April 22, 2002

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FROM: Mark F. Reinhart, Chief**/Signed by M. Caruso for**
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SUBJECT: RESULTS OF THE INDIAN POINT UNIT 3 SDP PHASE 2 NOTEBOOK BENCHMARKING VISIT

During January, 2002, NRC staff and a contractor visited the White Plains Entergy office to compare the Indian Point Unit 3 Significance Determination Process (SDP) Phase 2 notebook and licensee's risk model results to ensure that the SDP notebook was generally conservative. Indian Point Unit 3's PSA did not include external initiating events so no sensitivity studies were performed to assess the impact of these initiators on SDP color determinations. In addition, the results from analyses using the NRC's draft Revision 3i Standard Plant Analysis Risk (SPAR) model for Indian Point Unit 3 were also compared with the licensee's risk model. The results of the SPAR model benchmarking effort will be documented in a separate a trip report to be prepared by the Office of Research.

In the review of the Indian Point Unit 3 SDP notebook, it was found that some changes to the SDP worksheets were needed to reflect how the plant is currently designed and operated. Thirty six hypothetical inspection findings were processed through the SDP notebook. Results from this effort indicated that the total risk impacts modeled in the SDP notebook were underestimated by 8 percent, overestimated by 36 percent, and adequately estimated by 56 percent. The reviewers found that if nine fixes were made to the SDP notebook, the results would be 6 percent underestimation and 20 percent overestimation of risk impacts.

Attachment A describes the process and results of the comparison of the Indian Point Unit 3 SDP Phase 2 Notebook and the licensee's PSA.

If you have any questions regarding this effort, please contact Peter Wilson.

Attachments: As stated

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Attachment A describes the process and results of the comparison of the Indian Point Unit 3 SDP Phase 2 Notebook and the licensee's PSA.

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SUMMARY REPORT ON BENCHMARKING TRIP

to the Indian Point Nuclear Power Plant Unit-3
(January 29-31, 2002)

M. A. AZARM (BNL)

Energy Sciences and Technology Department
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February 2002

Attachment A

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1. Introduction

A benchmarking of the Indian Point Unit 3 (IP3) SDP Risk-Informed Inspection Notebook was conducted during a plant site visit on January 29-31, 2002. NRC staff (J. Trapp and P. Wilson) supported by BNL staff (M. A. Azarm) participated in this benchmarking exercise.

In preparation of the plant site visit, BNL staff reviewed the IP3 SDP notebook and evaluated a set of hypothetical inspection findings using the Rev 0 SDP worksheets, plant system diagrams and information in the licensees updated PSA. A copy of the site visit agenda was sent to the licensee by NRC staff (P. Wilson) prior to the meeting.

The major activities performed during this plant site visit were:

1. Discussed licensee's comments on the Rev 0 SDP notebook.

2. Obtained listings of the Risk Achievement Worth (RAW) values for basic events for of the internal event PRA model for average maintenance at model.

3. Identified a target set of basic events for the benchmarking exercise.

4. Performed benchmarking of the Rev 0 SDP worksheets with considerations of the licensee's proposed modifications to the SDP notebook.

5. Identified areas of discrepancies and reviewed the licensee's PSA model to determine the underlying reasons. Proposed additional changes to the SDP notebook if appropriate.

6. Performed a benchmarking exercise using the Revision 3i SPAR model for the IP3 (by Mr. R. Buell of INEEL)

The benchmarking exercise provided insights for significant improvement to the SDP notebook. The revised SDP notebook should provide either similar or slightly more conservative significance characterization (i.e.,maximum by one color) than the licensee's PRA model in about 95% (i.e., about 5% underestimation) of the cases analyzed. Further investigation into the cases of under estimation revealed that they can be simply explained by use of higher initiator frequency in the licensee's PSA compare to the SDP worksheets for ATWS, SLOCA, and MSLB. Furthermore, for these cases similar accident sequences were modeled in both SDP worksheets and the plant PSA.

The importance of this benchmarking trip was well demonstrated by significant reduction in the number of overestimations. The number of overestimations were reduced from 13 to 7. This reduction in number of overestimations were primarily attributed to more realistic modeling of three initiators; Loop, LNSW, and LCCW.

2. Summary Results from Benchmarking

This Section provides the results of the benchmarking exercise. The results of benchmarking analyses are summarized in Table 1. Table 1 consists of six column headings. In the first column, the out-of-service components (human and recovery actions) are identified for the case analyses. The second column shows the associated colors based on the Rev 0 SDP notebook. The third column shows the specific basic event name(s) associated with the item identified in the first column as used in the latest licensee's PSA. The RAW values based on the licensee's latest PSA model are shown in the fourth column. The colors assigned for significance characterization from using the modified Rev 0 SDP worksheets after incorporation of the licensee's comments are shown in the fifth column. Finally, some clarifying notes and the reasons for any differences in second and the fifth columns which resulted from incorporating the licensee's comments are noted in the sixth column. In addition the underlying reason(s) for any underestimations is also noted in this column.

