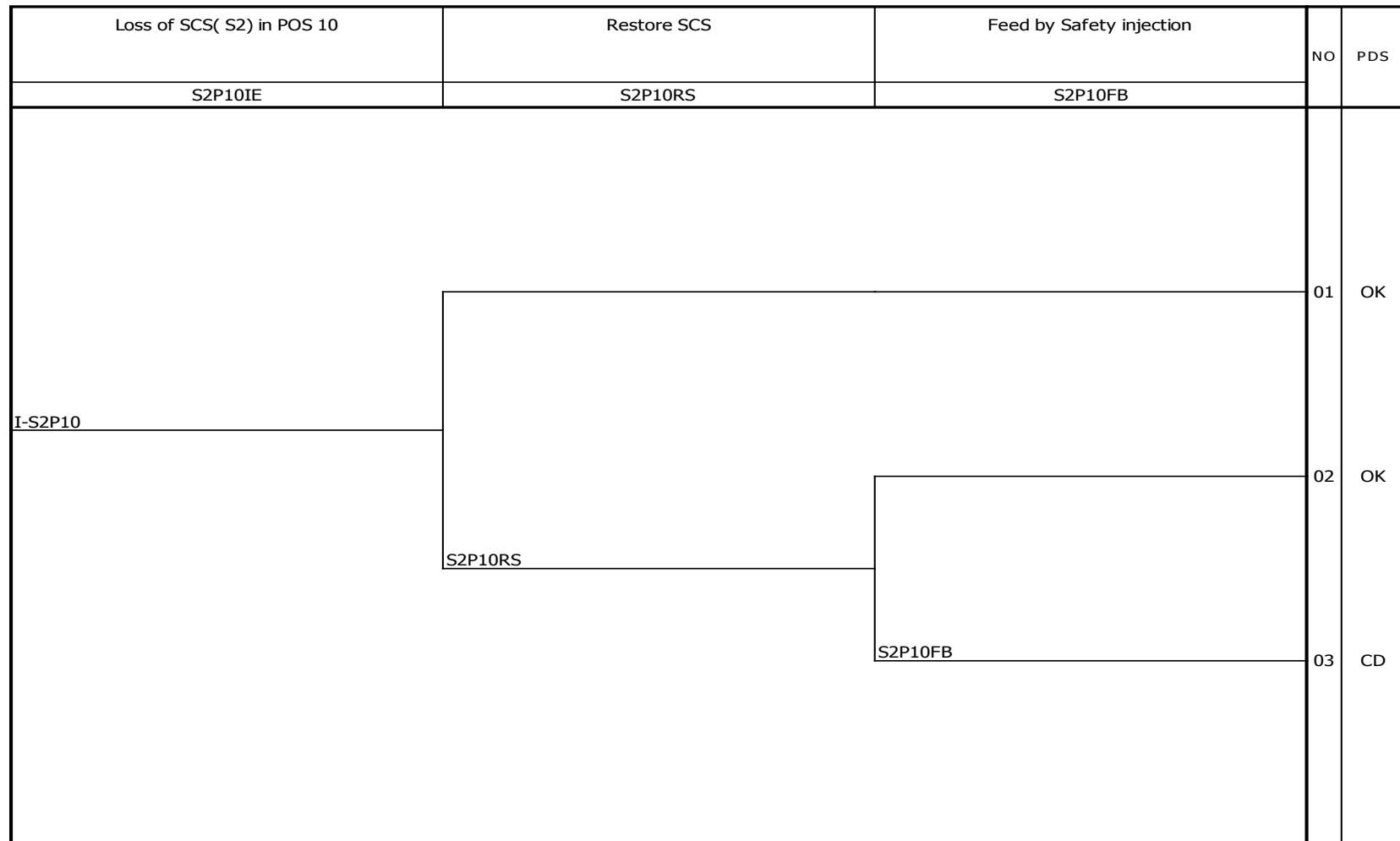


Figure 19.1-152 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 11

APR1400 DCD TIER 2

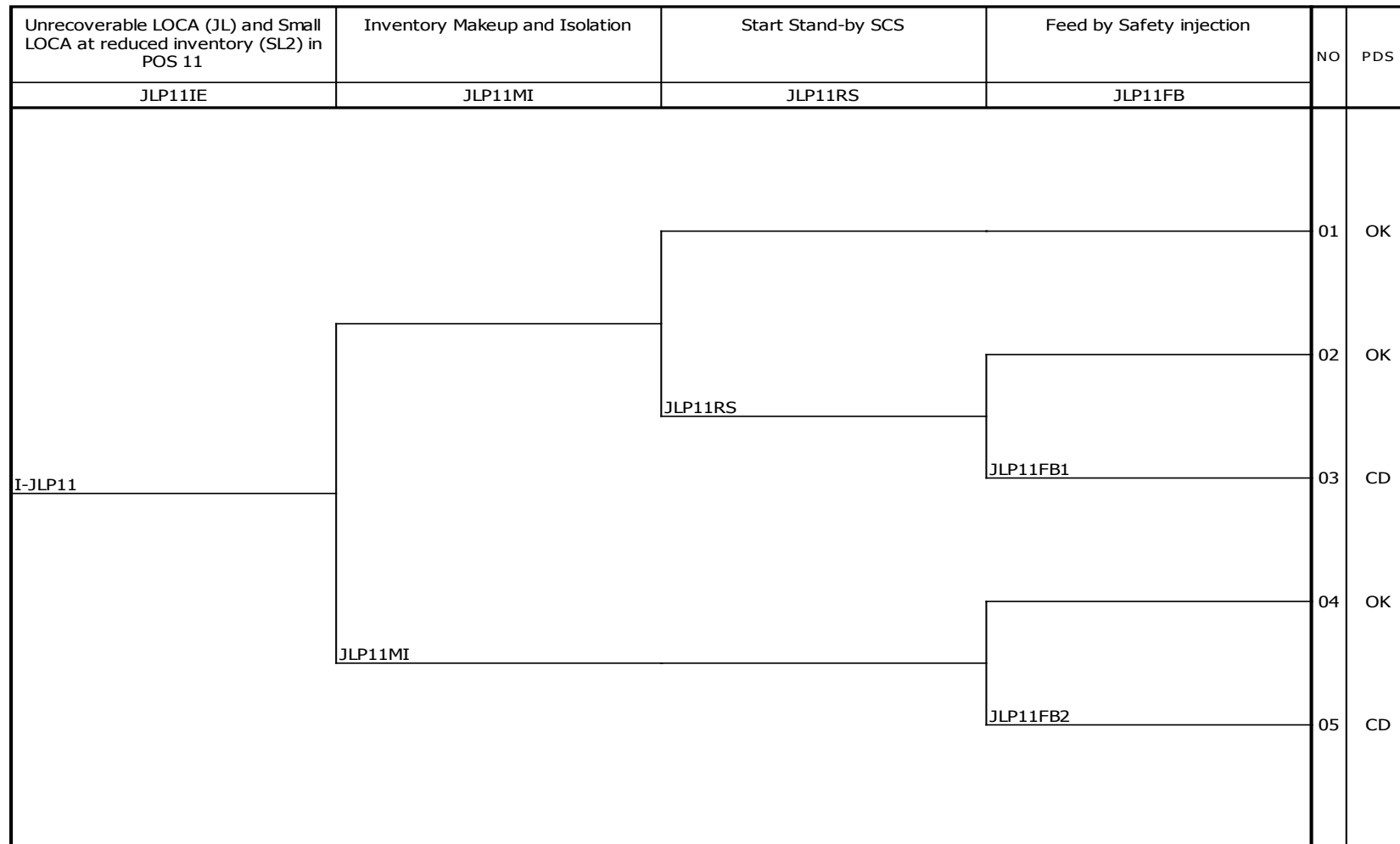


Figure 19.1-153 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 11

APR1400 DCD TIER 2

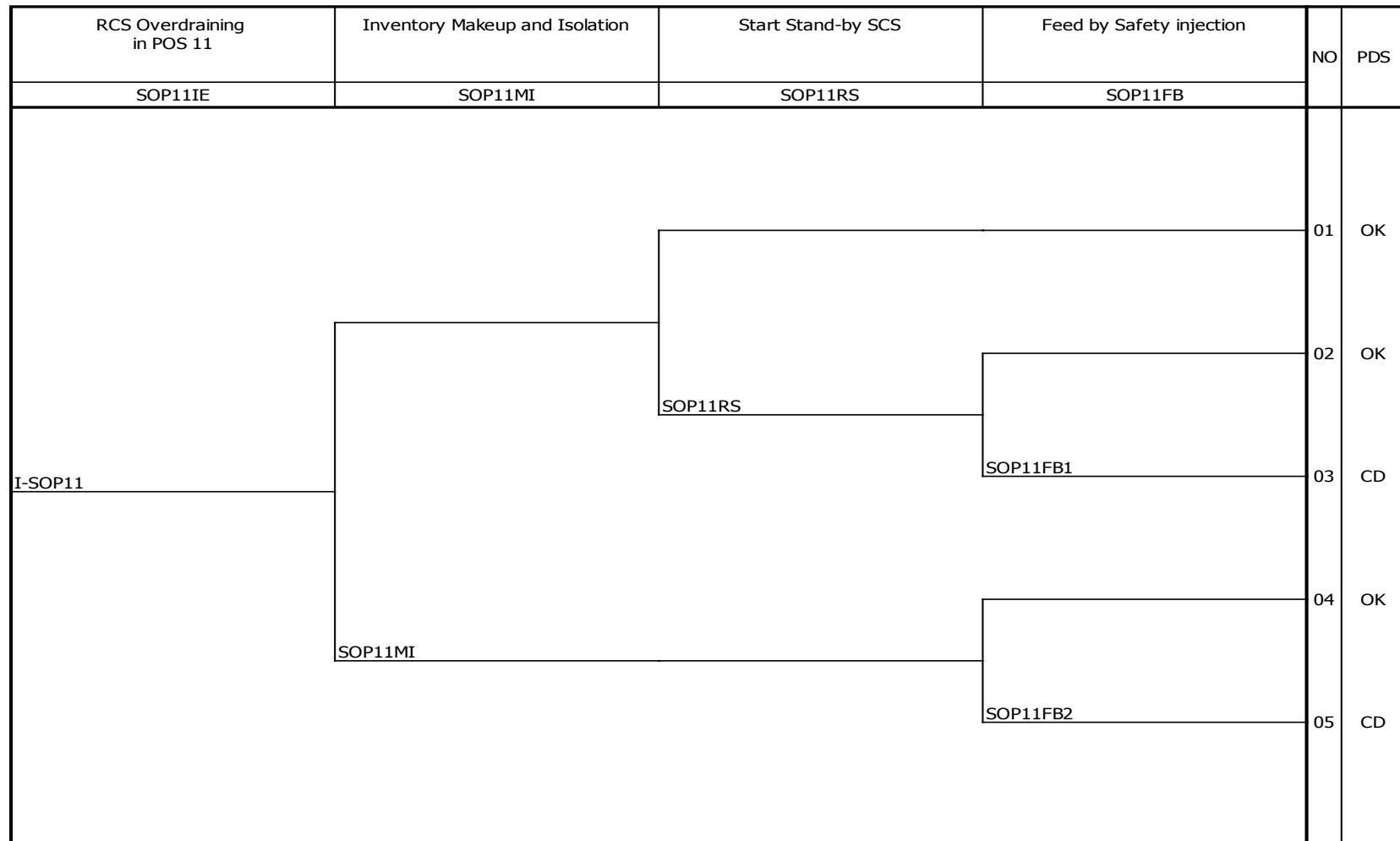


Figure 19.1-154 LPSD Level 1 Event Tree – Over-drainage During Reduced Inventory Operation (SO) in POS 11

APR1400 DCD TIER 2

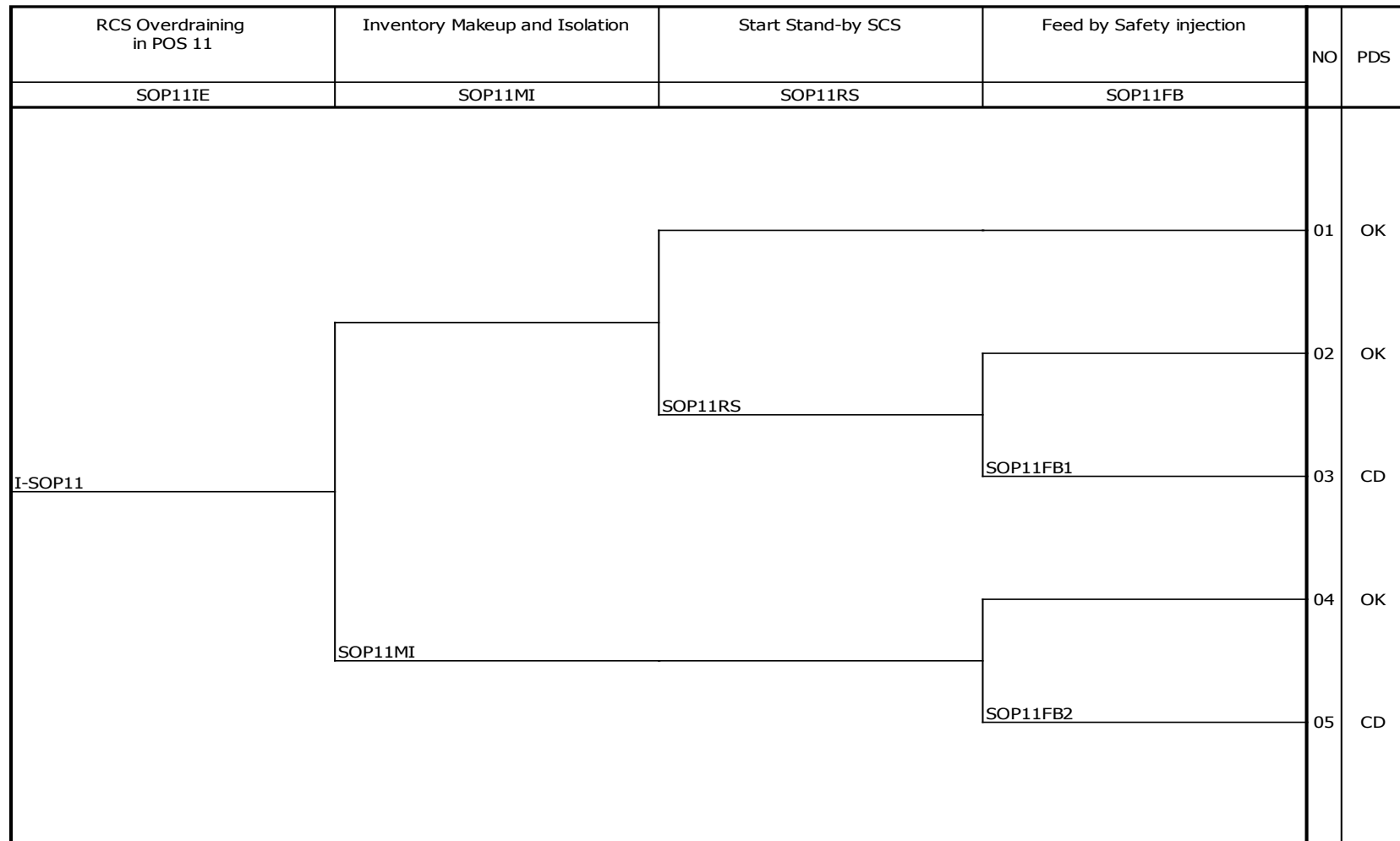


Figure 19.1-155 LPSD Level 1 Event Tree – Over-drainage During Reduced Inventory Operation (SO) in POS 11

APR1400 DCD TIER 2

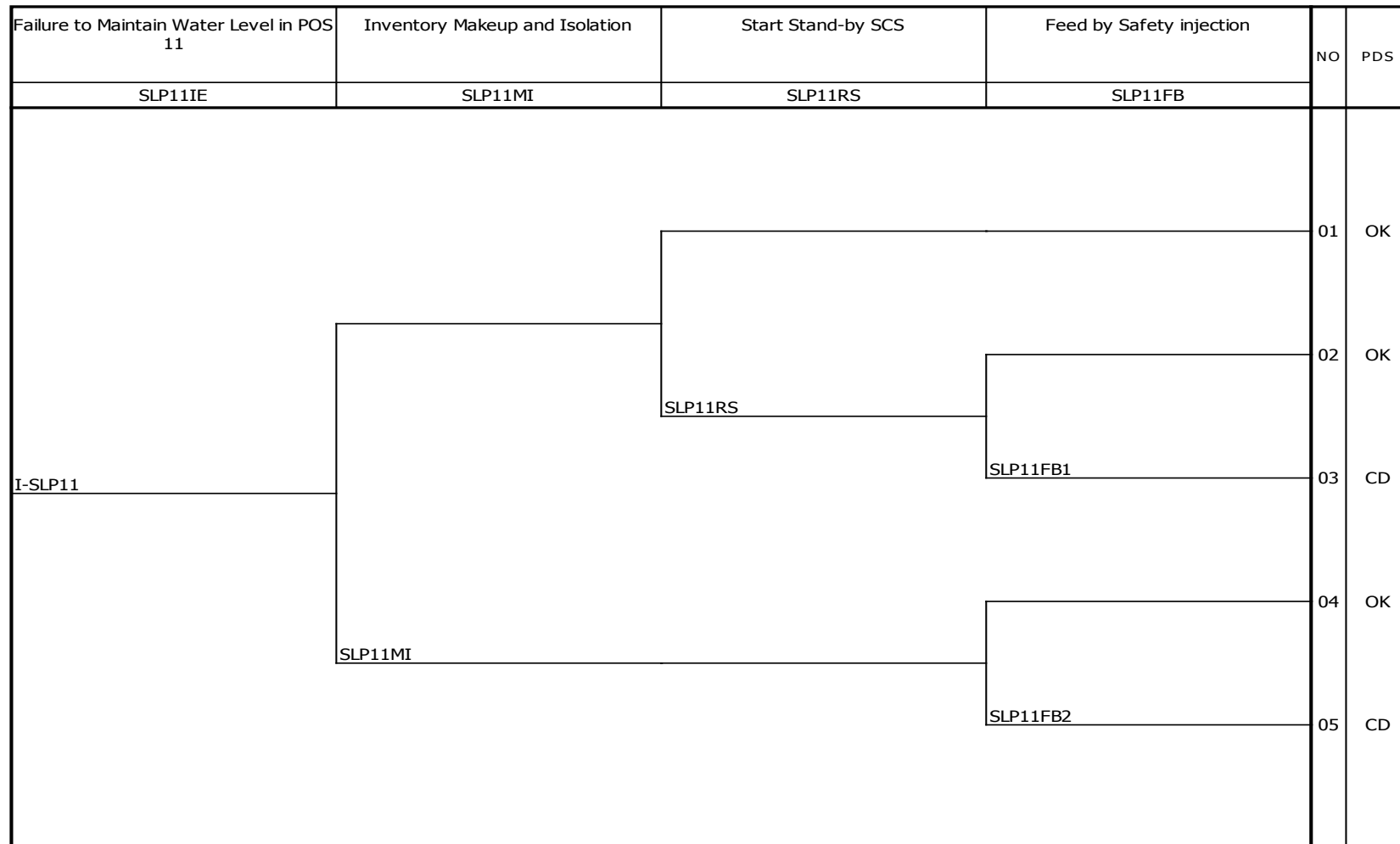


Figure 19.1-156 LPSD Level 1 Event Tree - Failure to Maintain Water Level During Reduced Inventory Operation (SL) in POS 11

APR1400 DCD TIER 2

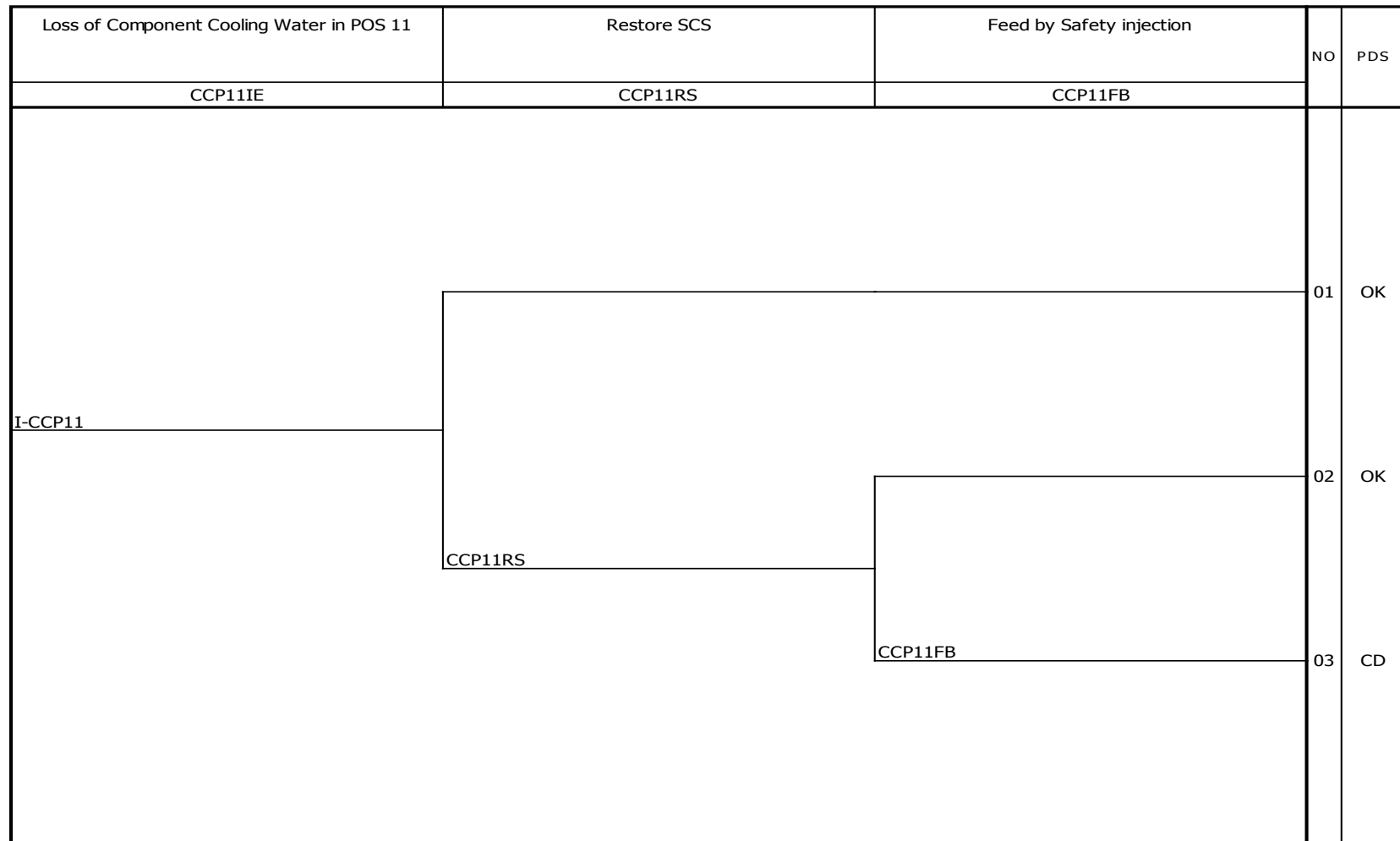


Figure 19.1-157 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 11

APR1400 DCD TIER 2

Total Loss of Component Cooling Water in POS 11	Feed and Bleed by Safety injection(SIP)	NO	PDS
TCP11IE	TCP11FB		
I-TCP11		01	OK
	TCP11FB	02	CD

Figure 19.1-158 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 11

APR1400 DCD TIER 2

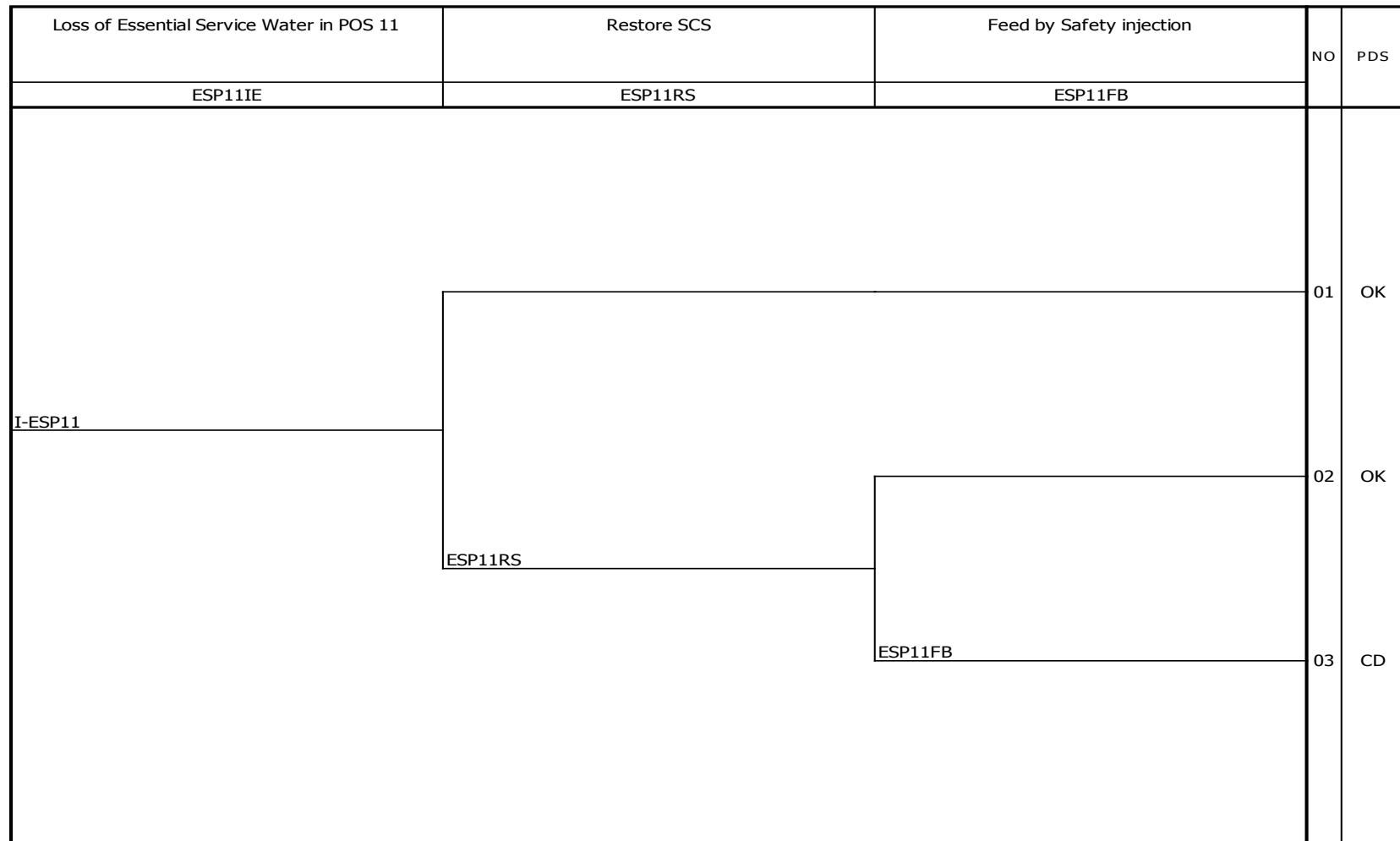


Figure 19.1-159 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 11

APR1400 DCD TIER 2

Total Loss of Essential Service Water in POS 11	Feed and Bleed by Safety injection(SIP)	NO	PDS
TSP11IE	TSP11FB		
I-TSP11		01	OK
	TSP11FB	02	CD

Figure 19.1-160 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 11

APR1400 DCD TIER 2

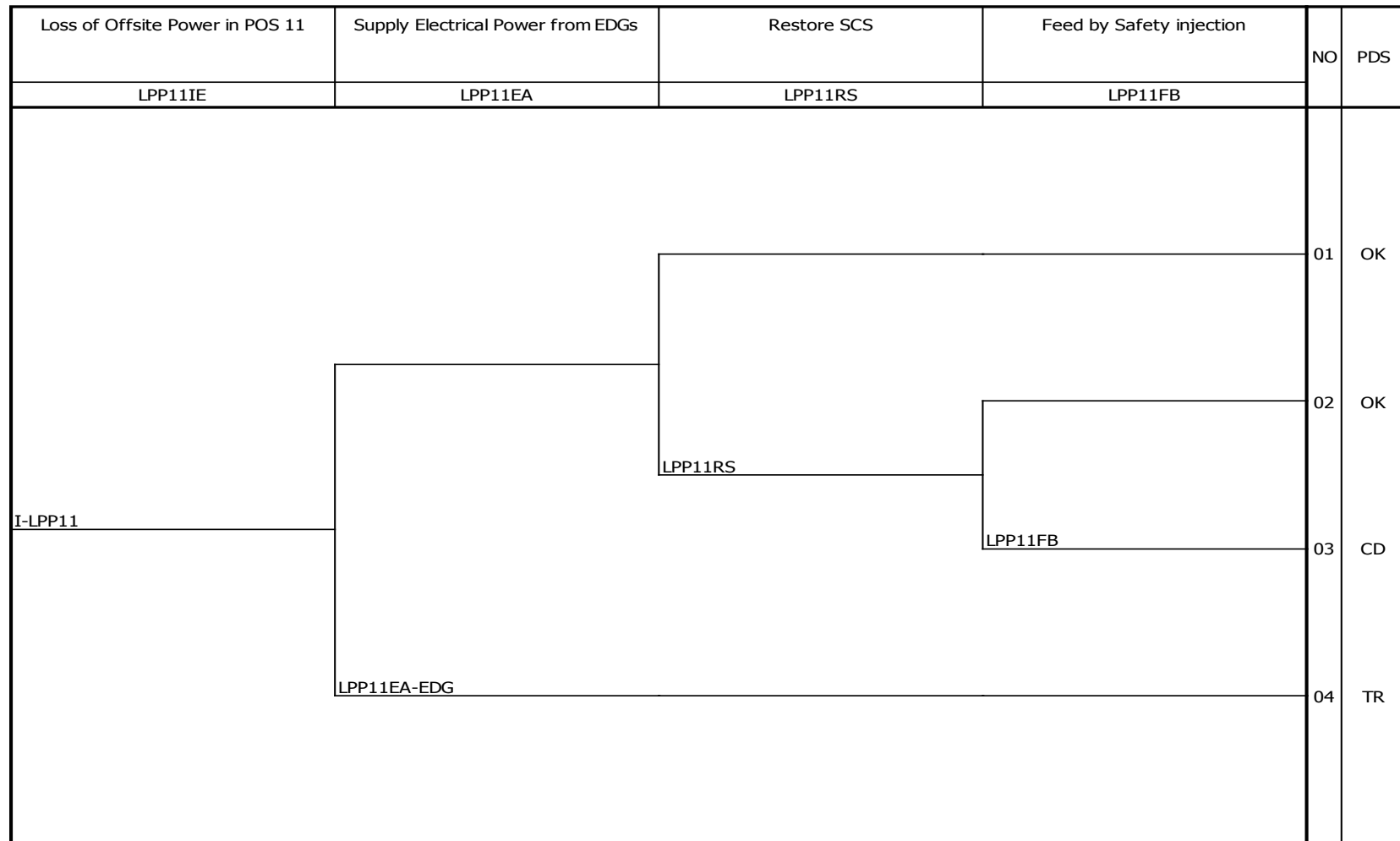
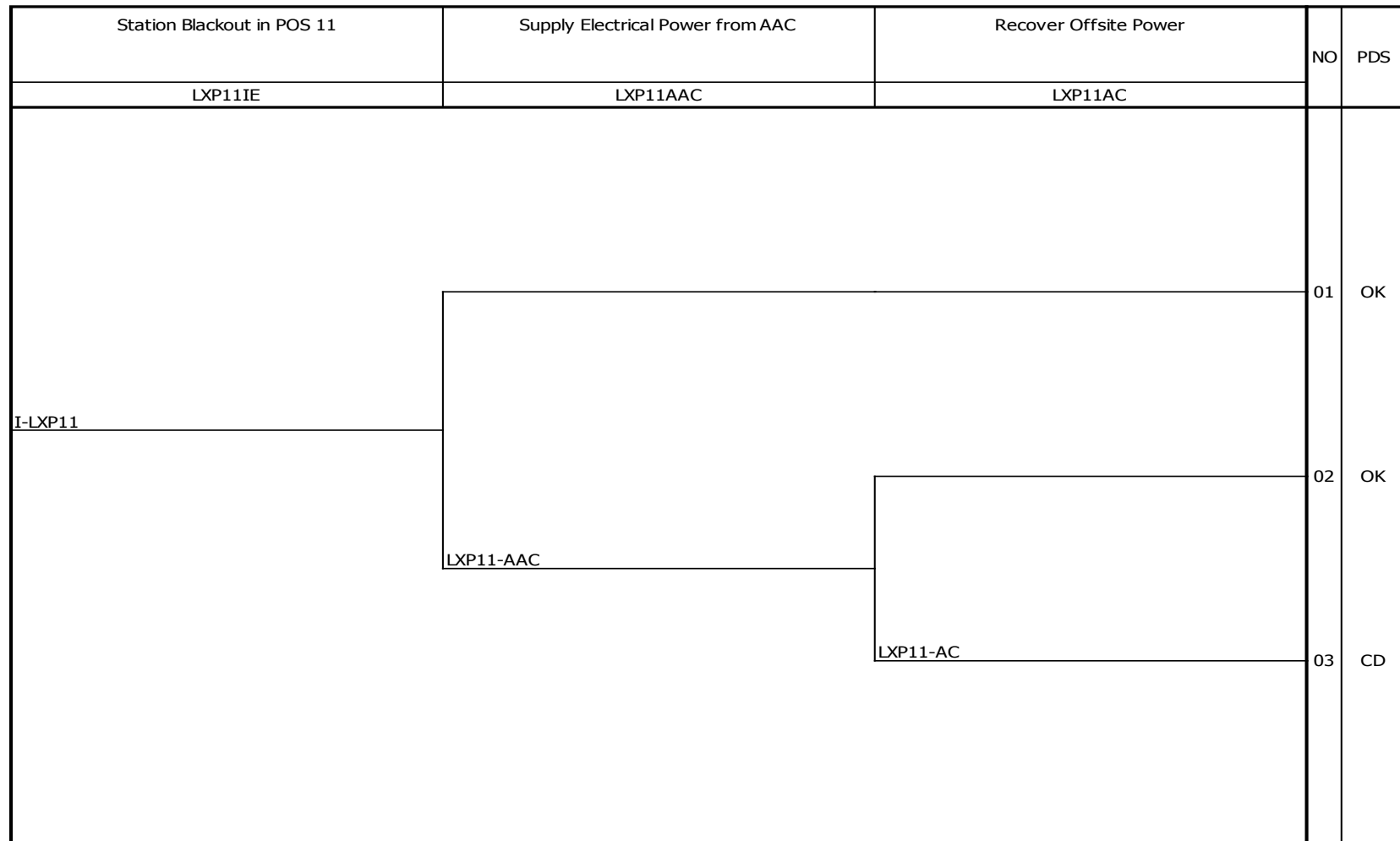
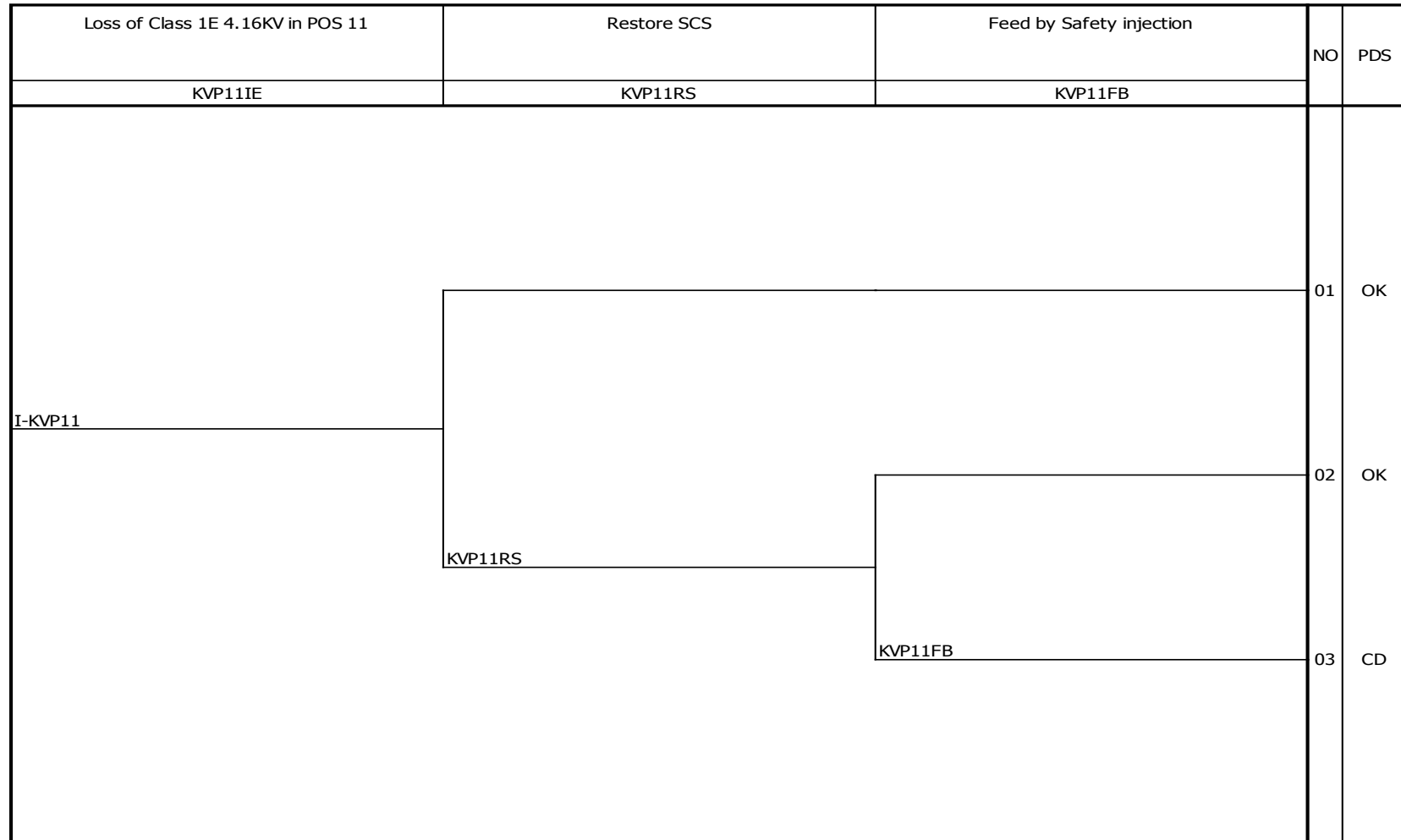
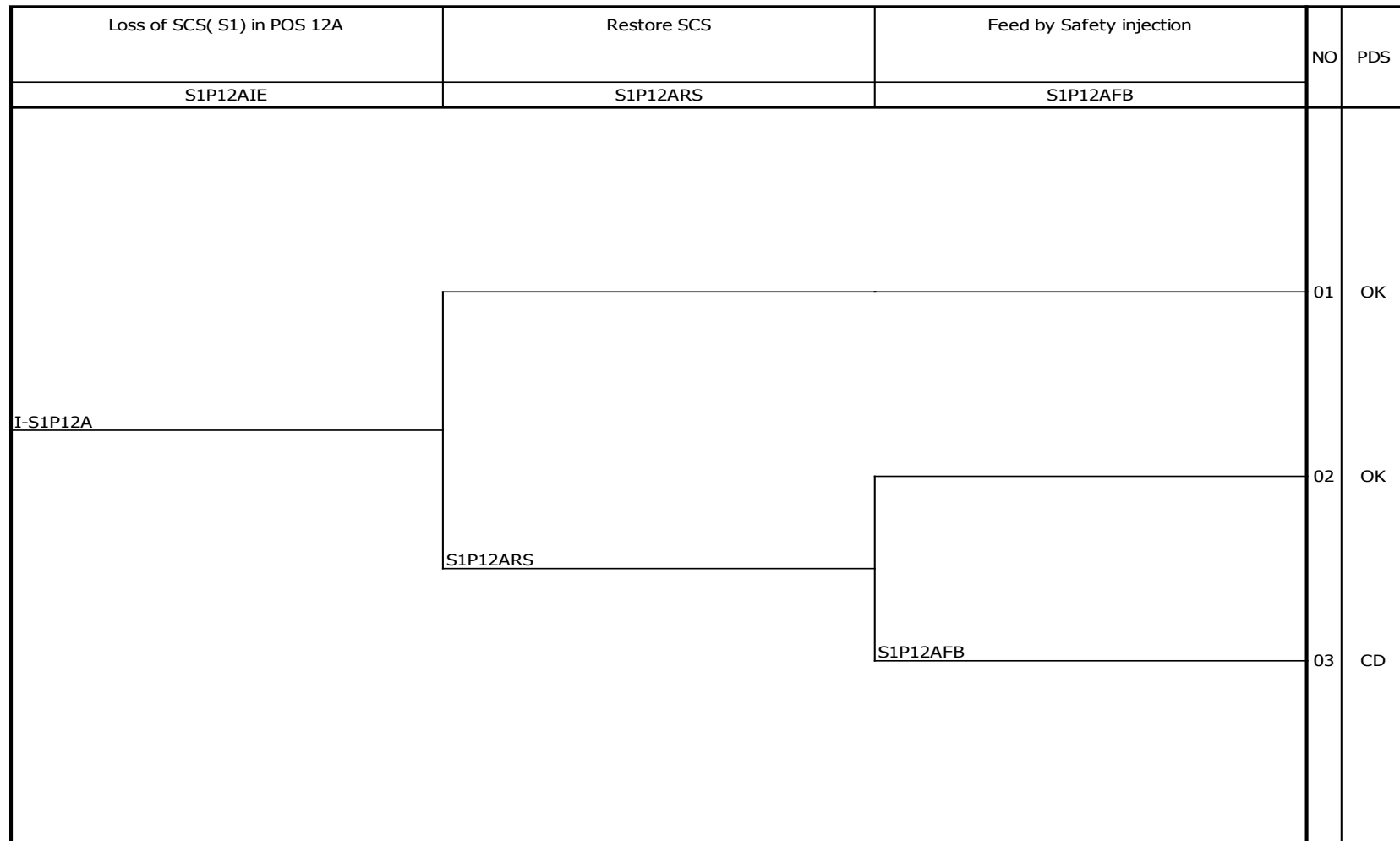
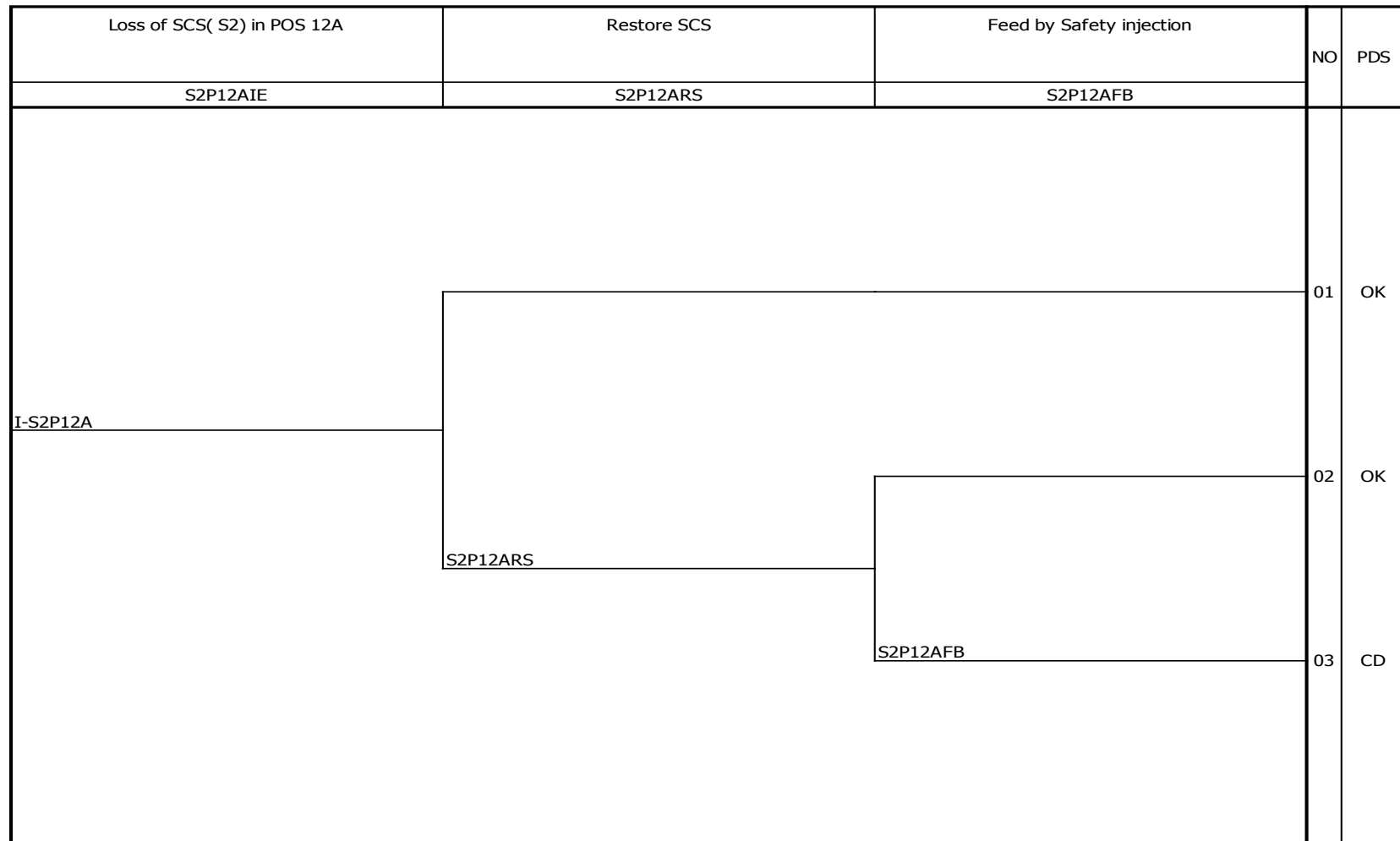


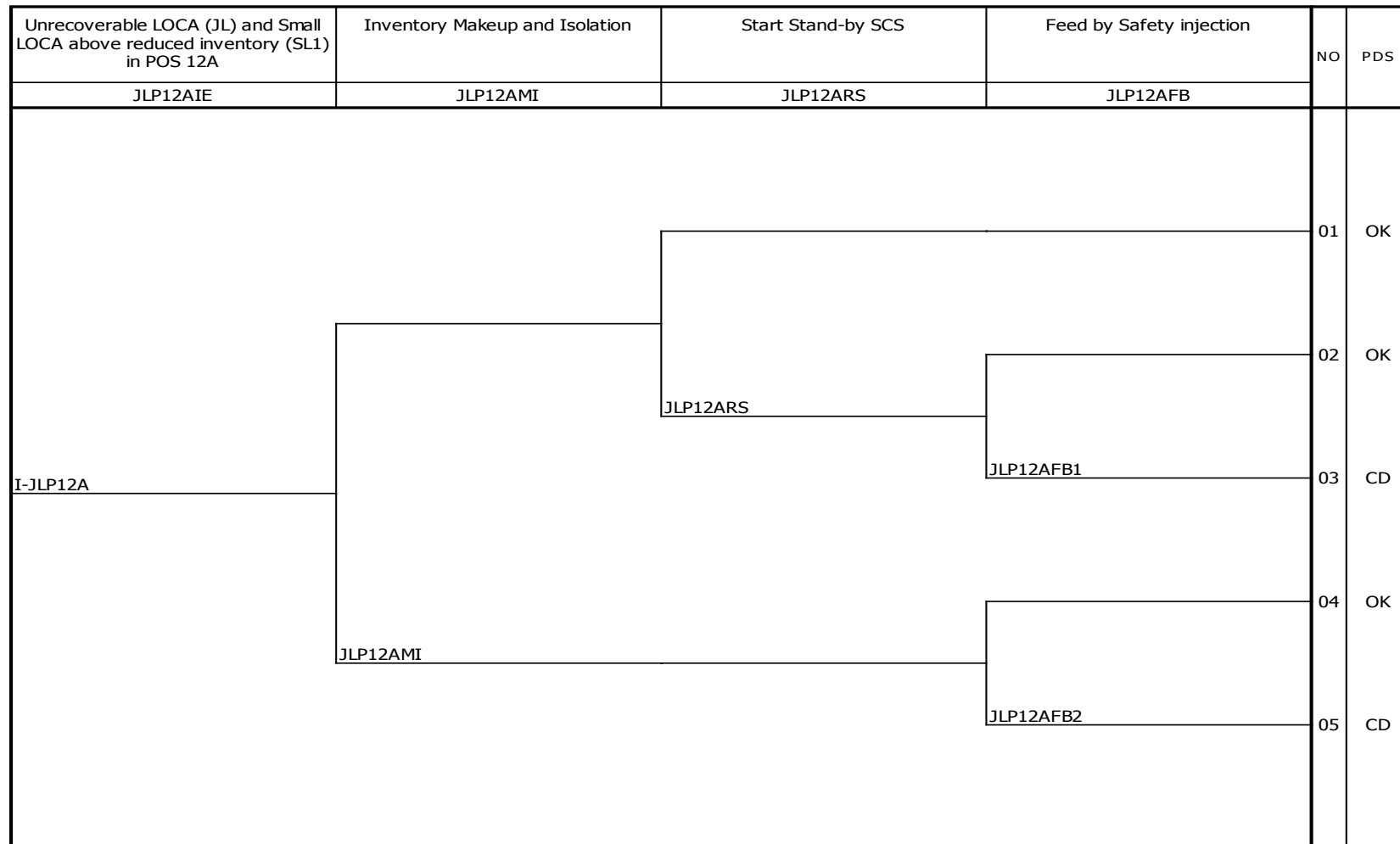
Figure 19.1-161 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 11

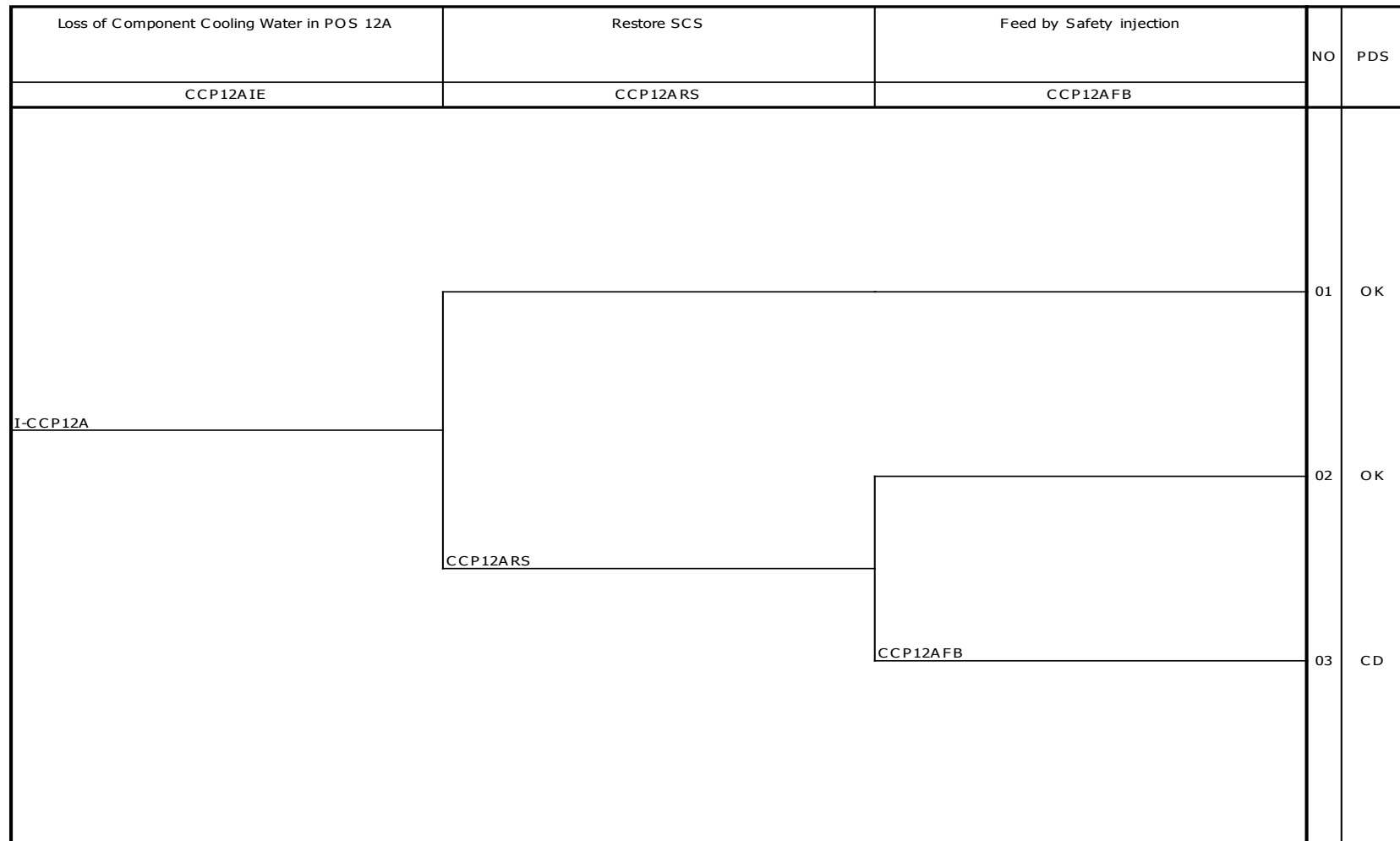
APR1400 DCD TIER 2**Figure 19.1-162 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 11**

APR1400 DCD TIER 2**Figure 19.1-163 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 11**

APR1400 DCD TIER 2**Figure 19.1-164 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 12A**

APR1400 DCD TIER 2**Figure 19.1-165 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 12A**

APR1400 DCD TIER 2**Figure 19.1-166 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 12A**

APR1400 DCD TIER 2**Figure 19.1-167 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 12A**