The two cases that were underestimated were related to the failure of MSIV to close and the RCS depressurization function and the associated hardware. The reasons for both of these underestimation stemmed from use of higher initiator frequencies in the licensee's PSA. The initiator frequencies for MSLB and SLOCA in the licensee's PSA are 1.0E-2 and 6.0E-3 per year in comparison to 1.0E-3 used in the SDP worksheets.

The reasons for four out of seven cases of overestimations by one color stemmed from the following assumptions made in licensee's PSA which are different from the generic guidelines and usage rules in the SDP notebooks. These are:

1. The licensee's PSA assumes that the isolation of the feed to two SGs will prevent PTS in cases where both MSIVs have failed to close.

2. Higher recovery action credits (e.g: for loss of ventilation in aux. Bldg. Feed pump) than the 0.1 credit allowed by the SDP rules.

3. Use of higher reliability for TDAFW by the licensee's PSA than that in SDP notebook (0.1 in SDP notebook vs. 0.03 in the licensee's PSA). This has resulted in two overestimations by SDP notebooks compare to licensee's PSA for those inspection findings involving failure of PORV to open or feed and bleed function.

No specific reason were found for the remaining three cases of overestimations by one color. These differences were expected to be caused by slightly different reliability and human error probabilities used in the licensee's PSA model compare to the generic values in the SDP notebook. The summary statistics of the benchmarking results is provided in Table-2.

Table 1: Comparison of Sensitivity Calculations between SDP Phase 2 Worksheets and IP3 RAWs CDF 1.35 E-5, W = 1.07, Y = 1.74, R = 8.4 TRUNCATION =1 E-9

Component Out of Service	SDP Worksheet Color	IP3 Basic Event	IP3 RAW ratio	SDP Work-sheet Modified	Comparison Summary and Comments
MDAFW Pump-31	R (M)	AFW-MDP-FR-PM31 AFW-MDP-FS-PM31 AFW-RCK-NO-PM31	14.10 14.06 13.40	R (M)	Due to loss of DC 32
MDAFW Pump- 33	Y (M)	AFW-MDP-FR-PM33 AFW-MDP-FS-PM33 AFW-RCK-NO-PM33	6.42 5.95 6.38	Y (M)	
TDAFW Pump	R (O)	AFW-TDP-FS-TDP32 AFW-RCK-NO-TDP32 AFW-TDP-FR-TDP32	7.69 7.64 7.59	R (O)	1Y, 2W, 6G/W
Accumulator	W				Acc. were not modeled. However, the associated check valves were modeled. RAW ~ 1. Due to multiple redundancy
HPSI TRAIN	W (M)	HHI-MDP-FS-SI31 HHI-RCK-NO-SI31 HHI-MDP-FR-SI31	1.06 1.12 1.10	W (M)	1W, 5G/W (with max. CR would be Y)

Component Out of Service	SDP Worksheet Color	IP3 Basic Event	IP3 RAW ratio	SDP Work-sheet Modified	Comparison Summary and Comments
RHR Pump TRAIN LPI/LPR	W (O)	LHI-RCK-NO-PM31 LHI-MDP-FR-PM31 LHI-MDP-FS-PM31	1.01 1.01 1.00	G/W (M)	LPR and Recir. Pump credit raised to 3+1=4
One CHG Pump	G (M)	CVC-RCK-NO-BPM31 CVC-MDP-FR-BPM31 CVC-MDP-FS-BPM31	1.02 1.02 1.02	G (M)	
CHG Pumps all	W (U)	CVC-CCF-FR-CHPMP	2.62	Y (M)	ATWS freq. In licensee's PSA is 1.3E-5
EDG 31 OR 32	Y (M)	EDG-ENG-FR-DG31R EDG-ENG-FS-DG31S	2.00 2.00	Y (M)	FEEDS ONE MDAFW
EDG 33	Y (O)	EDG-ENG-FS-DG33S EDG-ENG-FR-DG33R	1.34 1.35	W (M)	DOES NOT FEED AFW but on loss of bus32 and 33 we loose both RHR pumps
EDG Fuel Transfer pump 1/3 trains	G/W (M)	EDG-MDP-FR-FOT31 EDG-RCK-NO-FOT31 EDG-MDP-FS-FOT31	1.01 1.02 1.00	G/W (M)	
ACW Pump train	G (M)	ACC-MDP-FS-PM31 ACC-MDP-FR-PM31	1.00 1.00	G (M)	
CCW Pump train Standby	R (O)	CCW-MDP-FS-PM33	1.01	G (M)	Extended the event tree to mitigate the seal LOCA