APR1400 DCD TIER 2

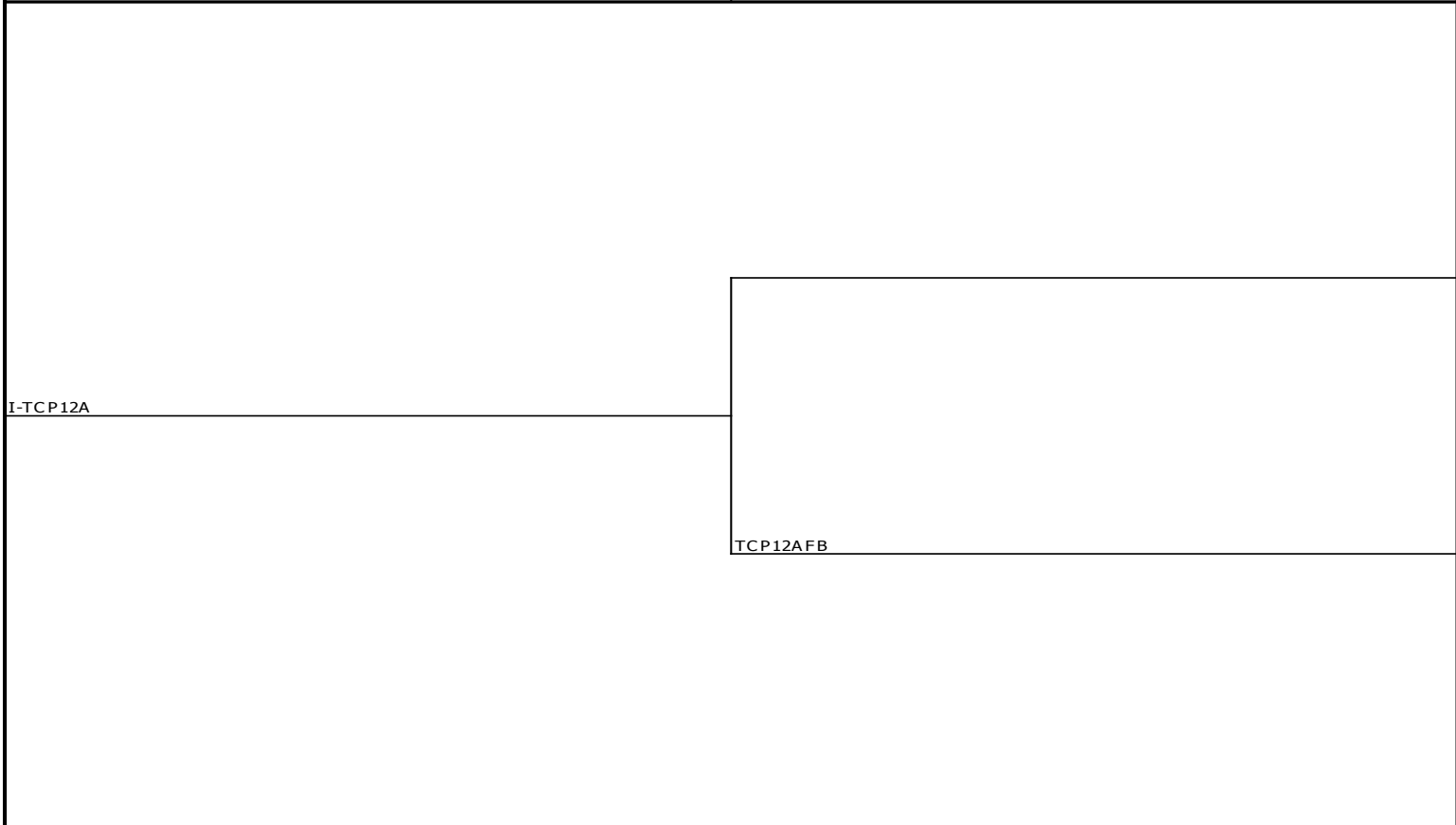
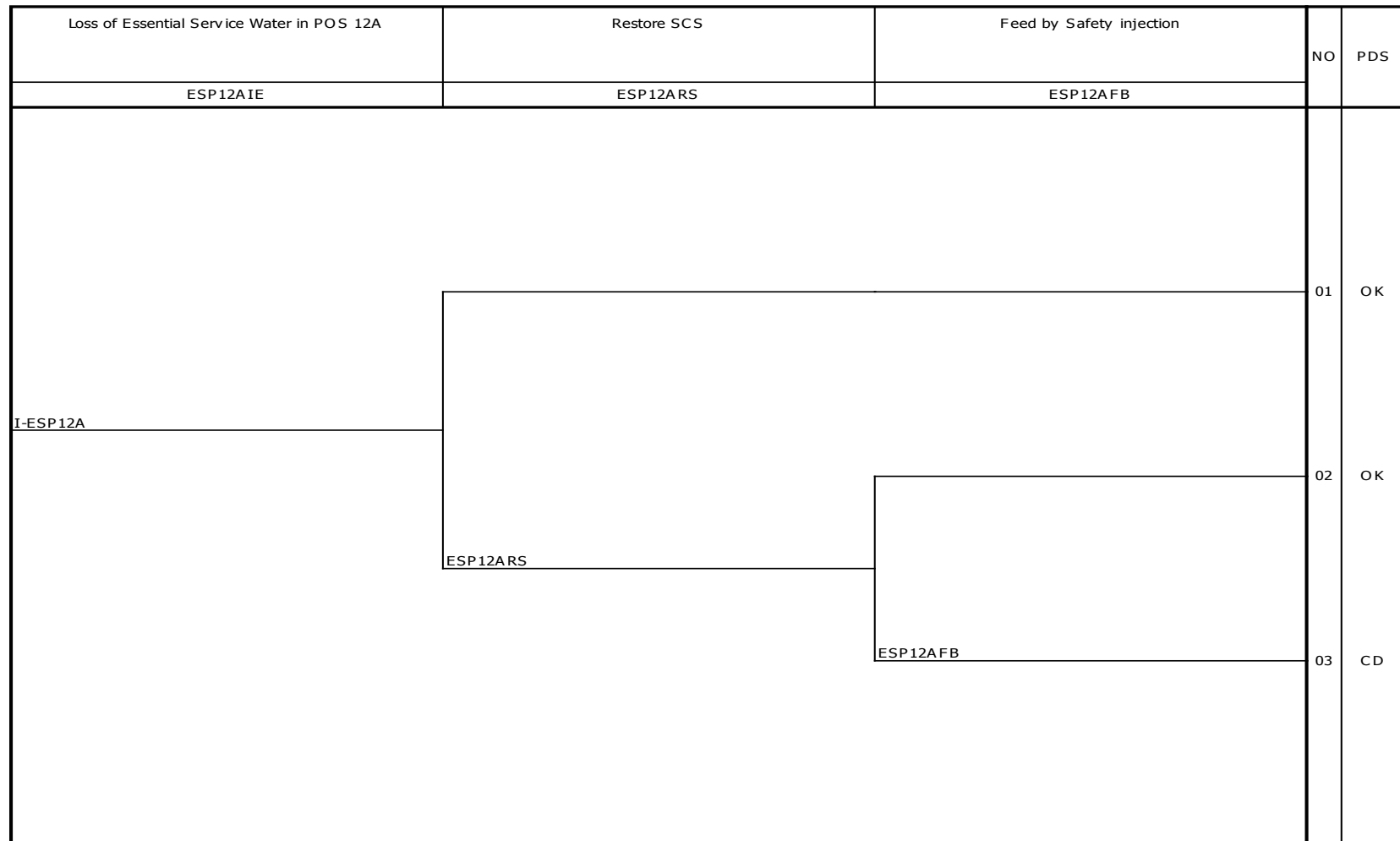
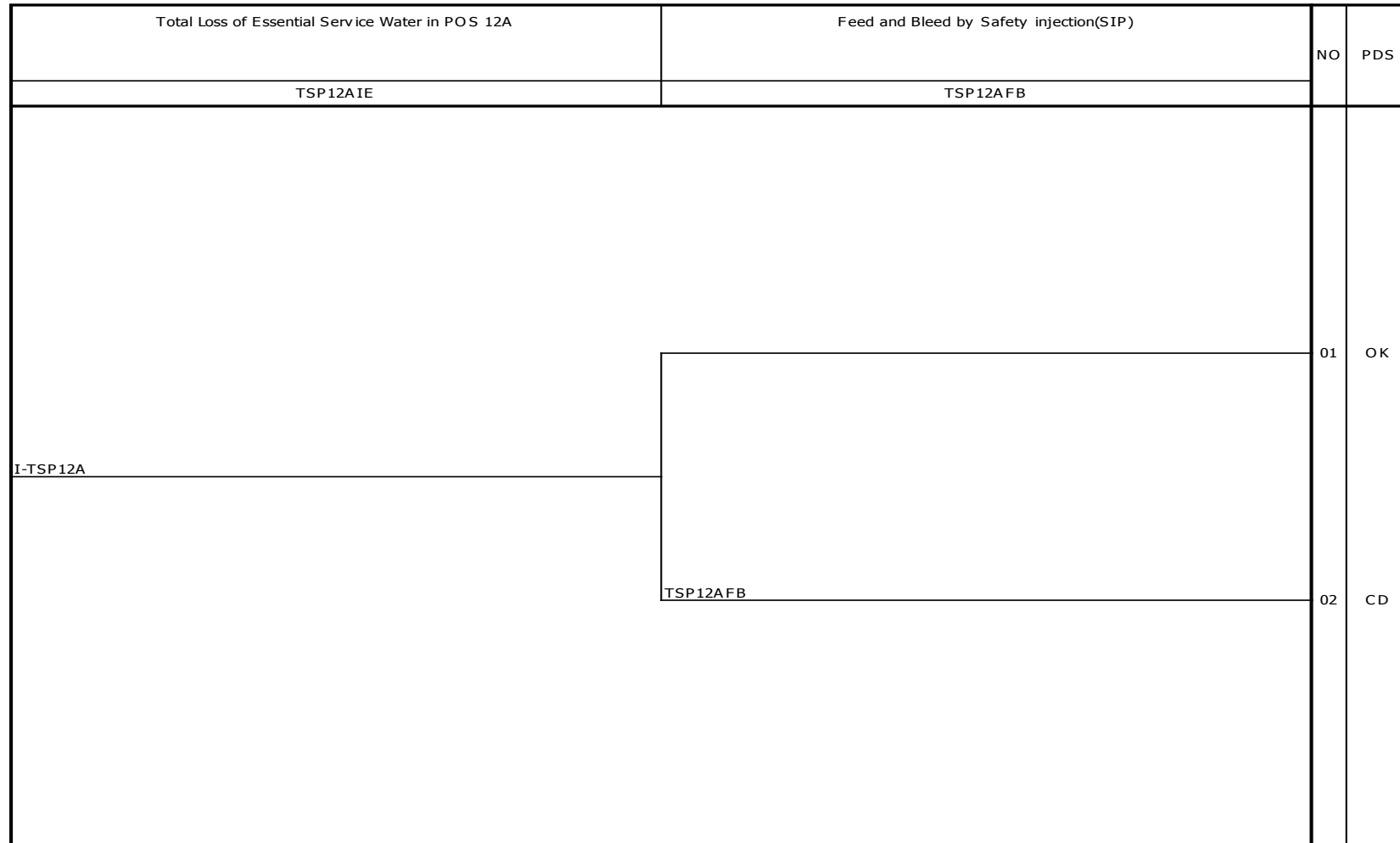
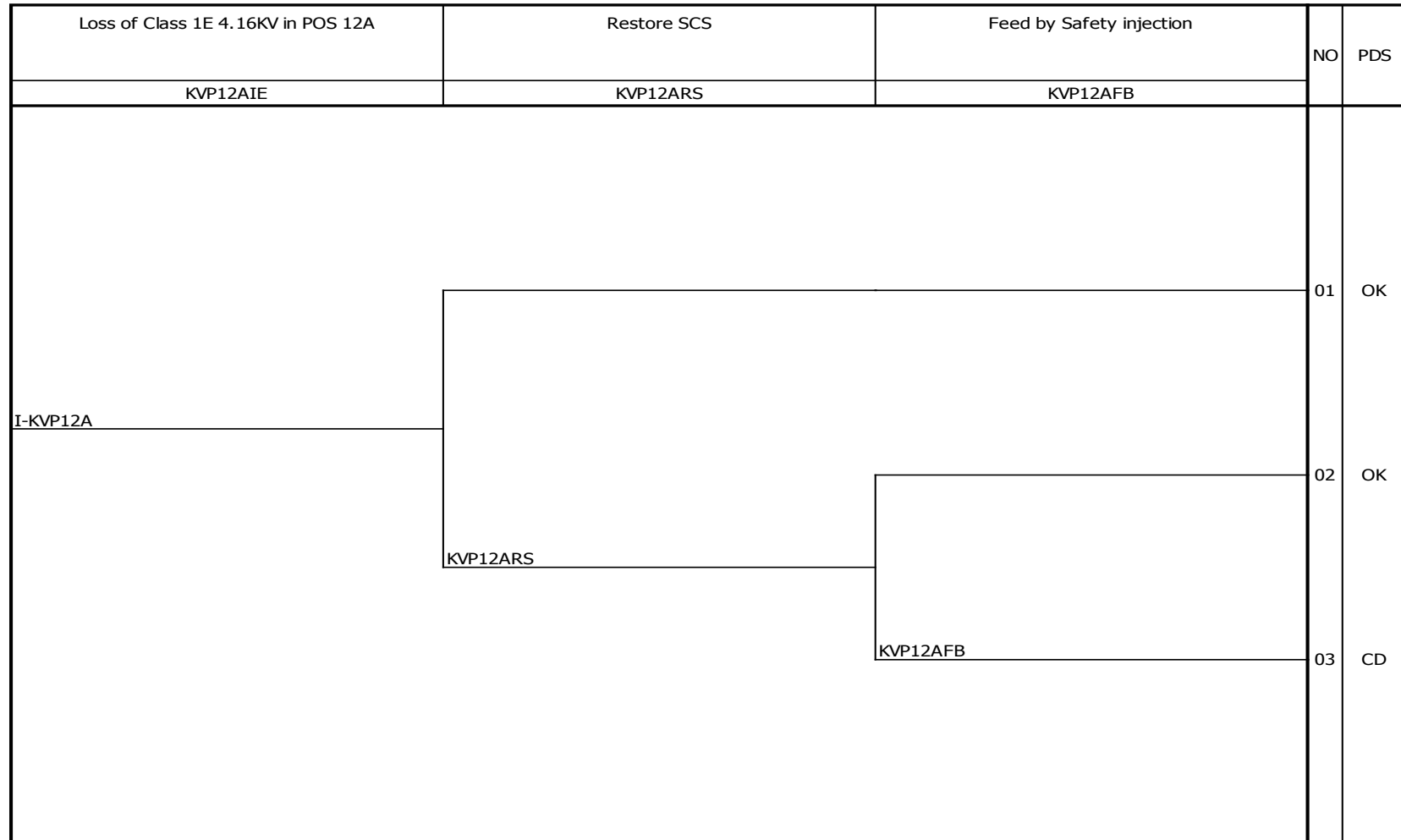
Total Loss of Component Cooling Water in POS 12A	Feed and Bleed by Safety injection(SIP)	NO	PDS
TCP12AIE	TCP12AFB		
 <p>The diagram is an event tree starting with the event 'I-TCP12A' on the left. A horizontal line extends to the right from 'I-TCP12A'. From this line, a vertical line goes up to a horizontal line, which then continues to the right edge of the diagram. This upper branch is labeled '01' and 'OK'. From the initial horizontal line, a vertical line goes down to another horizontal line, which then continues to the right edge of the diagram. This lower branch is labeled '02' and 'CD'. The label 'TCP12AFB' is placed at the start of the lower branch's horizontal line.</p>		01	OK
		02	CD

Figure 19.1-168 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 12A

APR1400 DCD TIER 2**Figure 19.1-169 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 12A**

APR1400 DCD TIER 2**Figure 19.1-170 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 12A**

APR1400 DCD TIER 2**Figure 19.1-171 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 12A**

APR1400 DCD TIER 2

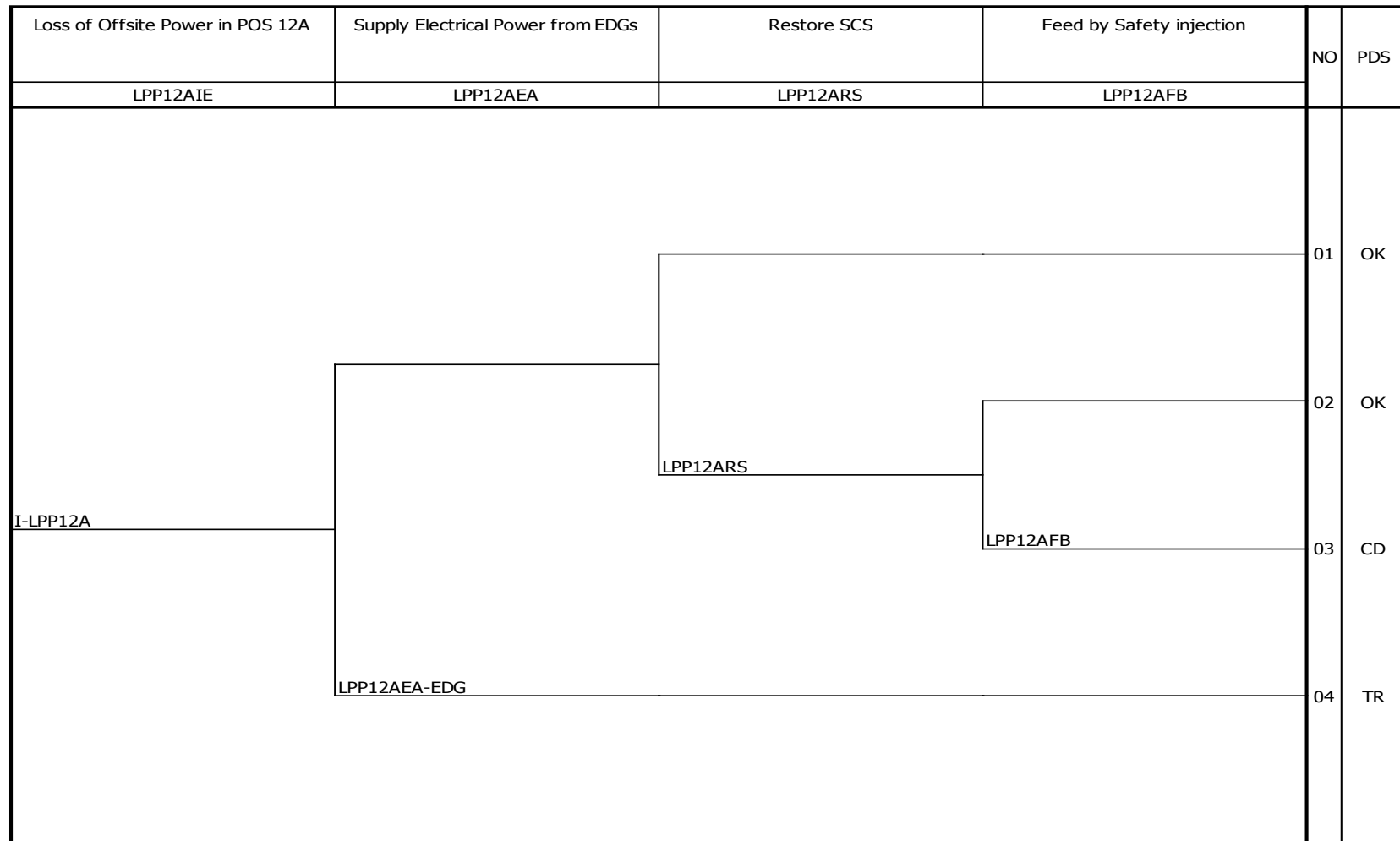
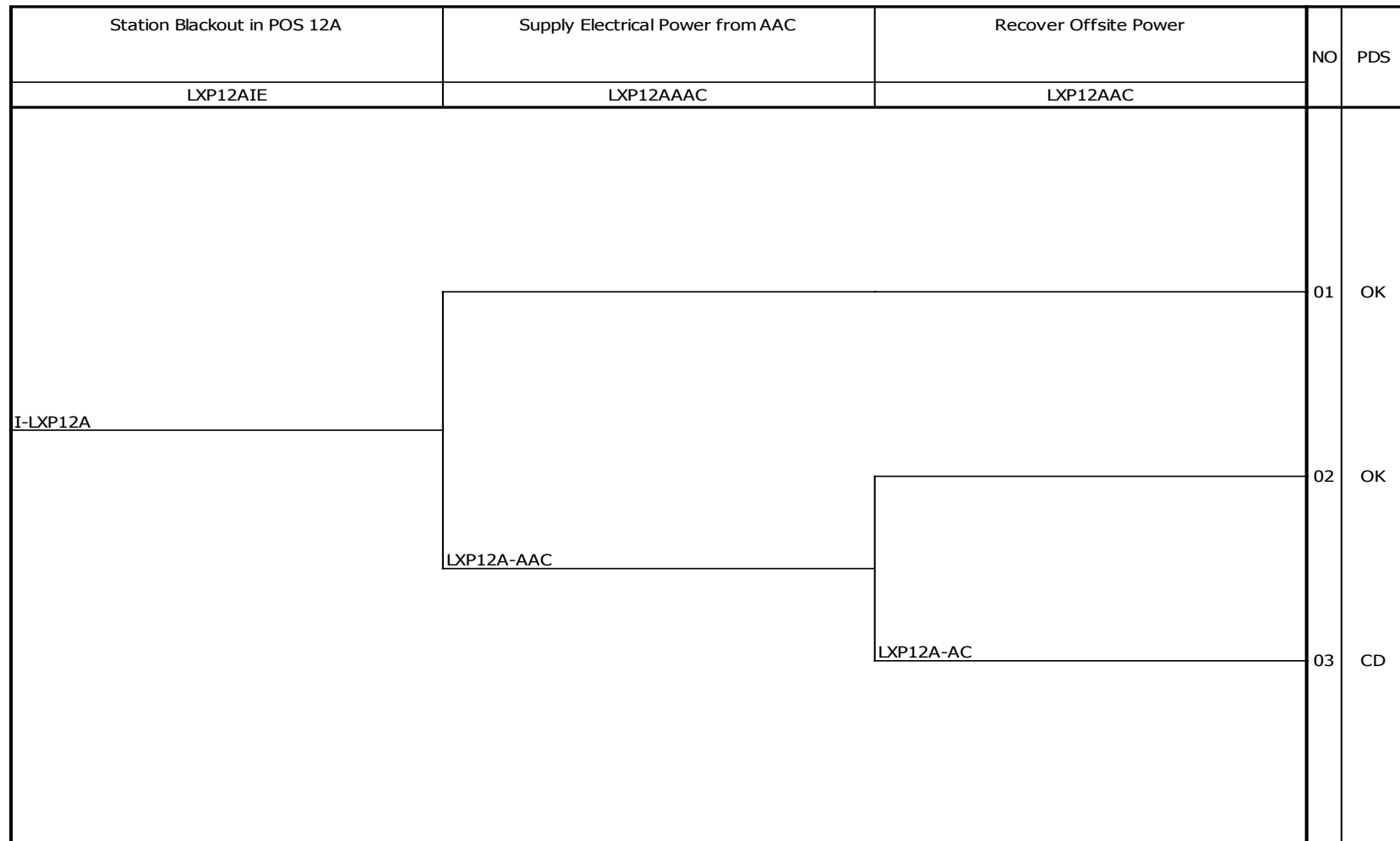


Figure 19.1-172 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 12A

APR1400 DCD TIER 2**Figure 19.1-173 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 12A**

APR1400 DCD TIER 2

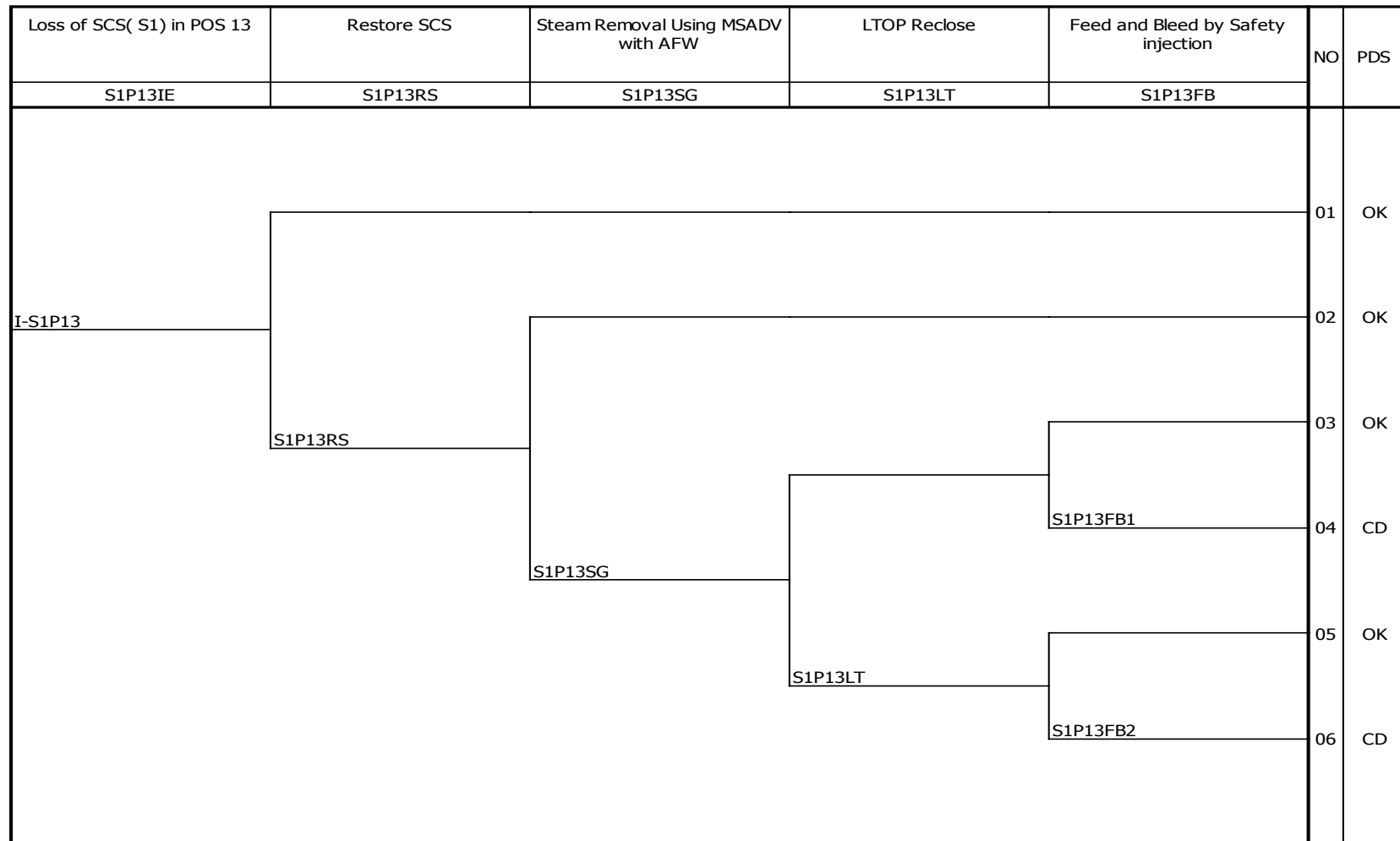


Figure 19.1-174 LPSD Level 1 Event Tree - Recoverable Loss of Shutdown Cooling (S1) in POS 13

APR1400 DCD TIER 2

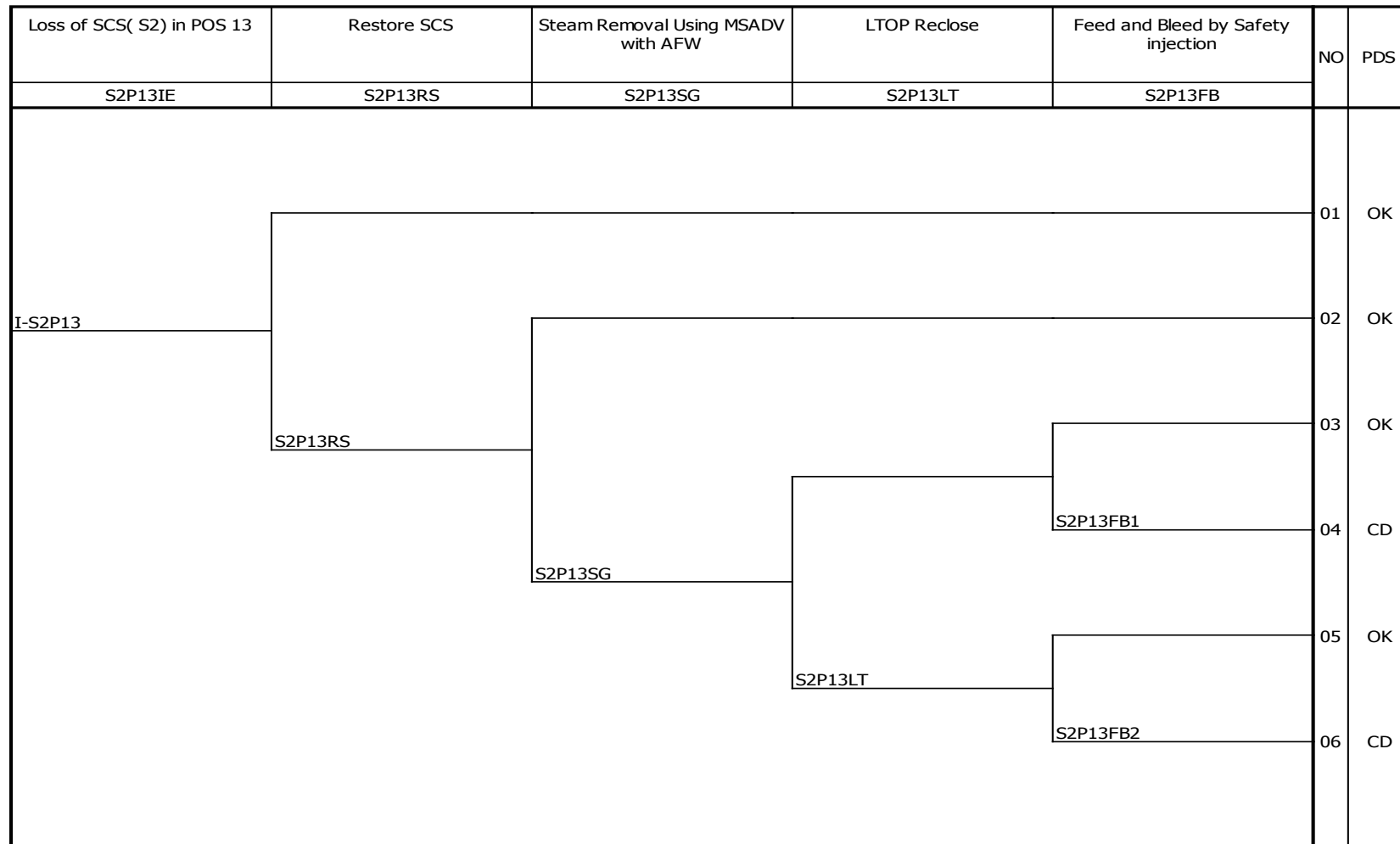


Figure 19.1-175 LPSD Level 1 Event Tree - Unrecoverable Loss of Shutdown Cooling (S2) in POS 13

APR1400 DCD TIER 2

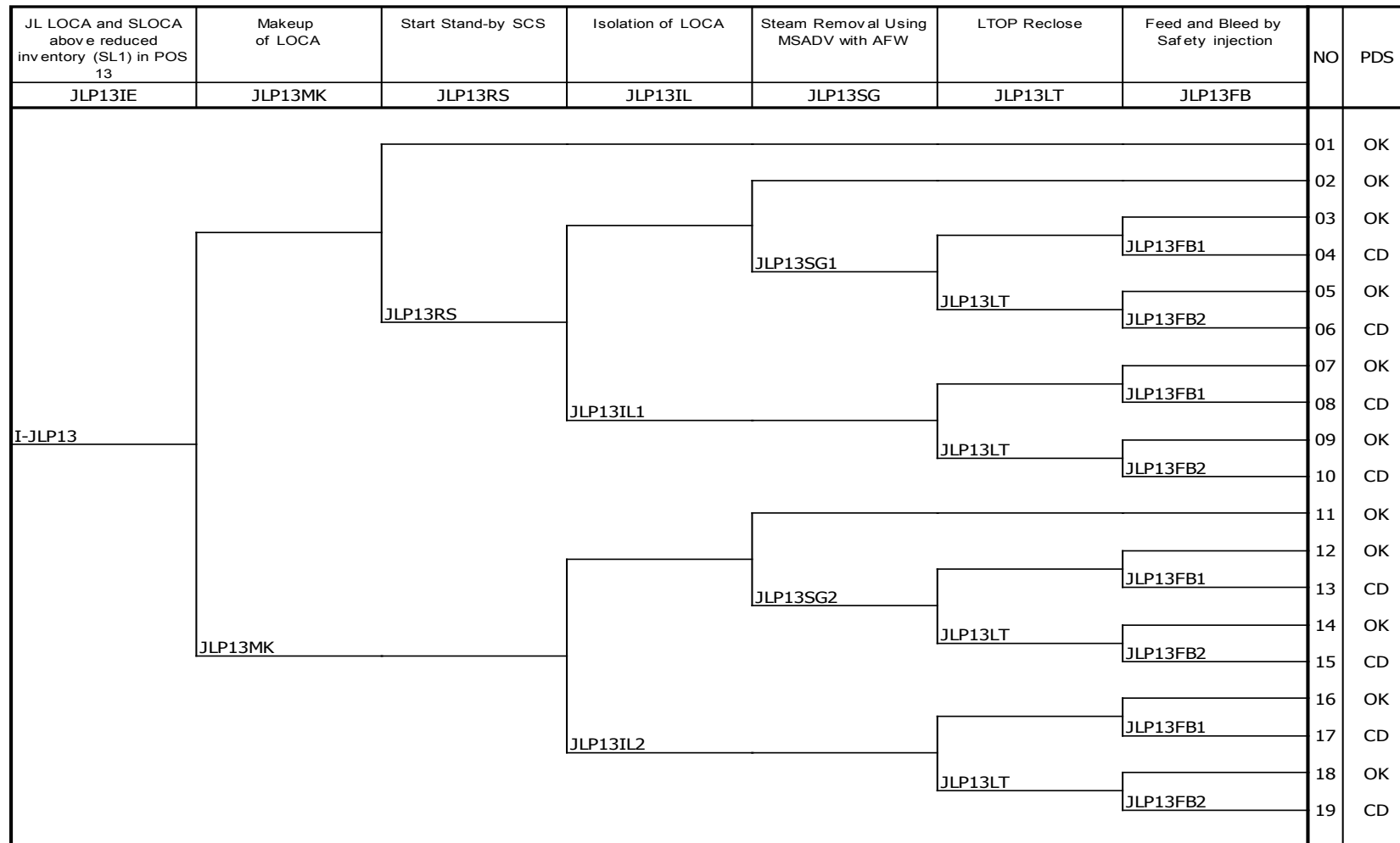
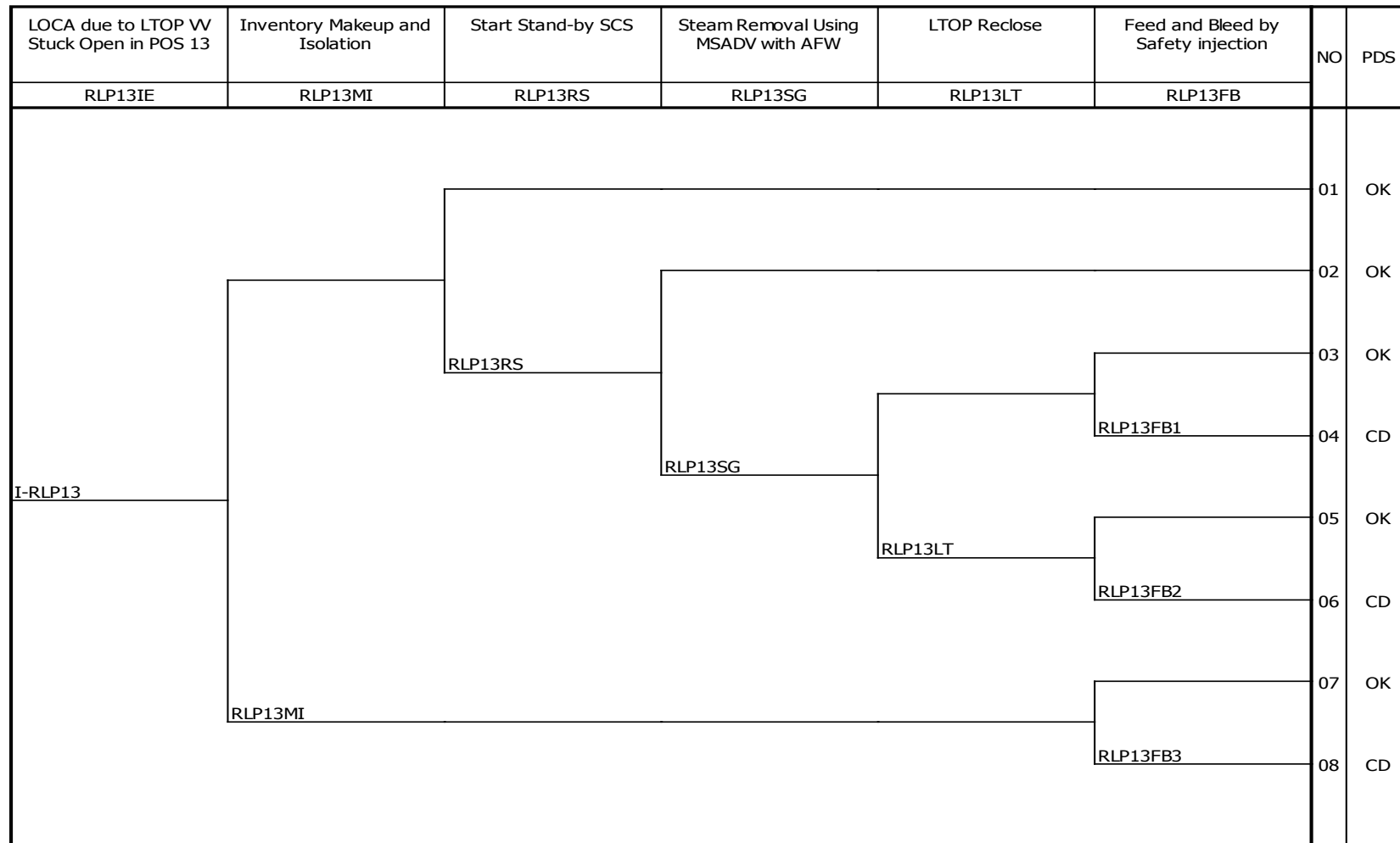
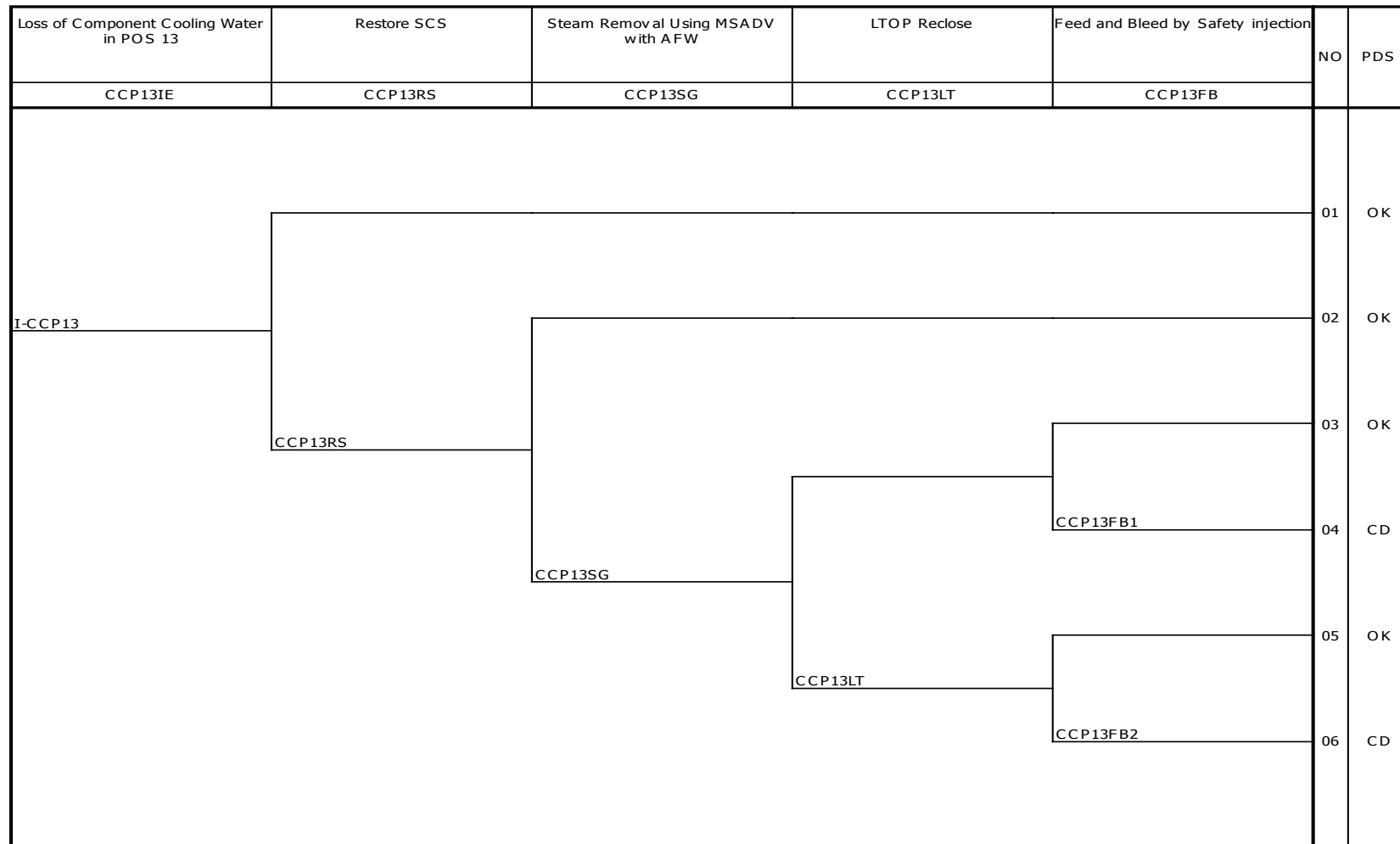
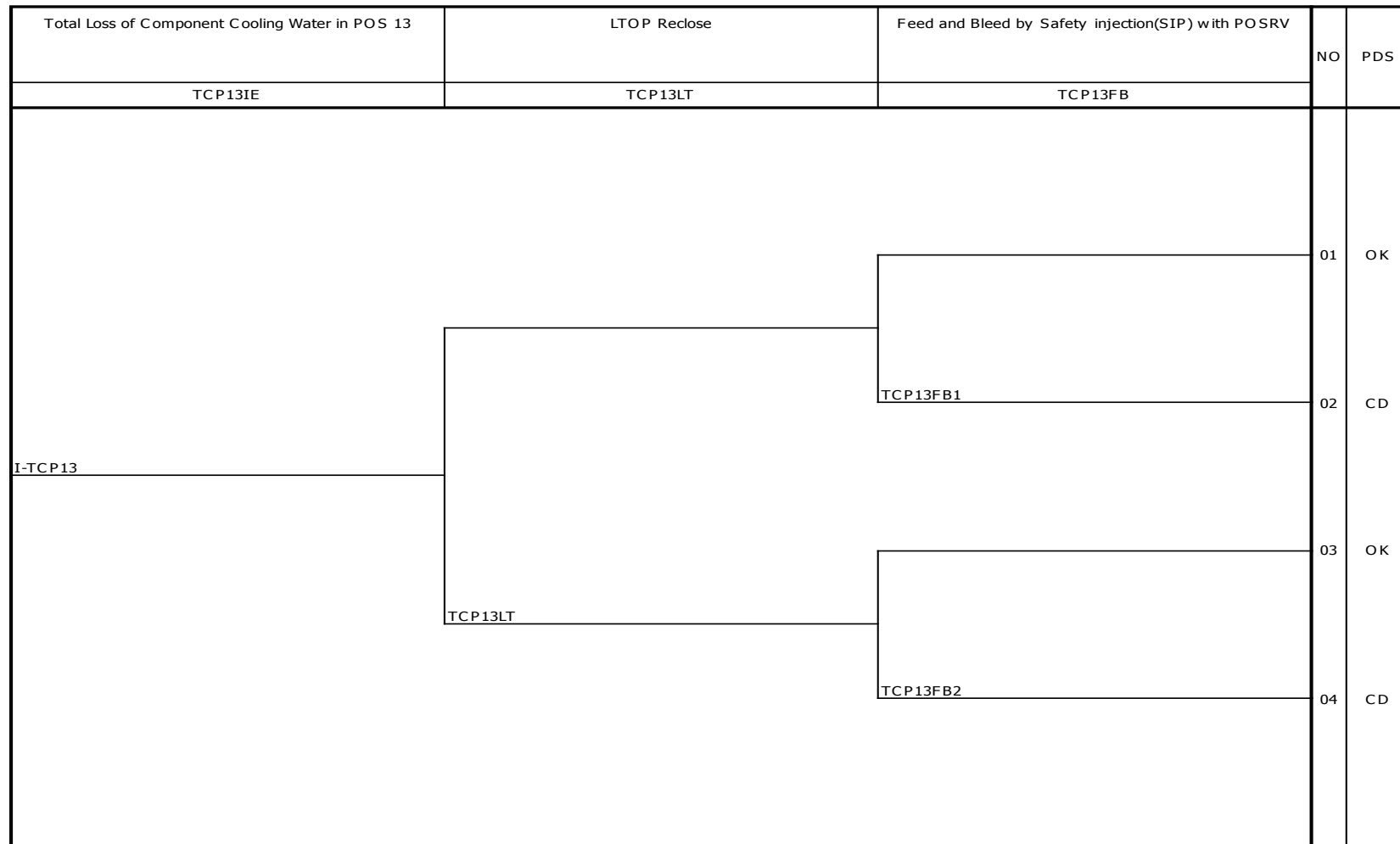
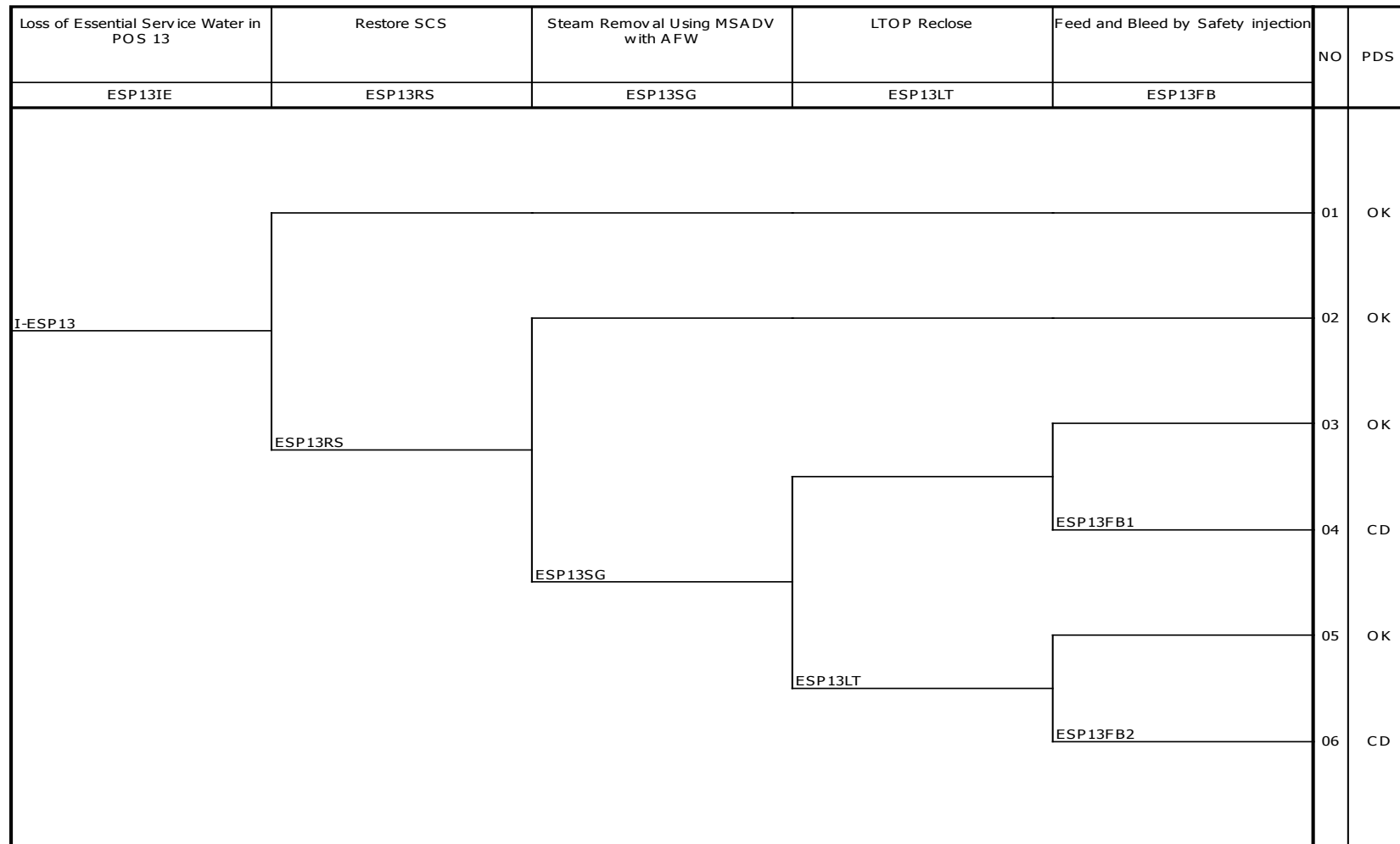


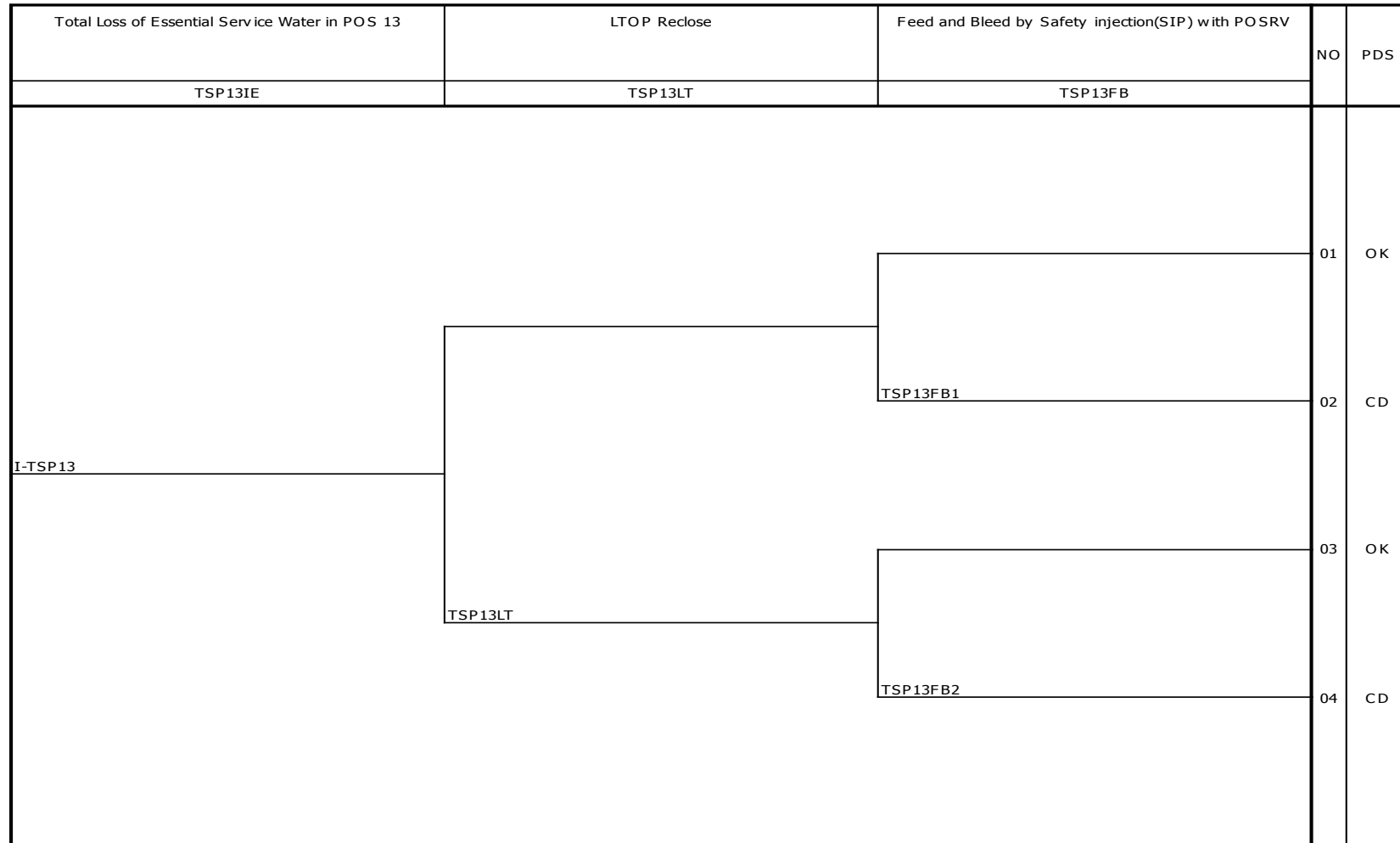
Figure 19.1-176 LPSD Level 1 Event Tree - Recoverable LOCA (JL – purification line rupture) in POS 13

APR1400 DCD TIER 2**Figure 19.1-177 LPSD Level 1 Event Tree - LTOP Relief Valve Fails to Reclose (RL) in POS 13**

APR1400 DCD TIER 2**Figure 19.1-178 LPSD Level 1 Event Tree - Partial Loss of Component Cooling Water (CC) in POS 13**

APR1400 DCD TIER 2**Figure 19.1-179 LPSD Level 1 Event Tree - Total Loss of Component Cooling Water (TC) in POS 13**

APR1400 DCD TIER 2**Figure 19.1-180 LPSD Level 1 Event Tree - Partial Loss of Essential Service Water (ES) in POS 13**

APR1400 DCD TIER 2**Figure 19.1-181 LPSD Level 1 Event Tree - Total Loss of Essential Service Water (TS) in POS 13**

APR1400 DCD TIER 2

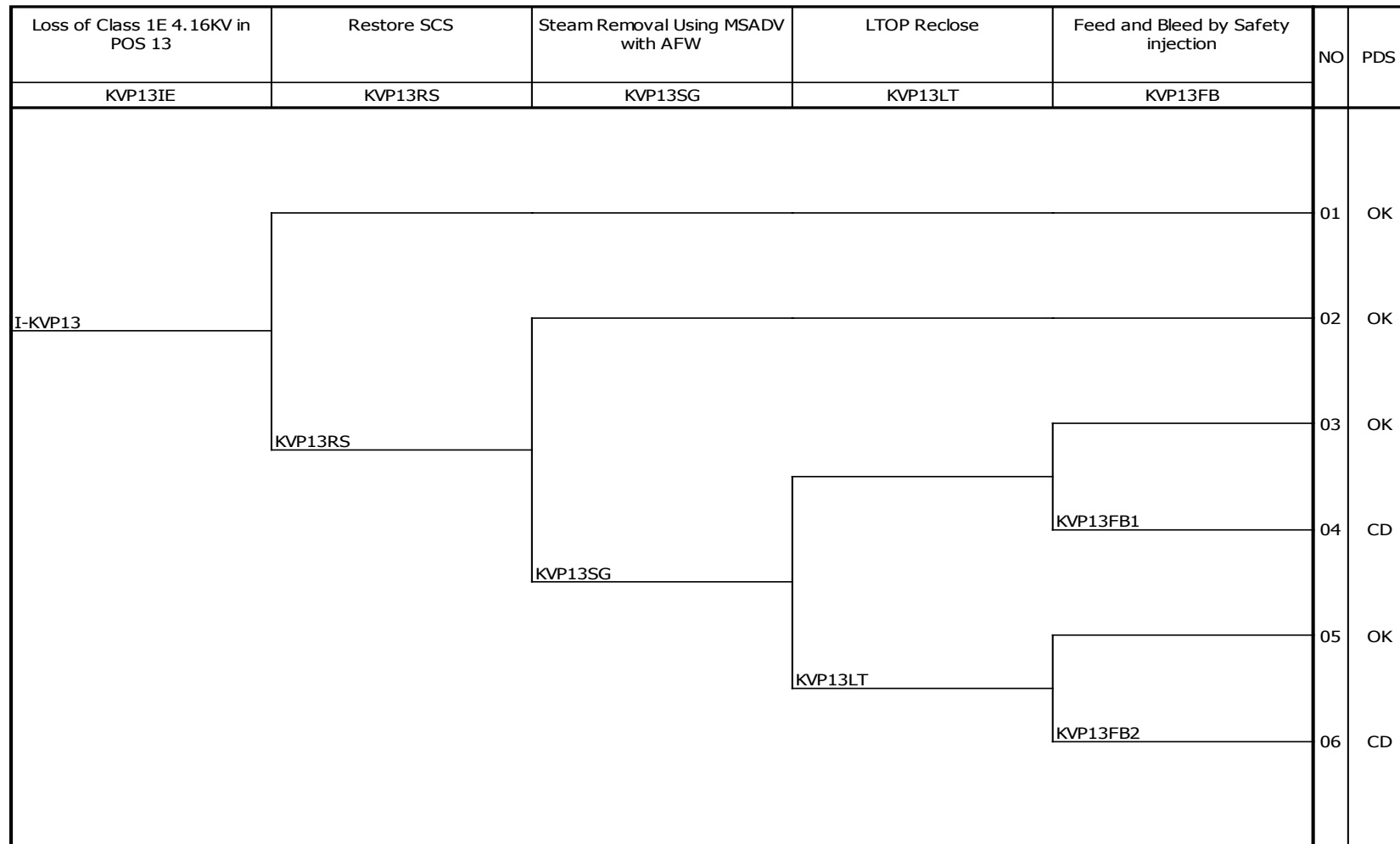


Figure 19.1-182 LPSD Level 1 Event Tree - Loss of 4kV Emergency Bus (KV) in POS 13

APR1400 DCD TIER 2

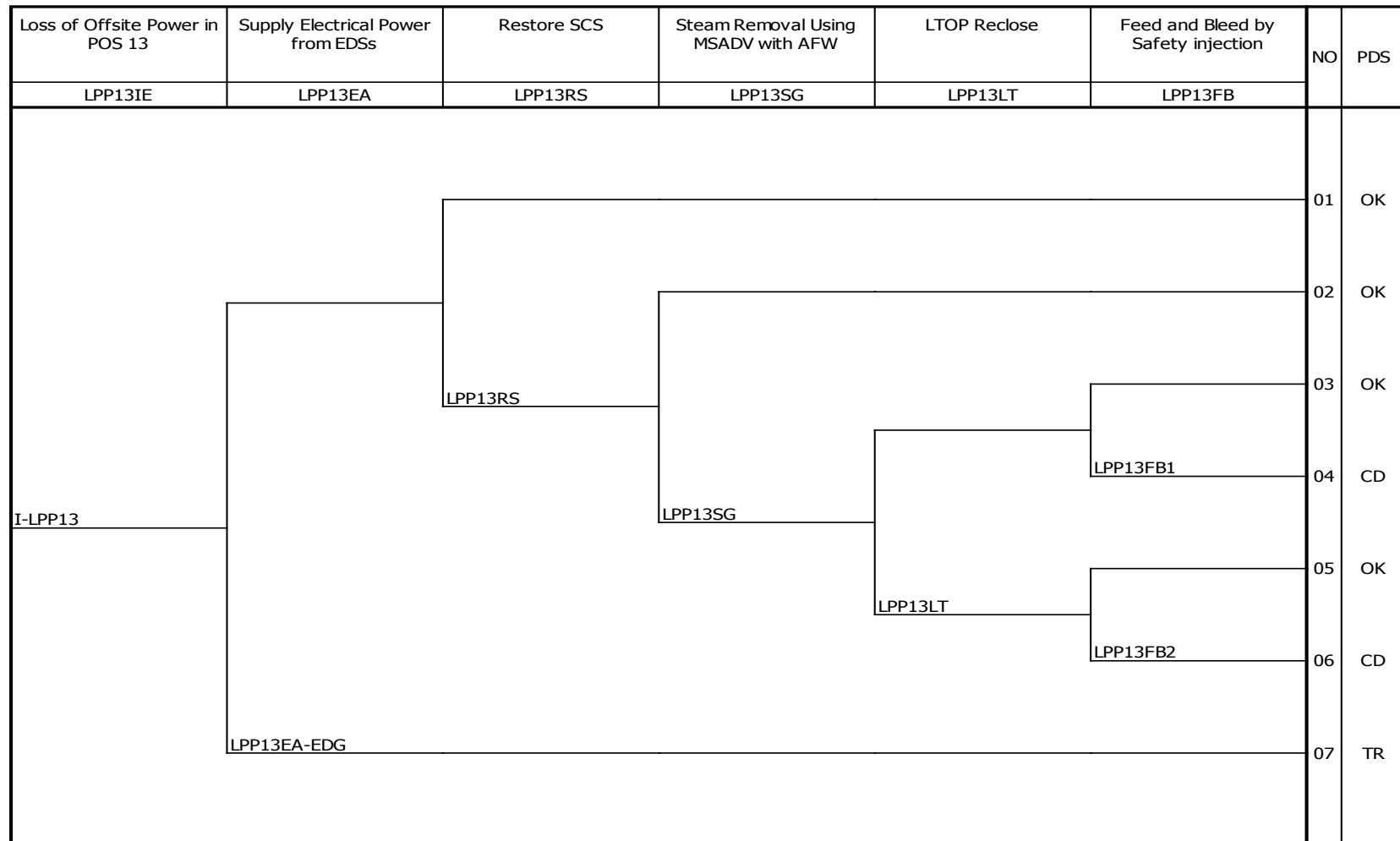
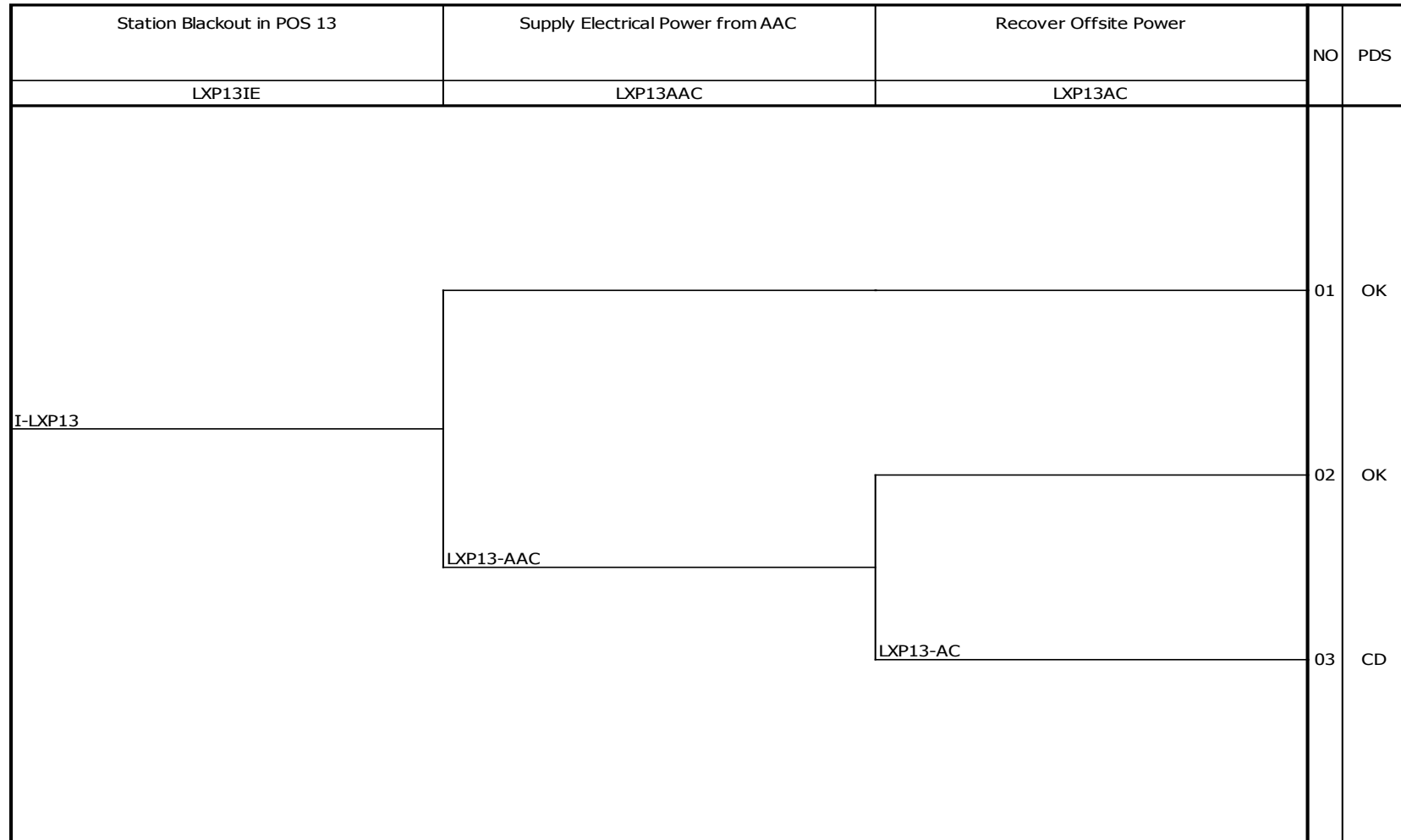


Figure 19.1-183 LPSD Level 1 Event Tree - Loss of Offsite Power (LP) in POS 13

APR1400 DCD TIER 2**Figure 19.1-184 LPSD Level 1 Event Tree - Station Blackout (LX) in POS 13**

APR1400 DCD TIER 2

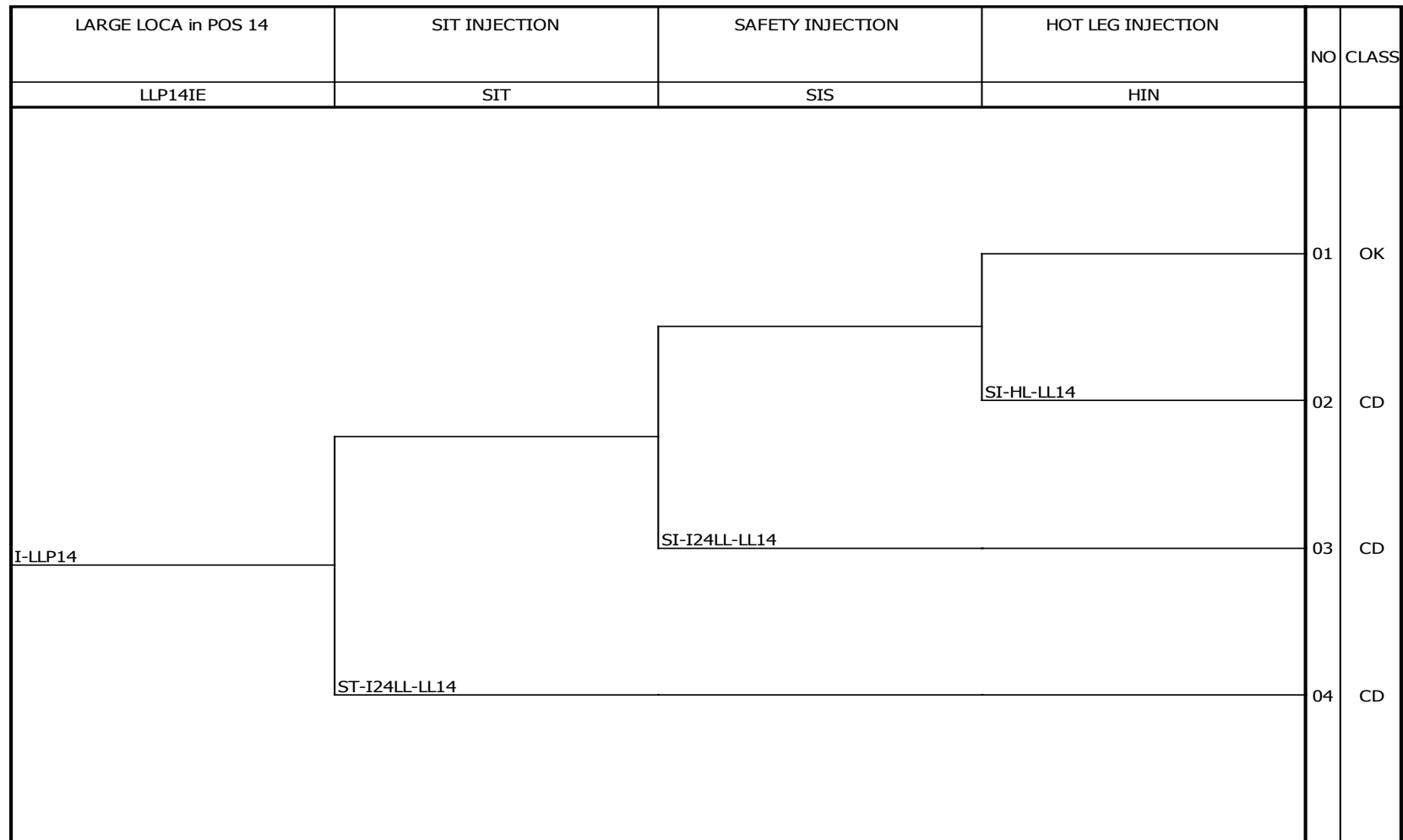


Figure 19.1-185 LPSD Level 1 Event Tree – Large LOCA (LLOCA) in POS 14

APR1400 DCD TIER 2

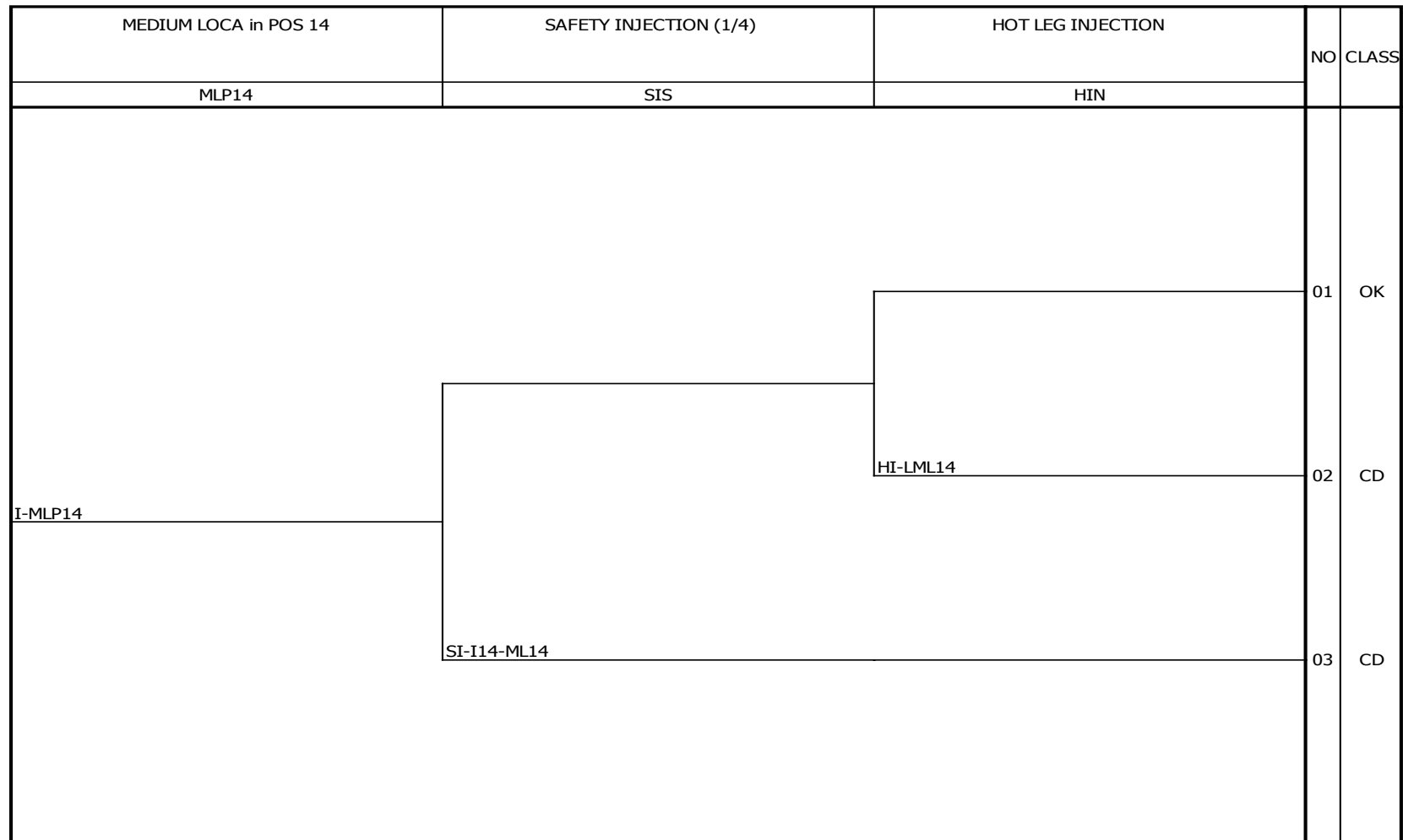


Figure 19.1-186 LPSD Level 1 Event Tree – Medium LOCA (MLOCA) in POS 14

APR1400 DCD TIER 2

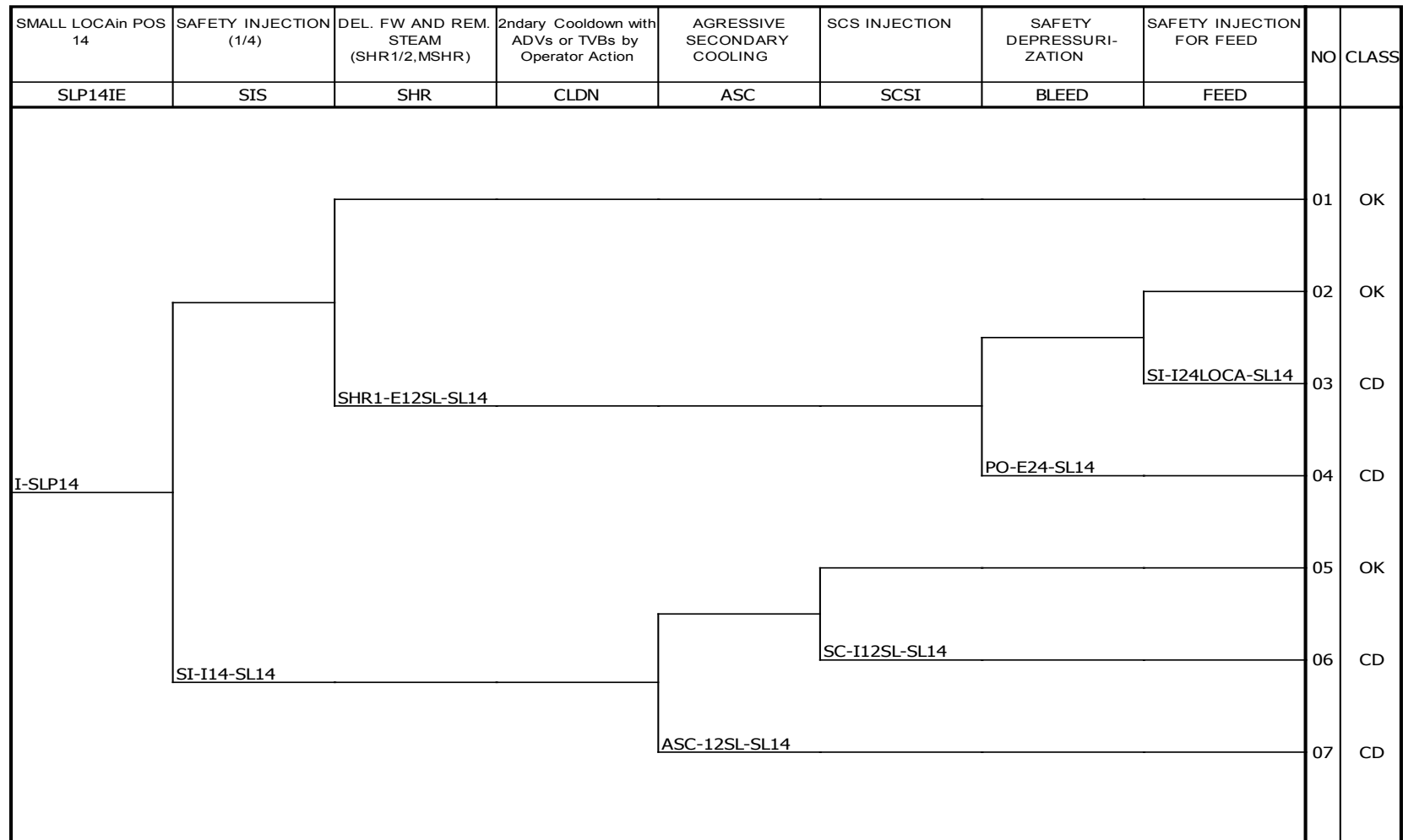


Figure 19.1-187 LPSD Level 1 Event Tree – Small LOCA Pipe Rupture (SL) in POS 14

APR1400 DCD TIER 2

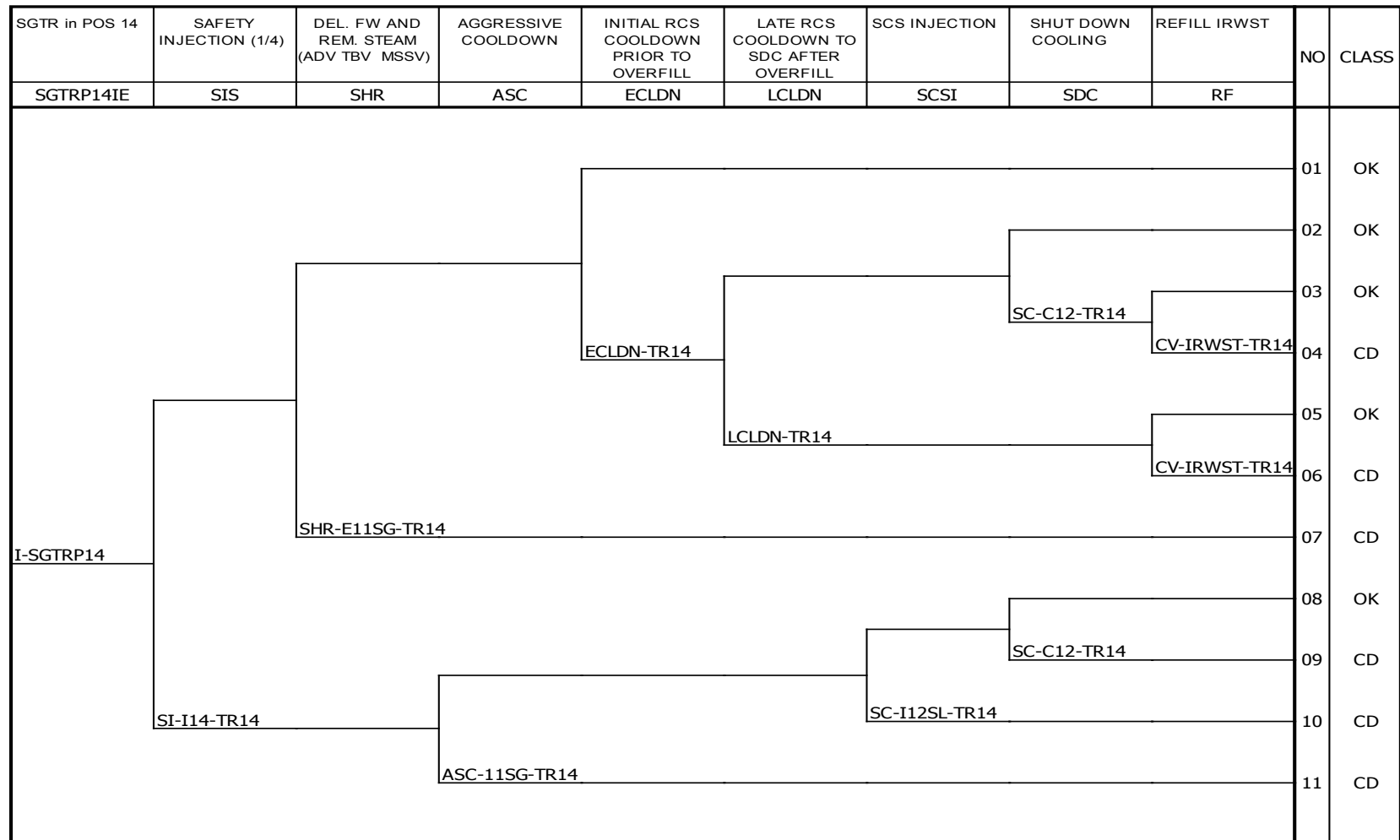


Figure 19.1-188 LPSD Level 1 Event Tree – Steam Generator Tube Rupture (SG) in POS 14

APR1400 DCD TIER 2

LOSS OF a CCWS DIVISION I in POS 14	DEL. AFW AND REM. STEAM (ADV TBV MSSV)	RCP SEAL FAILURE	SAFETY INJECTION	SAFETY DEPRESSURIZATION	SAFETY INJECTION FOR FEED	NO	CLASS
PLOCCWP14IE	SHR	RSF	SIS	BLEED	FEED		
<pre> graph LR I_PLOCCWP14[I-PLOCCWP14] --> SHR_E12CC_PC14[SHR-E12CC-PC14] I_PLOCCWP14 --> RSF_CC_AFSUC_PC14[RSF-CC-AFSUC-PC14] RSF_CC_AFSUC_PC14 --> SI_I12CC_PC14[SI-I12CC-PC14] SI_I12CC_PC14 --> SI_I22CC_PC14[SI-I22CC-PC14] SI_I22CC_PC14 --> PO_E24CC_PC14[PO-E24CC-PC14] SHR_E12CC_PC14 --> PO_E24CC_PC14 PO_E24CC_PC14 --> OK1[OK] SI_I12CC_PC14 --> CD1[CD] SI_I22CC_PC14 --> CD2[CD] PO_E24CC_PC14 --> OK2[OK] </pre>						01	OK
						02	OK
						03	CD
						04	OK
						05	CD
						06	CD

Figure 19.1-189 LPSD Level 1 Event Tree – Partial Loss of Component Cooling Water (CC) in POS 14

APR1400 DCD TIER 2

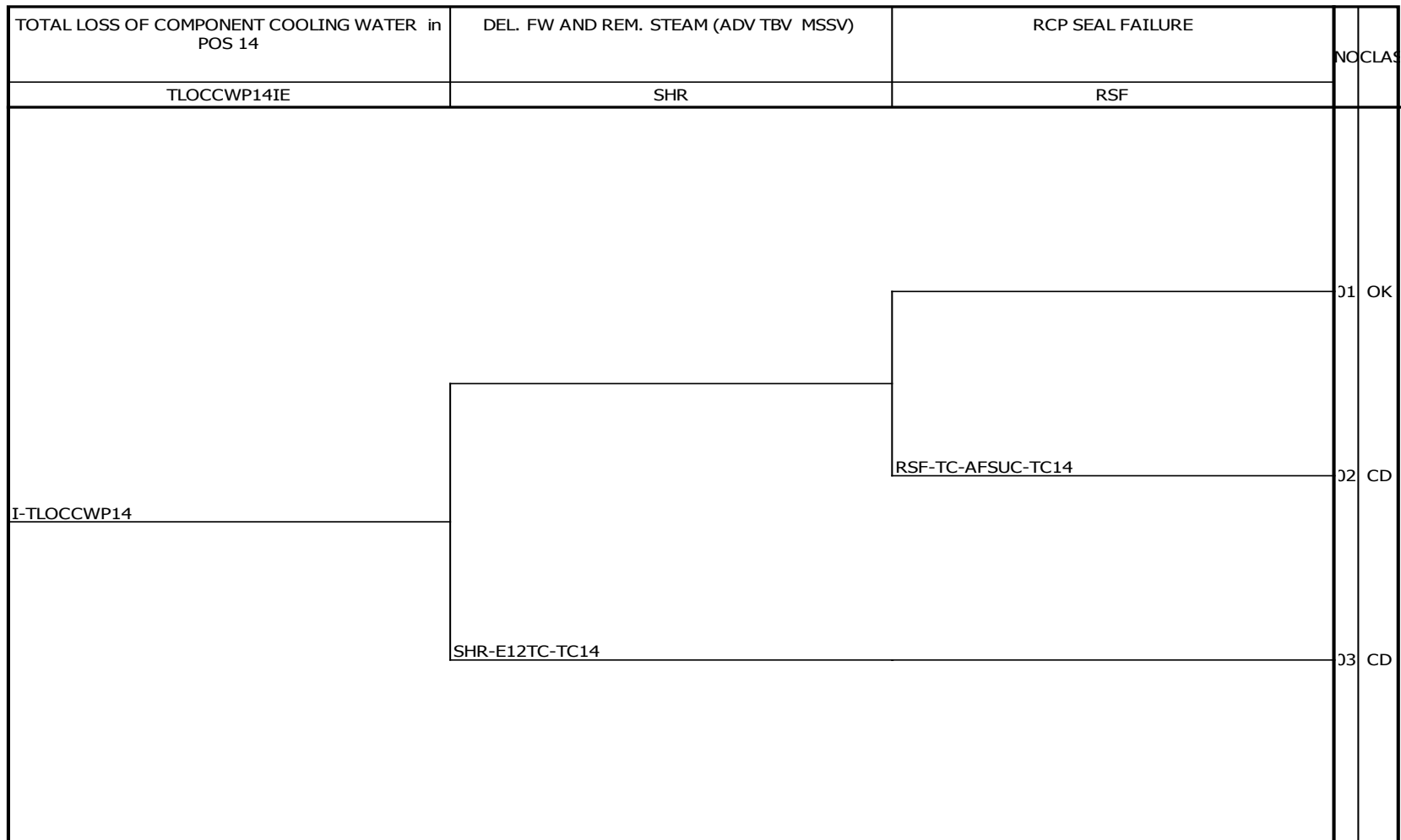


Figure 19.1-190 LPSD Level 1 Event Tree – Total Loss of Component Cooling Water (TC) in POS 14

APR1400 DCD TIER 2

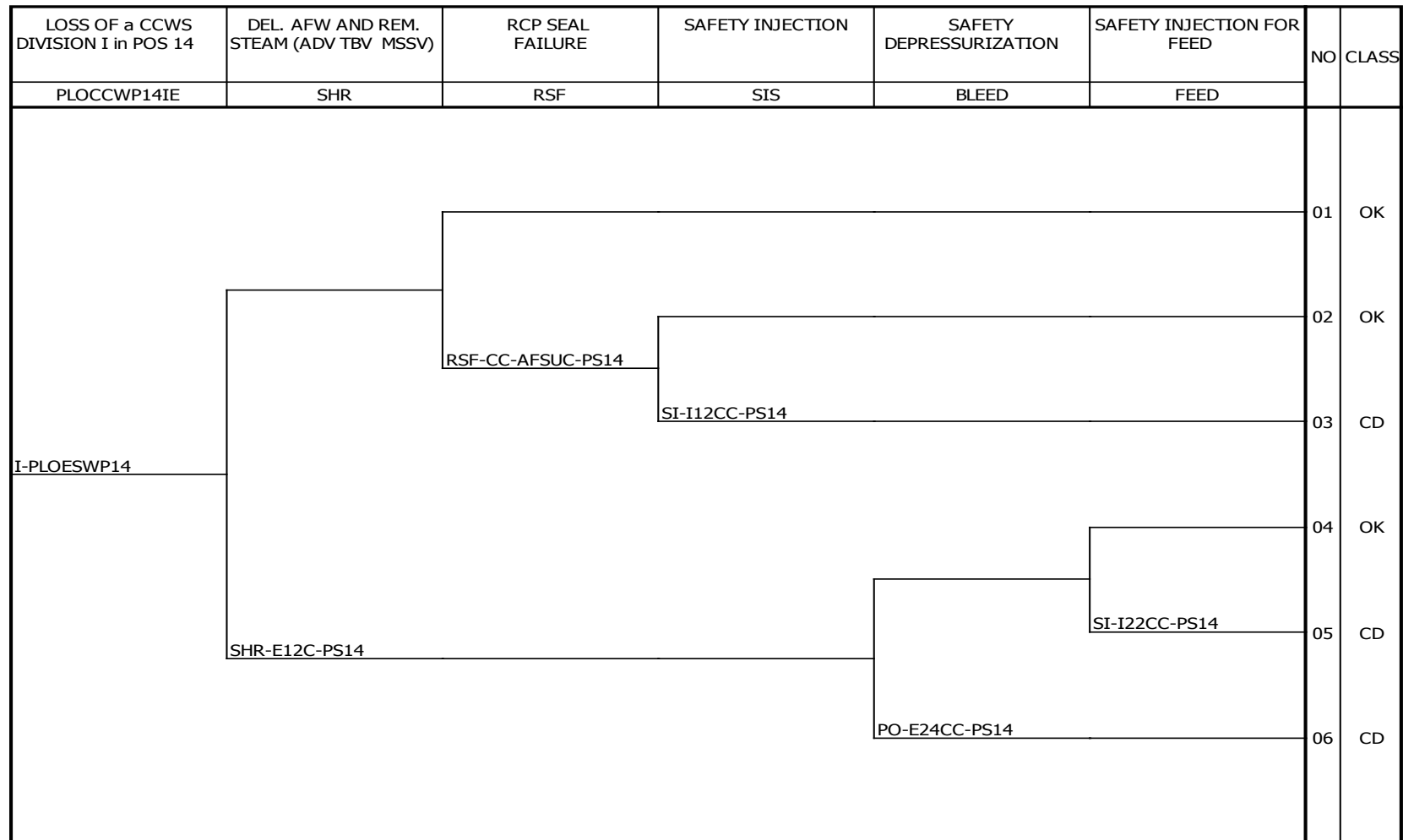


Figure 19.1-191 LPSD Level 1 Event Tree – Partial Loss of Essential Service Water (CC) in POS 14

APR1400 DCD TIER 2

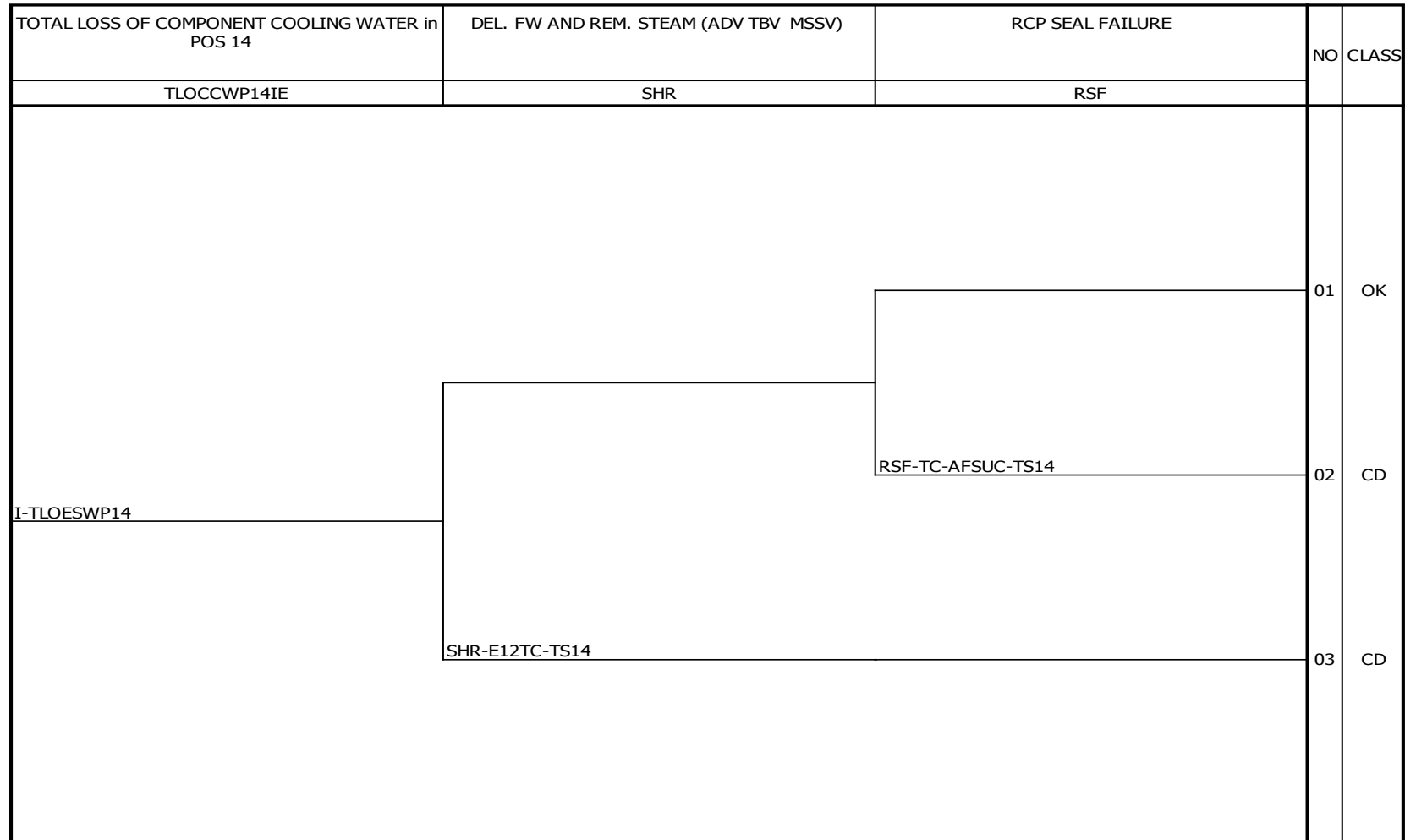
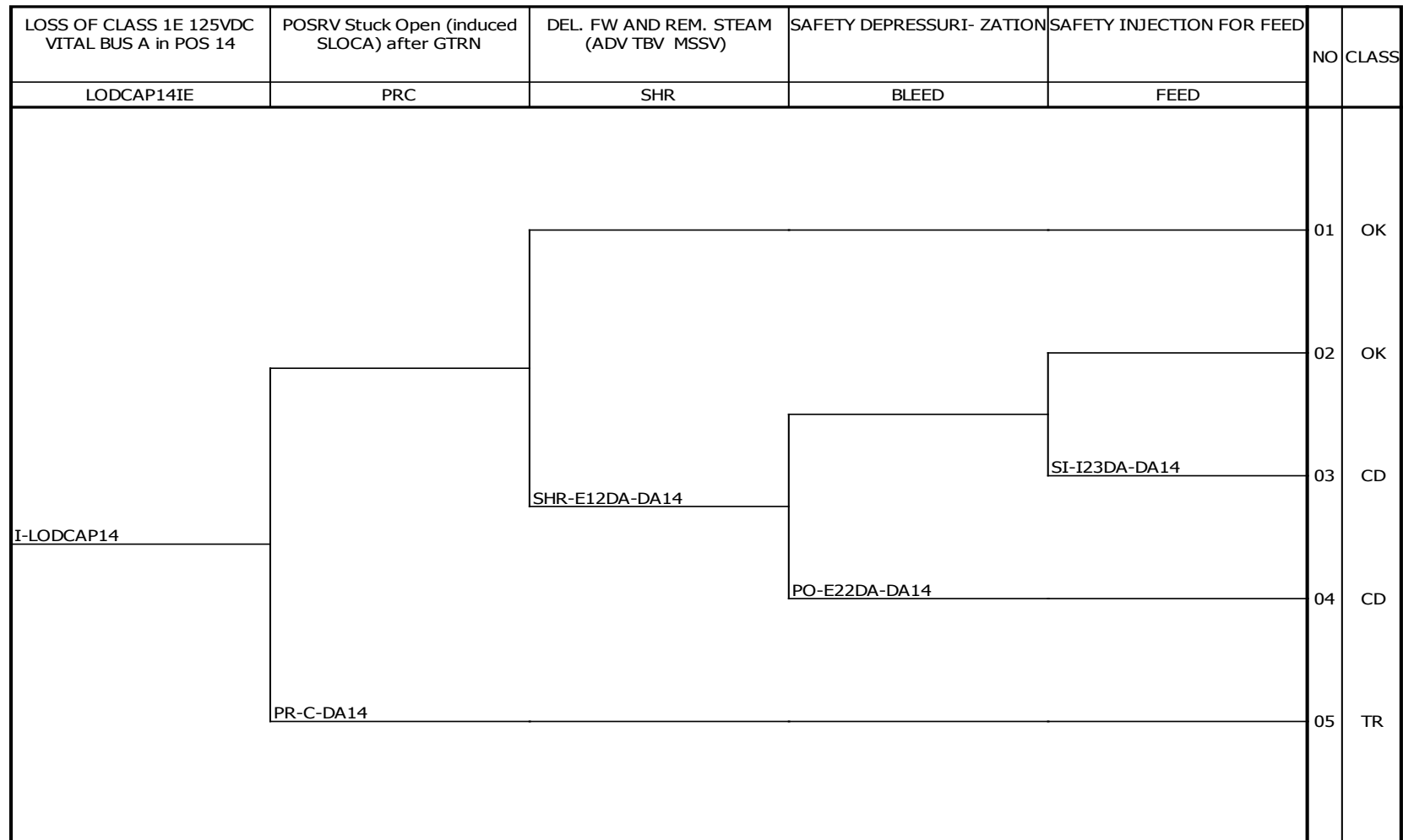


Figure 19.1-192 LPSD Level 1 Event Tree – Total Loss of Essential Service Water (CC) in POS 14

APR1400 DCD TIER 2**Figure 19.1-193 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel A (DCA) in POS 14**

APR1400 DCD TIER 2

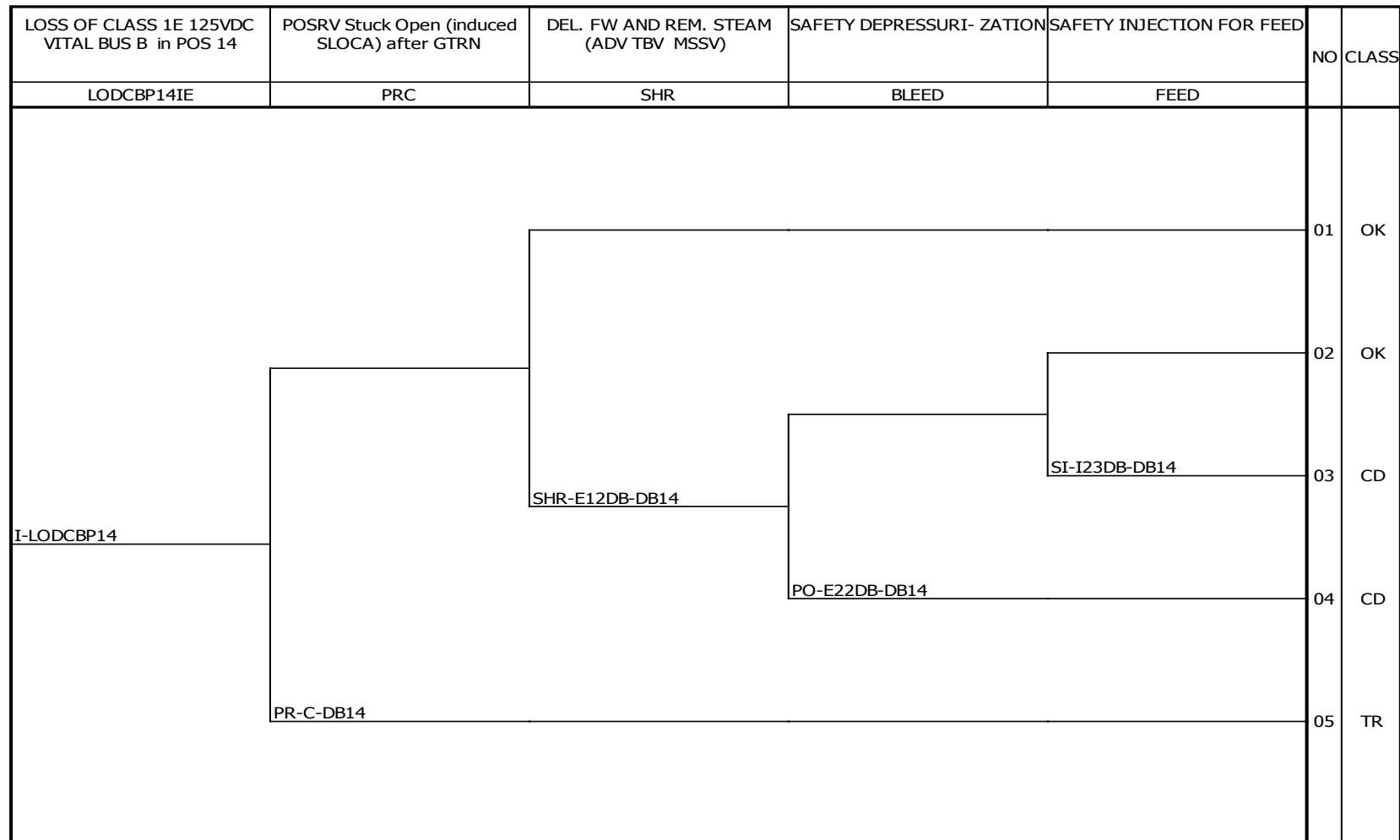


Figure 19.1-194 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel B (DCB) in POS 14

APR1400 DCD TIER 2

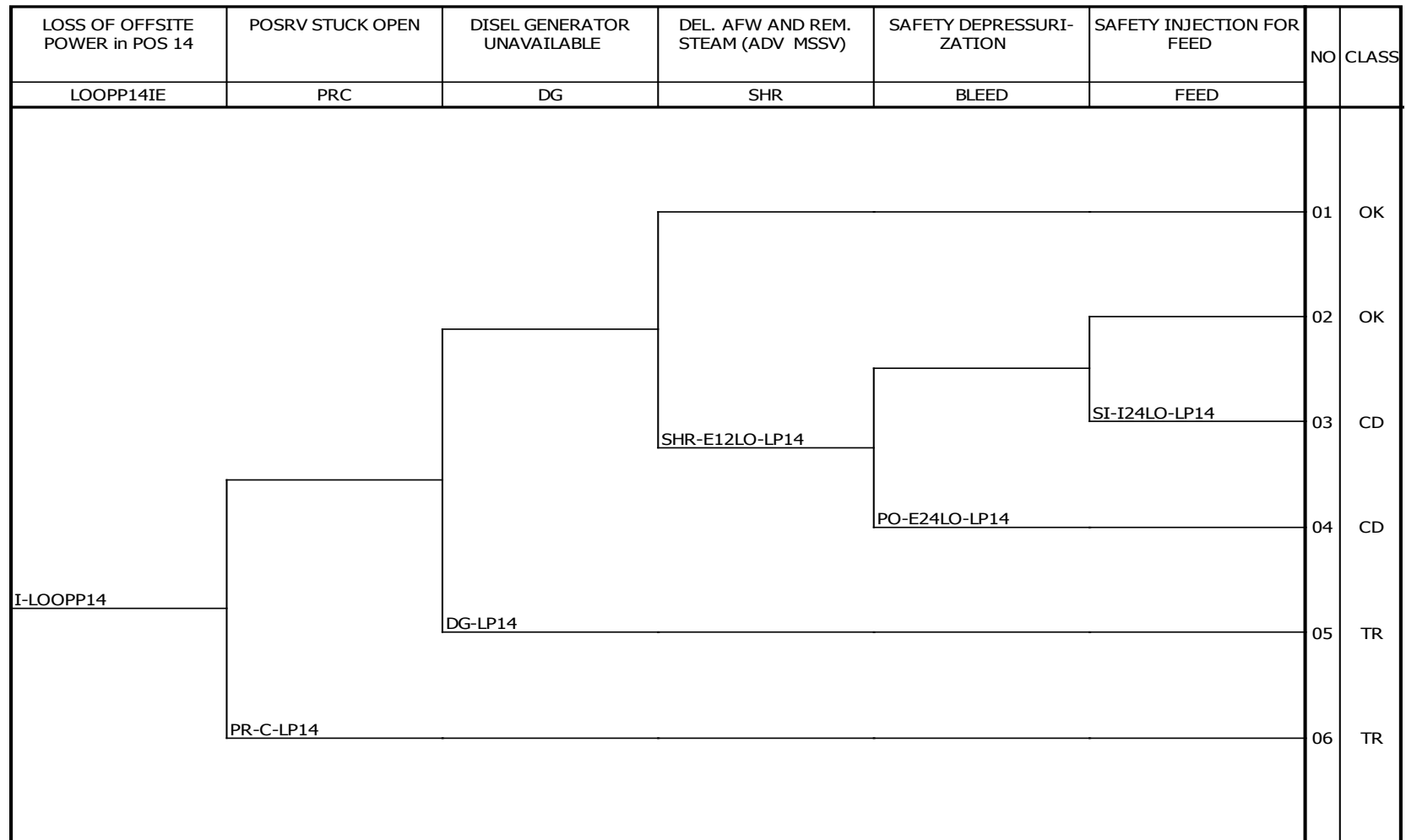


Figure 19.1-195 LPSD Level 1 Event Tree – Loss of Offsite Power (LP) in POS 14

APR1400 DCD TIER 2

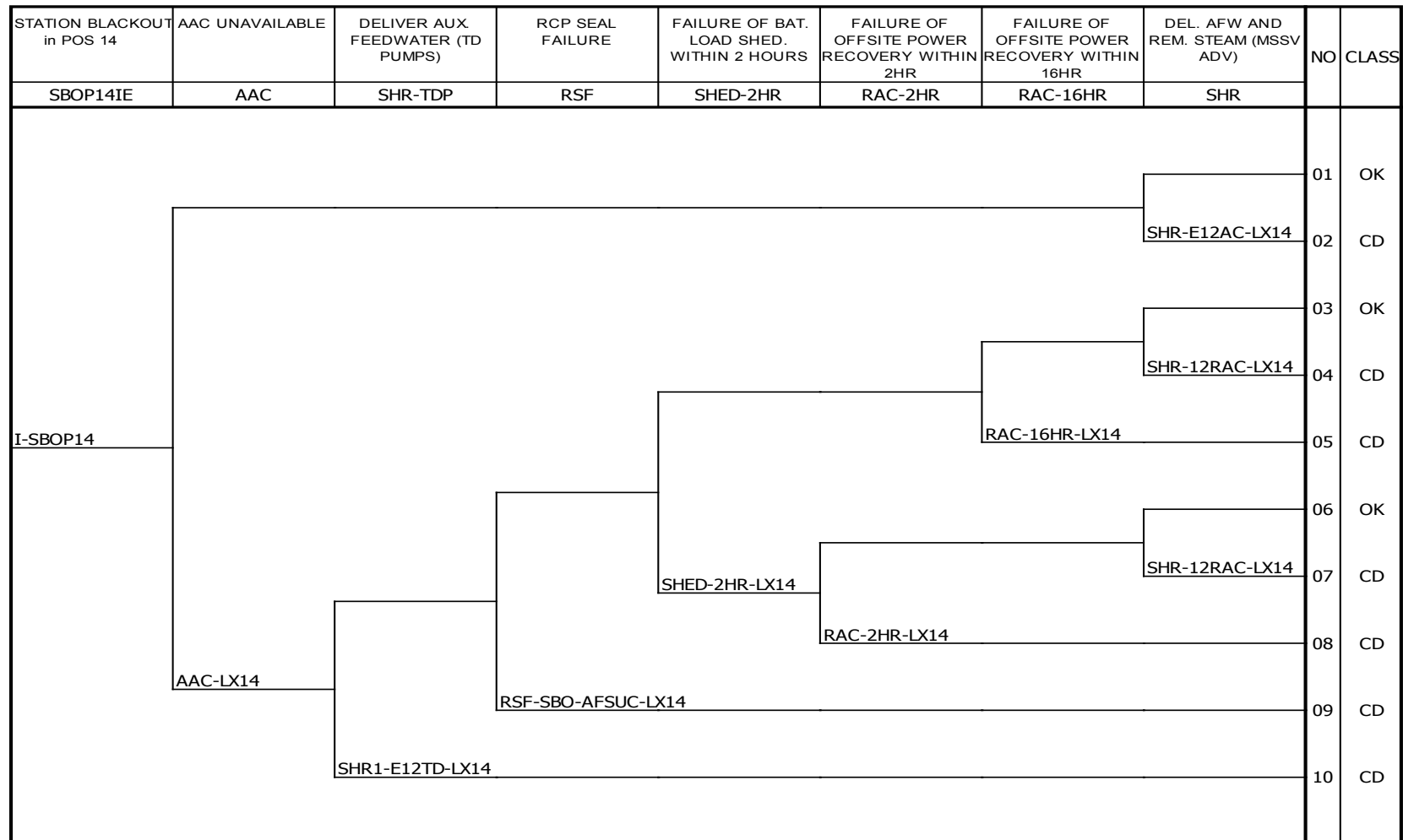
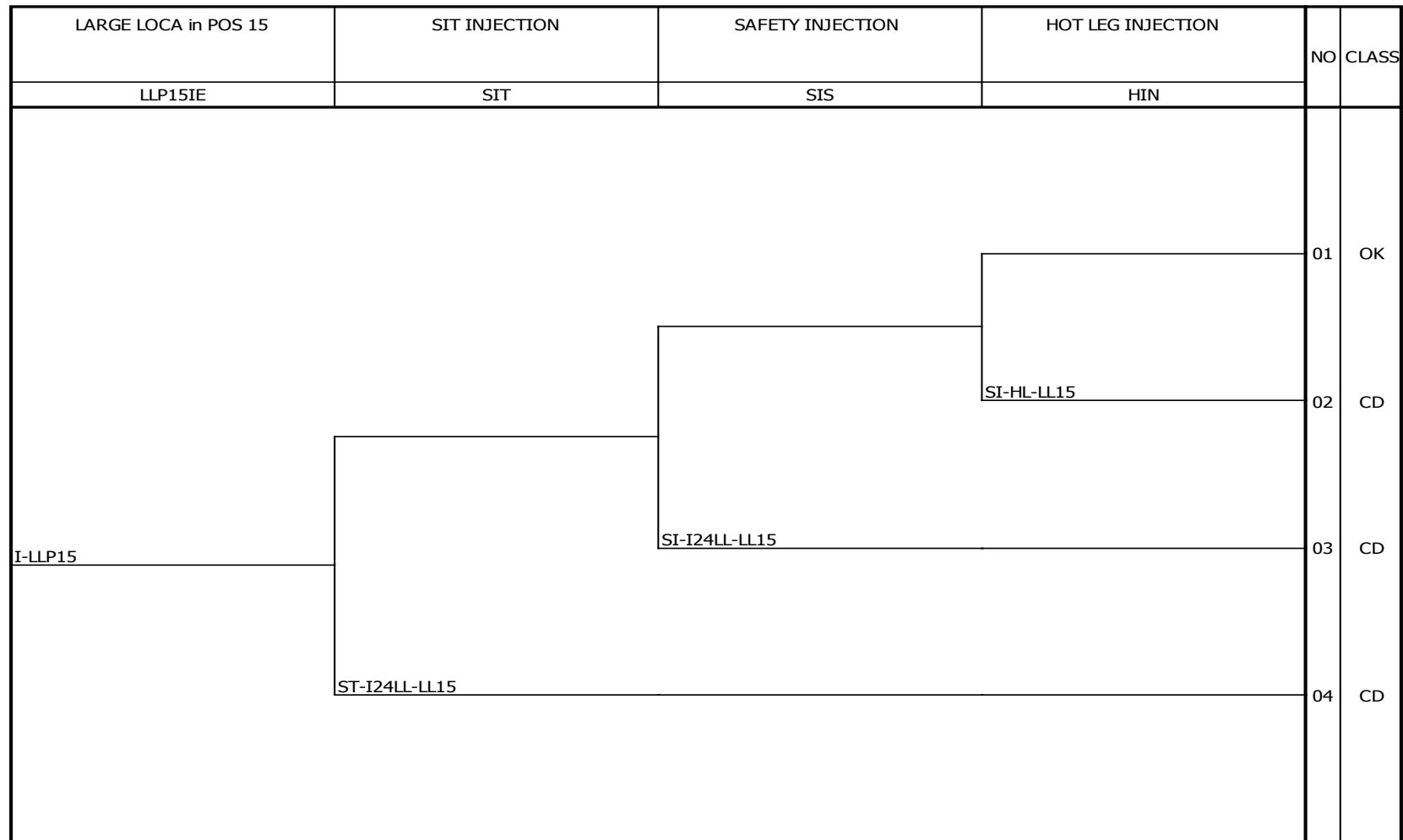


Figure 19.1-196 LPSD Level 1 Event Tree – Station Blackout (LX) in POS 14

APR1400 DCD TIER 2**Figure 19.1-197 LPSD Level 1 Event Tree – Large LOCA (LLOCA) in POS 15**

APR1400 DCD TIER 2

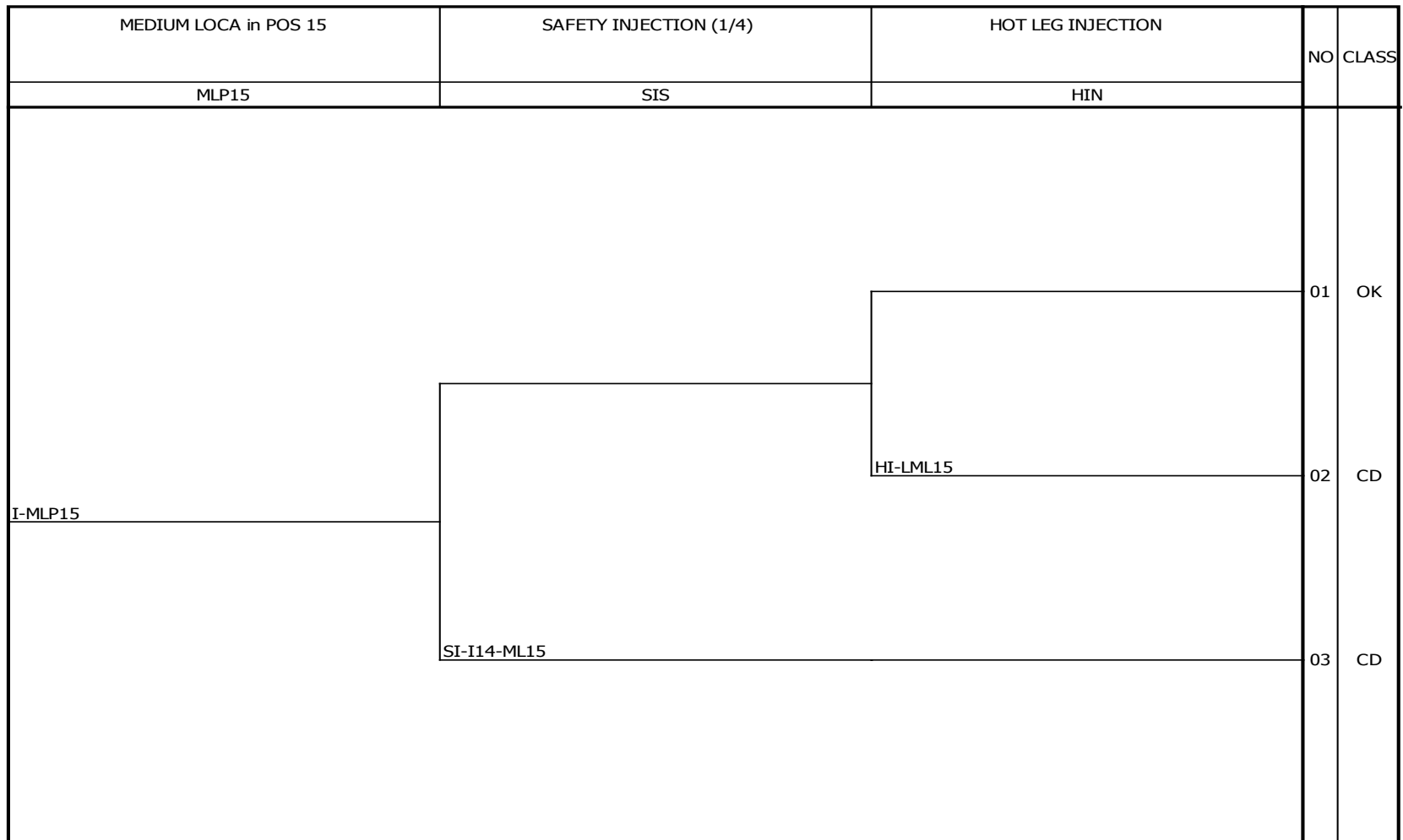


Figure 19.1-198 LPSD Level 1 Event Tree – Medium LOCA (MLOCA) in POS 15

APR1400 DCD TIER 2

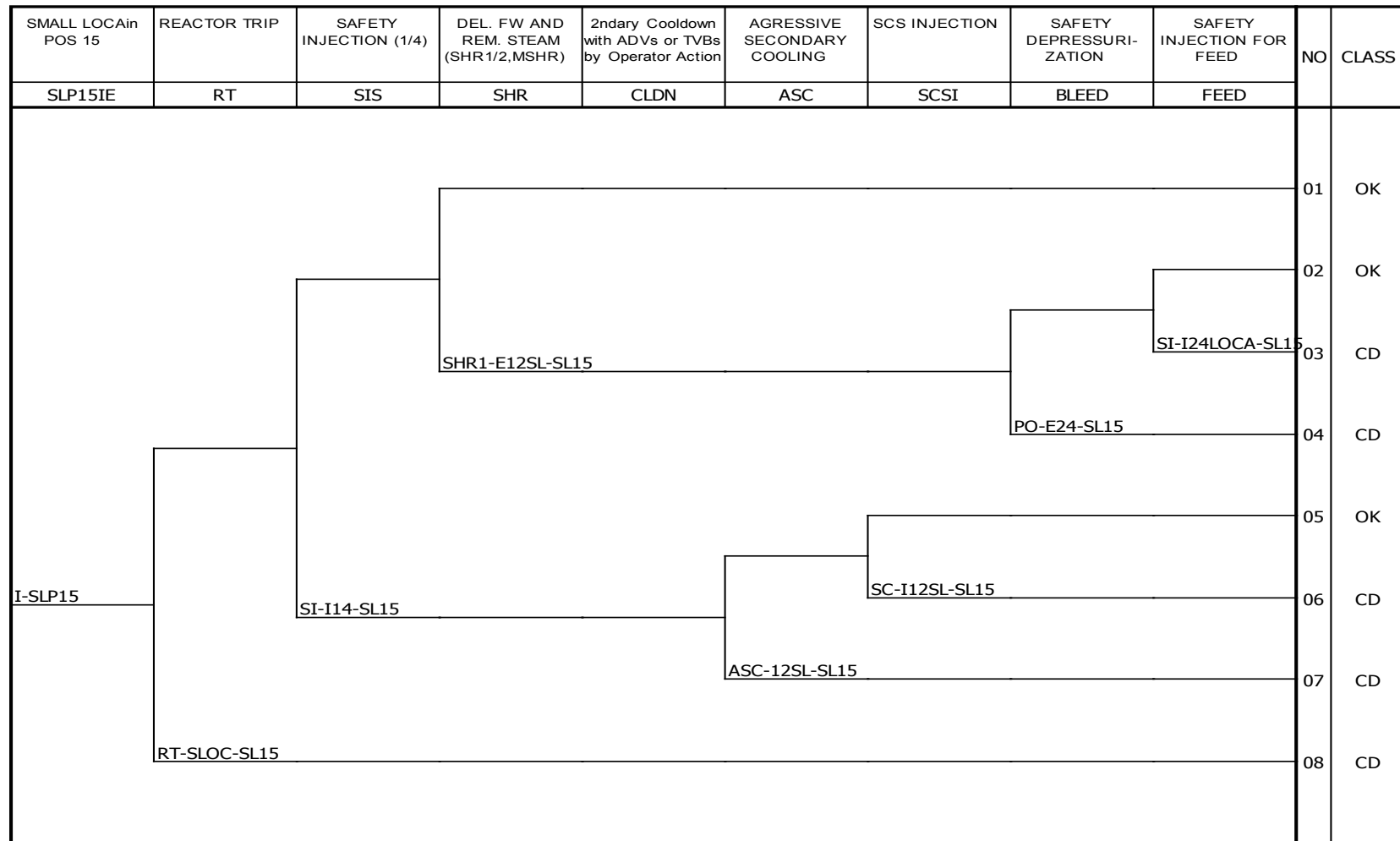


Figure 19.1-199 LPSD Level 1 Event Tree – Small LOCA Pipe Rupture (SL) in POS 15

APR1400 DCD TIER 2

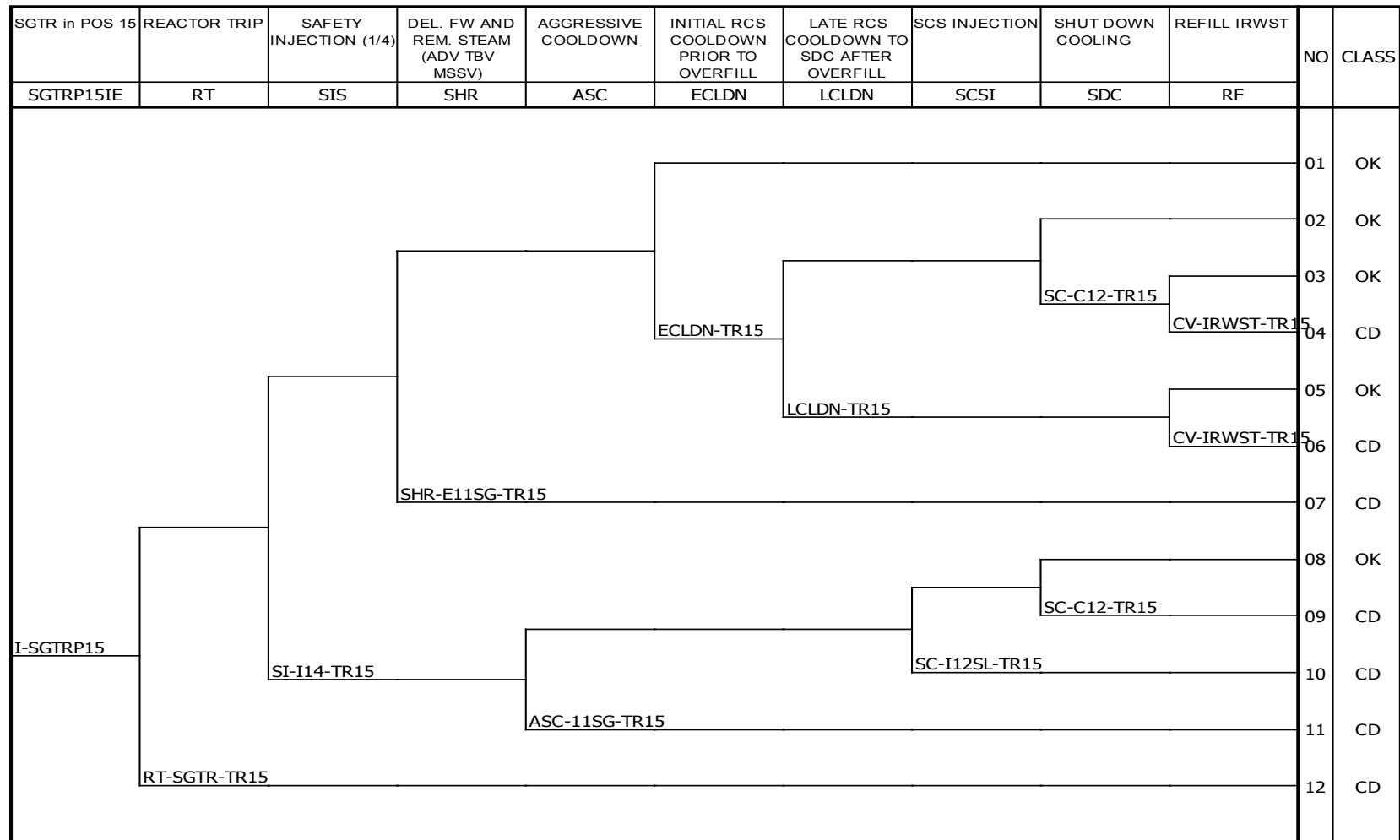


Figure 19.1-200 LPSD Level 1 Event Tree – Steam Generator Tube Rupture (SG) in POS 15

APR1400 DCD TIER 2

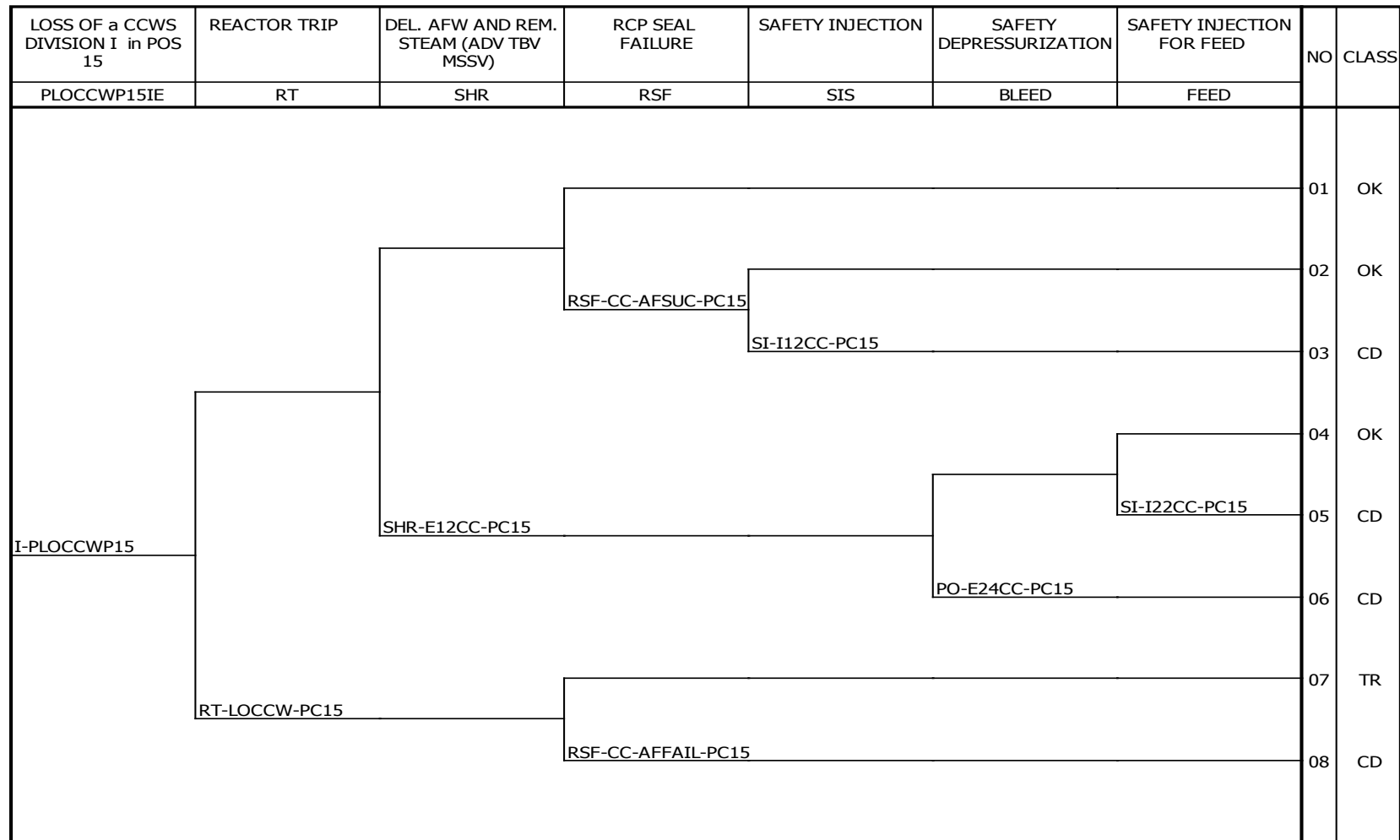


Figure 19.1-201 LPSD Level 1 Event Tree – Partial Loss of Component Cooling Water (CC) in POS 15

APR1400 DCD TIER 2

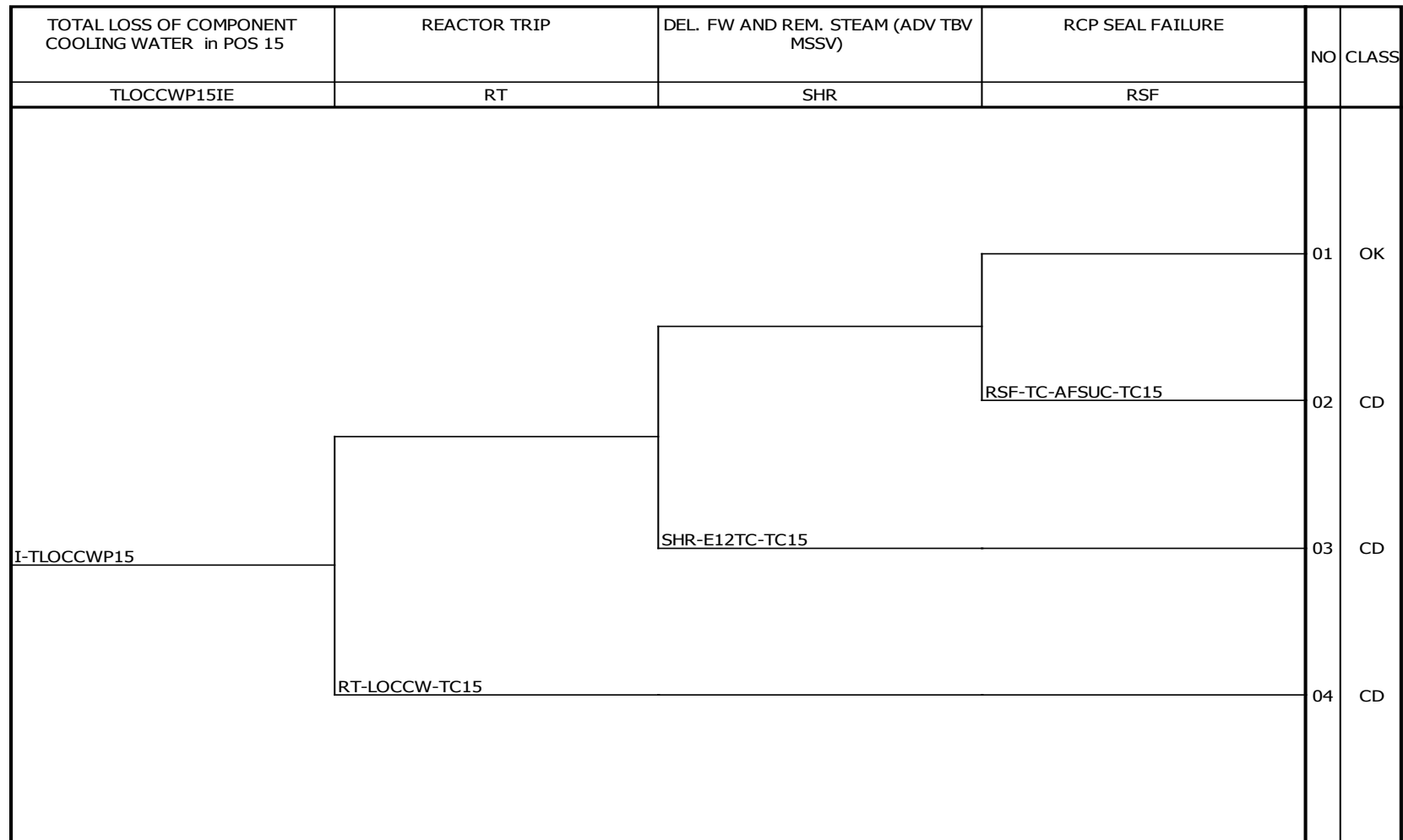


Figure 19.1-202 LPSD Level 1 Event Tree – Total Loss of Component Cooling Water (TC) in POS 15

APR1400 DCD TIER 2

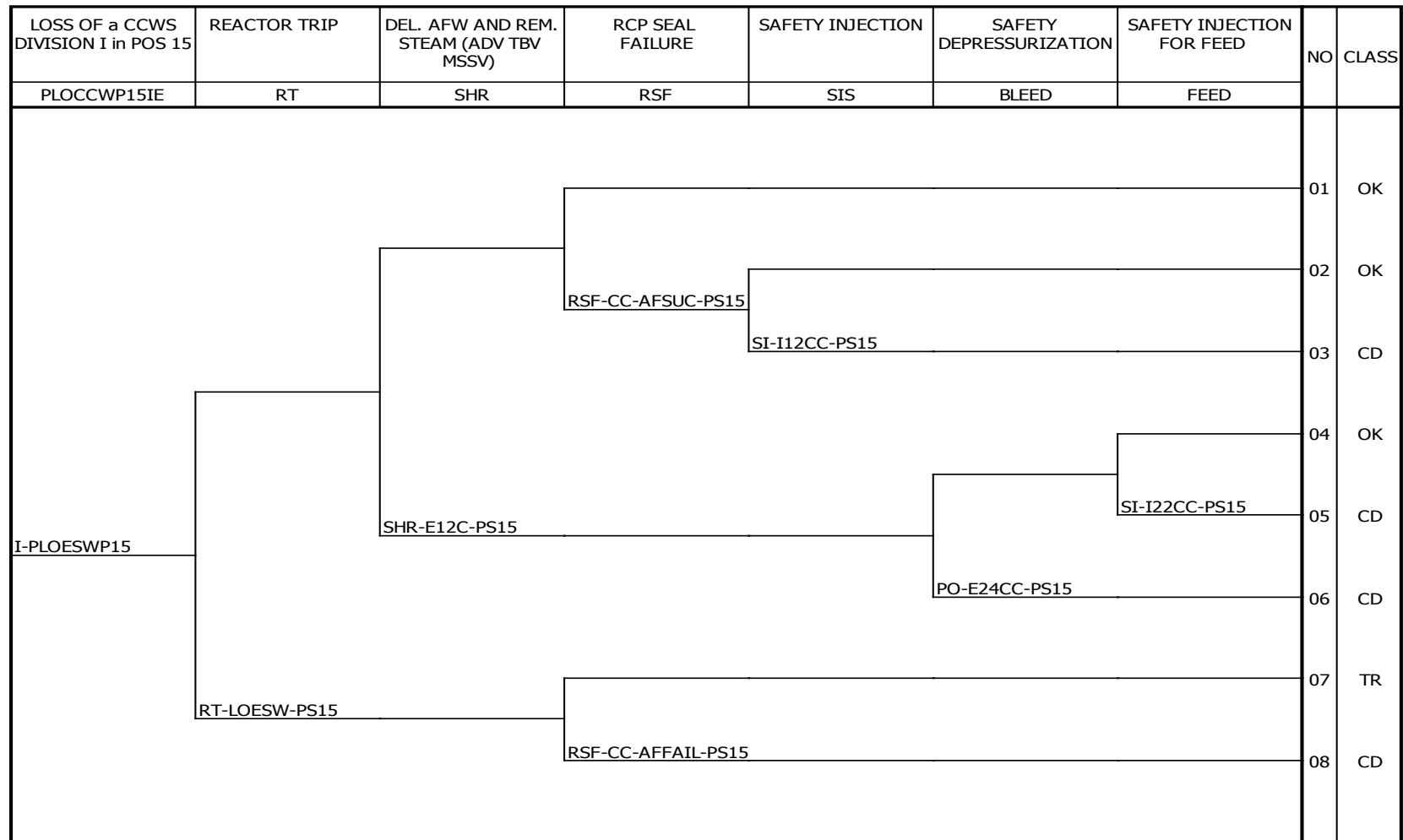


Figure 19.1-203 LPSD Level 1 Event Tree – Partial Loss of Essential Service Water (CC) in POS 15

APR1400 DCD TIER 2

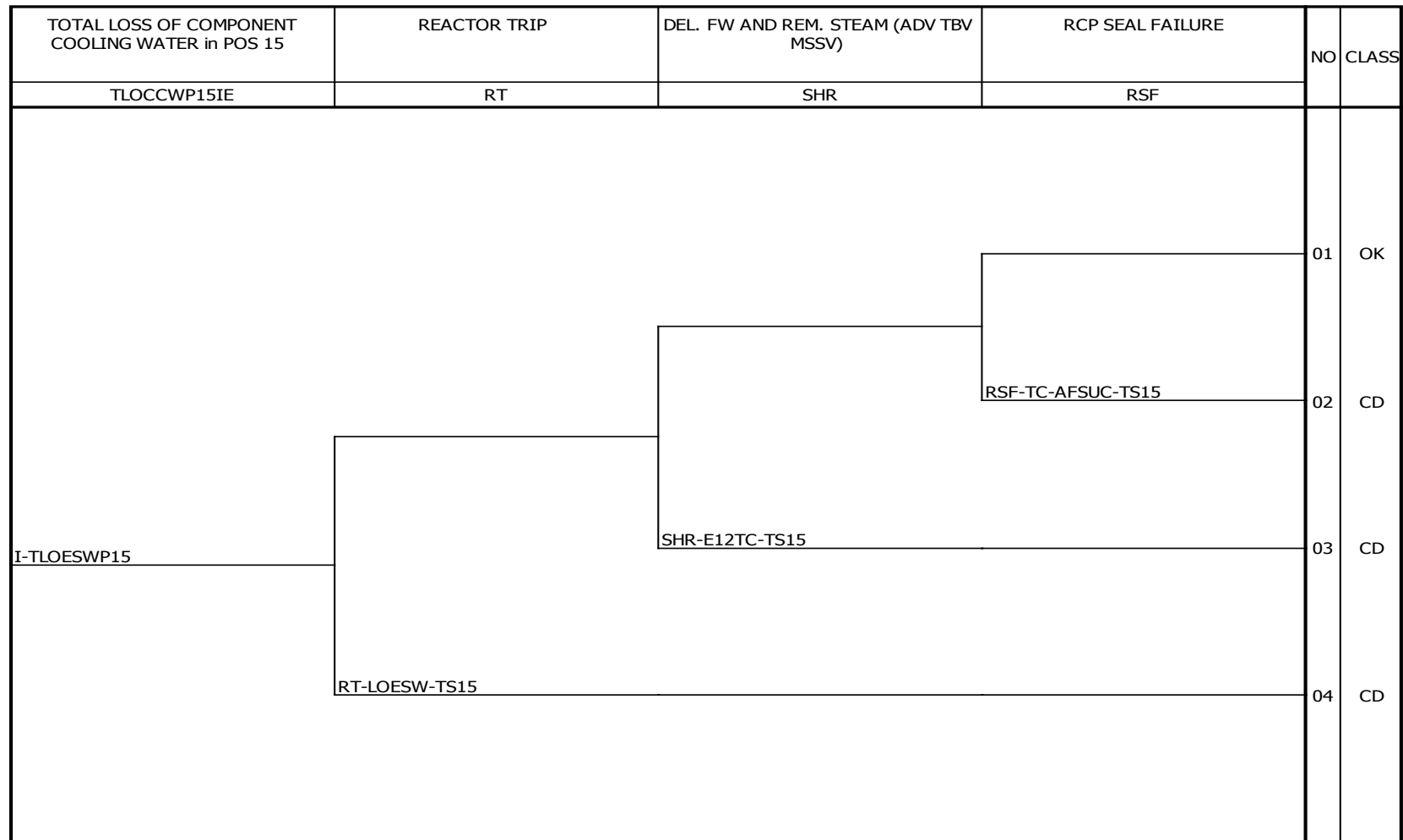


Figure 19.1-204 LPSD Level 1 Event Tree – Total Loss of Essential Service Water (CC) in POS 15

APR1400 DCD TIER 2

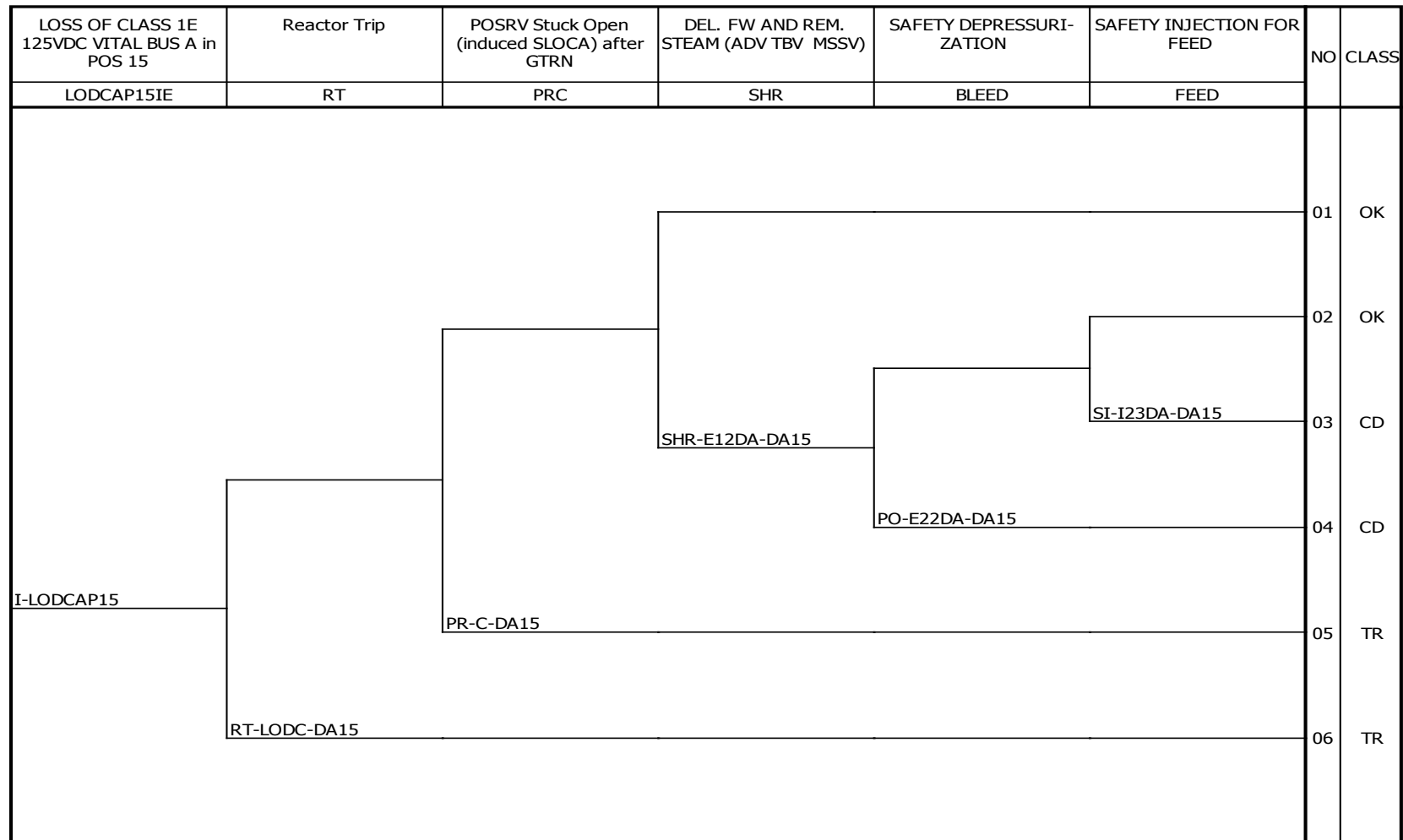


Figure 19.1-205 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel A (DCA) in POS 15

APR1400 DCD TIER 2

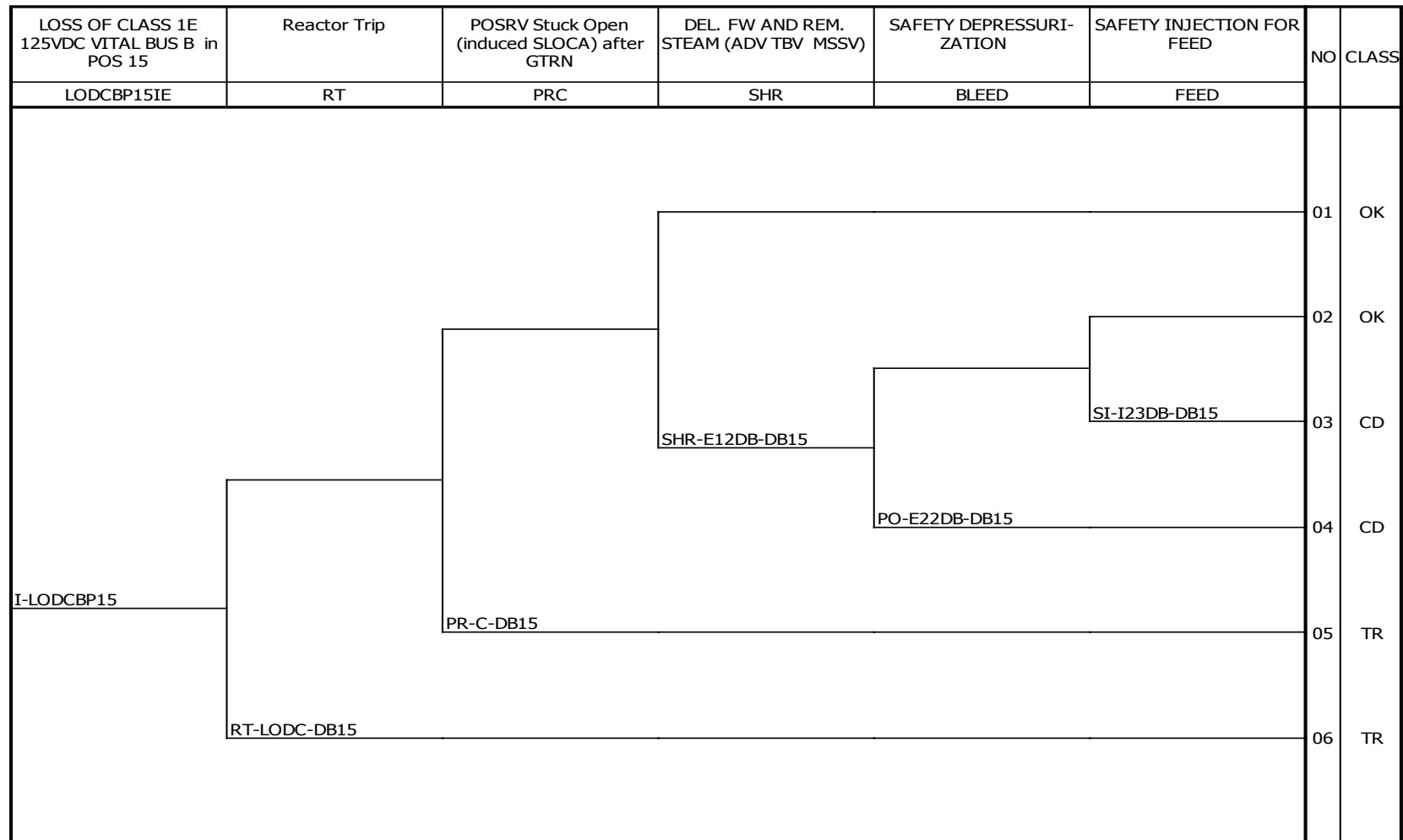


Figure 19.1-206 LPSD Level 1 Event Tree – Loss of 125VDC Vital Bus Channel B (DCB) in POS 15

APR1400 DCD TIER 2

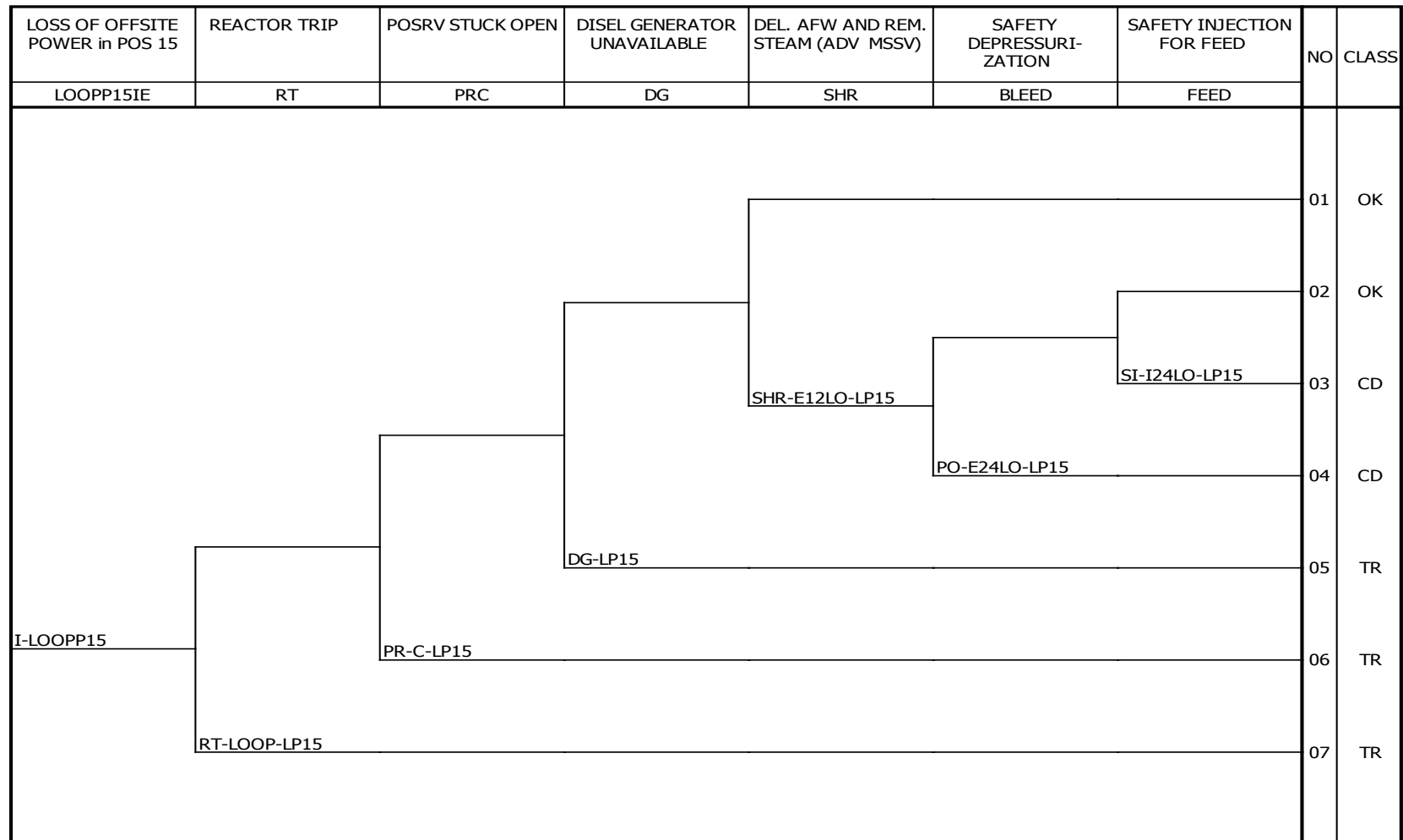


Figure 19.1-207 LPSD Level 1 Event Tree – Loss of Offsite Power (LP) in POS 15

APR1400 DCD TIER 2

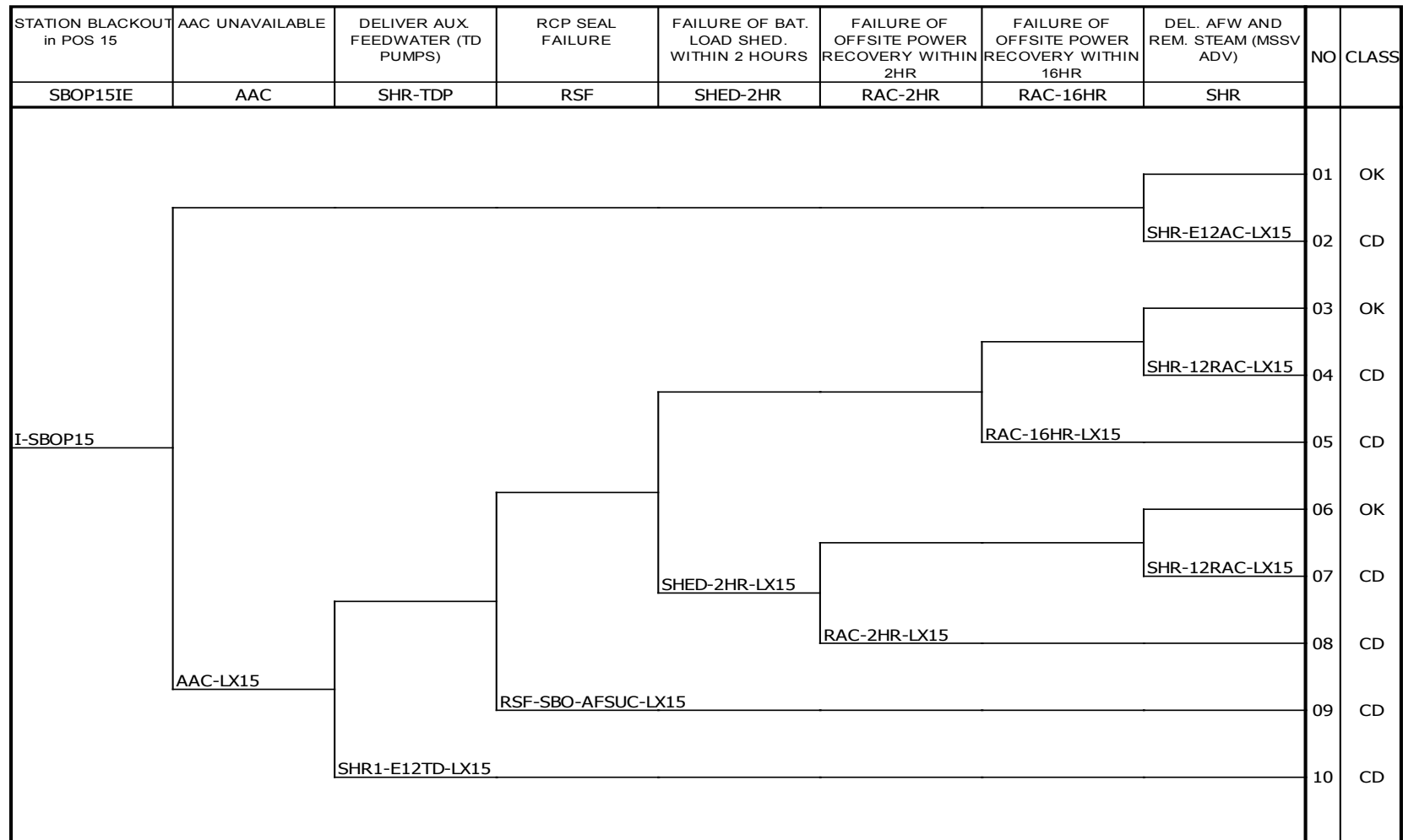


Figure 19.1-208 LPSD Level 1 Event Tree – Station Blackout (LX) in POS 15

CD	BYPASS	CISO	MELTSTOP	DCF	ECF	CSLATE	DBCOOL	LCF	BMT	Name
CD Seqs from LPSD PCSs	Containment Not Bypassed	Containment Isolated	Molten Core Retained	No Dynamic Containment	No Early Containment	Late Cont Heat Removal	Debris is Cooled	No Late Containment	No Basemat Melt-through	
LPSD-L2-N										1-INTACT
LPSD-L2-D LPSD-L2-N										2-INTACT
LPSD-L2-D LPSD-L2-R										3-LLATE
LPSD-L2-D LPSD-L2-N LPSD-L2-N										4-INTACT
LPSD-L2-D LPSD-L2-R LPSD-L2-B										5-BMT
LPSD-L2-D LPSD-L2-N BMT										6-LLATE
LPSD-L2-D LPSD-L2-R										7-BMT
LPSD-L2-E LPSD-L2-N										8-LLATE
LPSD-L2-E LPSD-L2-R										9-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-N										10-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-R										11-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-N BMT										12-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-R										13-BMT
LPSD-L2-E LPSD-L2-D LPSD-L2-N										14-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-R										15-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-N LPSD-L2-N										16-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-R LPSD-L2-B										17-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-N										18-BMT
LPSD-L2-E LPSD-L2-D LPSD-L2-R										19-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-N BMT										20-BMT
LPSD-L2-E LPSD-L2-D LPSD-L2-R										21-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-N										22-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-R										23-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-N										24-INTACT
LPSD-L2-E LPSD-L2-D LPSD-L2-R										25-LLATE
LPSD-L2-E LPSD-L2-D LPSD-L2-N BMT										26-BMT
LPSD-L2-E LPSD-L2-D LPSD-L2-R										27-LLATE
LPSD-L2-A										28-LEARLY
GCI-TOP										29-LEARLY
LPSD-JL-N										30-LEARLY
										31-LEARLY

Figure 19.1-209 LPSD Containment Event Tree

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system availability, can differ significantly from one POS to the next. The reactor core vulnerability to inventory boil-off and subsequent fuel uncovering can differ as well.

The time between boiling inception and fuel uncovering is a strong function of the decay heat level and the primary system inventory. Thus, the potential accident sequences are highly dependent upon the plant configuration and timing, as characterized for each POS.

The important safety functions for LPSD are inventory control and decay heat removal, including the support systems. A core damage sequence typically will occur following the failure of at least one of these functions. Conversely, core protection is maintained by ensuring that both of these functions are established for long-term operation. A safety function may be accomplished by more than one system. For example, decay heat removal in the transition and shutdown modes may be accomplished by the shutdown cooling system, or by safety injection system for feed and bleed.

The accident sequence progression reflects the phenomenological response that is unique to each operating state.

Due to differences in mitigation system availability and plant conditions at each POS, different event trees are developed for some states for the same initiating events.

The LPSD core damage sequences are summarized in Table 19.1-88. This table does not include the large, medium, and small break LOCA, SGTR, and dc bus failure sequences, which are already described for the at-power analysis.

~~The LPSD event trees for POS 5, which occurs during mid-loop operation, are contained in Figure 19.1-52 through Figure 19.1-63.~~

19.1.6.1.1.5 Success Criteria Analysis

The LPSD event trees for all plant operational states (POSs) are presented in Figures 19.1-52 through 19.1-208. The LPSD containment event tree is presented in Figure 19.1-209.

Plant conditions evaluated in the LPSD PRA are characterized by low temperatures, low RCS pressure or depressurized RCS conditions, and decreasing decay heat. Plant configuration changes during an outage are conducted in a controlled and deliberate manner according to outage plans. In the transition modes, e.g., Technical Specification (TS)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.: 268-8308
SRP Section: SRP 19
Application Section: 19.1
Date of RAI Issue: 10/02/2015

Question No. 19-13

10 CFR 52.47(27) requires that a standard design certification applicant provide a description of the design specific probabilistic risk assessment (PRA) and the results. Standard Review Plan (SRP) Chapter 19, Revision 3 (Draft), "Design-Specific PRA (PRA for Non-Power Modes of Operation)" states that, "Given that shutdown risk may be highly outage-specific, the staff reviews the shutdown PRA insights to confirm that operational assumptions used to develop an average shutdown model (e.g., use of nozzle dams, outage schedule, containment status, procedural requirements) have been clearly documented in the FSAR." The staff is requesting additional information in the design control document (DCD) regarding how the reactor coolant system (RCS) is drained to mid-loop conditions sufficient to install steam generator (SG) nozzle dams. From evaluating the applicant's response to request for additional information (RAI) question 19-4, in plant operational state (POS) 04A, the staff understands the RCS is drained from normal operating levels in the pressurizer with the Reactor Coolant System Gas Vent system open, and the low temperature overpressure protection (LTOP) valves are in automatic protection mode. RCS inventory is drained through the chemical and volume control system (CVCS) letdown line. The staff has the following specific requests for additional information:

1. In POS 4A, the staff is requesting clarification in the DCD whether a cover gas is used to speed draining or prevent the RCS from drawing a vacuum.
2. In POS 4B, the staff is requesting clarification in the DCD whether the pressurizer manway is opened once mid-loop conditions are reached. Mid-loop conditions are defined in Generic Letter 88-17 as when the RCS water level is below the top of the flow area of the hot-legs at the junction with the reactor vessel.
3. The staff is also requesting the applicant to document in the DCD whether vacuum refill of the RCS is performed from mid-loop conditions.

Response

1. Instrument air is ported to the RCS through the pressurizer vent path before the pressurizer manway is opened. This alignment prevents the RCS from drawing a vacuum and speeds draining.
2. The pressurizer manway is opened before mid-loop conditions are reached. This administrative requirement ensures that the nozzle dam abnormal design pressure limit is not exceeded during reduced inventory operations with boiling conditions in the reactor vessel. When the manway is opened to the containment atmosphere, the surge line provides sufficient venting capacity to prevent RCS pressurization and subsequent nozzle dam failure.

The definition of POSs with additional information are summarized in Table 19.1-81. The status of pressurizer manway in POS 4B is explained in POS 4B, but additional notes will be added on POS 4B in Table 19.1-81 to clarify this detail.

3. No vacuum refill of the RCS is performed during midloop conditions. The POS descriptions in the DCD will be revised to clarify this detail.

Impact on DCD

DCD 19.1 will be revised to reflect the response of this RAI.

Table 19.1-81 will be revised as shown in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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

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Table 19.1-81

LPSD Plant Operating States

POS	Description	Tech Spec Mode	Decay Heat
1	Reactor trip and Subcritical operation	1, 2	High
2	Cooldown with Steam Generators to 177°C (350°F)	3	High
3A	Cooldown with Shutdown Cooling System to 100°C (212°F)	4	High
3B	Cooldown with Shutdown Cooling System from 100°C (212°F) to 60°C (140°F)	5	High
4A	Reactor Coolant System drain-down (Pressurizer manway closed) ¹	5	High
4B	Reactor Coolant System drain-down (manway open) ²	5	High
5	Reduced Inventory operation and nozzle dam installation	5	High
6	Fill for refueling ³	5	High
7	Offload	6	High
8	Defueled	Defueled	High
9	Onload	6	Low
10	Reactor Coolant System drain-down to Reduced Inventory after refueling	5	Low
11	Reduced Inventory operation with steam generator manway closure	5	Low
12A	Refill Reactor Coolant System (pressurizer manway open)	5	Low
12B	Refill Reactor Coolant System (pressurizer manway closed) ³	5	Low
13	Reactor Coolant System heat-up with Shutdown Cooling System isolation at 177°C (350°F)	4, 5	Low
14	Reactor Coolant System heat-up with steam generators	3	Low
15	Reactor startup	2,1	Low

Note :

1. Instrument air is ported to the RCS through the pressurizer vent path before the pressurizer manway is opened.
2. The pressurizer manway is opened before mid-loop conditions are reached. It ensures that the nozzle dam abnormal design pressure limit is not exceeded during reduced inventory operations with boiling conditions in the reactor vessel.
3. Vacuum refill is administratively prohibited during mid-loop operation.