Component Out of Service	SDP Worksheet Color	IP3 Basic Event	IP3 RAW ratio	SDP Work-sheet Modified	Comparison Summary and Comments
CCW Pump train runing	R (O)	CCW-MDP-FR-PM31	1.00	G (M)	Extended the event tree to mitigate the seal LOCA
IA any of three compressors	W (O)	IAS-CMP-FR-IAC31	1.05	W (O)	TPCS
PORV FTO	R (O)	PPR-PRV-CC-455C	1.97	R (O)	NO FB OR DEP
PORV FTC	W (M)	PPR-AOV-OO-455C	1.50	W (M)	SORV&LAC5A/6A
Block Valve FTC	W (M)	PPR-MOV-OO-RC535	1.39	W (M)	LEAC
PCS/CDS	W (M)	IE-T2	1.19	W (M)	
1 MSIV fail to close	W (U)	MSS-MSV-OO-MS131 MSS-MSV-OO-MS132 MSS-MSV-OO-MS133 MSS-MSV-OO-MS134	3.47 3.47 3.47 3.47	W (U)	High Freq. For MSLB (1.0E-2)
2 MSIVs fail to close	R (O)	MSS-CCF-OO-MSIV	6.23	R (O)	Licensee PSA assumes that the isolation of the feed to both affected SGs will prevent PTS

Component Out of Service	SDP Worksheet Color	IP3 Basic Event	IP3 RAW ratio	SDP Work-sheet Modified	Comparison Summary and Comments
Isolation of the feed to that affected SG	W (M)	SGISO (SGTR) MSS-XHE-FO-SGISO	1.00 1.26	W (M)	
ADVs FTO/MSSVs FTO	G/W (M)	MSS-ADV-CC-1134	1.07	G/W (M)	
125V DC Panel D31	R (M)	DC1-BDC-ST-PP-31	11.55	R (M)	
125V DC Panel D32	R (M)	DC1-BDC-ST-PP-32	107.1 1	R (M)	
One Battery	Y (M)	DC1-BAT-HW-BAT31	3.06	Y (M)	CHARGERS TAKE SI LOADS
Battery Charger	Y (M)	DC1-BCC-HW-BCC31	3.06	Y (M)	
1 NSW pump	R (O)	SWS-MDP-FR-PM34	1.50	W (M)	Extended models to mitigate loss of RCP seals
Loss of NSW	R (O)	IE-TSWS-E	1.86	R (O)	Extended models to mitigate loss of RCP seals
RCSDEP after SLOCA (DEPR)	W (U)	ODEPR-S2	2.08	W (U)	6E-3 was used as SLOCA frequency
Feed and Bleed	R (O)	Sum RAW for applicable events	2.1	R (O)	
Tripping the RCP	R			R	Not modeled at IP3

Component Out of Service	SDP Worksheet Color	IP3 Basic Event	IP3 RAW ratio	SDP Work-sheet Modified	Comparison Summary and Comments
City water backup for RCP seal injection	R (O)	SL-TCCW	1.52	W (M)	
REC2	W (M)	B-2HRS	1.29	W (M)	
REC5	Y				
Fan Coolers (Function)	G/W (M)		1.01 1.21	G/W (M)	The higher RAW is due to binning for Level 2 Analysis
Makeup to RWST	G/W (M)		1.04	G/W (M)	
Equalization During SGTR	R (M)		689	R (M)	This is failure of both early and late equalization
AFV: Aux. Bldg. Feed Pump Ventillation	R (O)		3.32	R (O)	The recovery action credit of 0.1 per SDP usage rule causes the over-estimation

Notes:

1. IP3 Internal event, average maintenance CDF is.

2. IP3 RAWs for internal events, average maintenance case.

3. Delta CDF represents the change in CDF due to component out of service for 1 year.

4. IP3 RAW Values for defining Colors:

RAW< 1.07	"Green"	(G)
1.07 < RAW< 1.74	"White"	(W)
1.74 < RAW< 8.4	"Yellow"	(Y)
RAW> 8.4	" Red"	(R)

5. In Comparison Summary, Match is abbreviated as M, Conservative by one order of magnitude is abbreviated as O, and non-conservative by one order of magnitude by U.

Table 2: Comparative Summary of the Benchmarking Results

Total Number of Cases Compared	SDP Notebook Before (Rev 0)		SDP Notebook After (Rev 1)	
	Number of Cases (36)	Percentage	Number of Cases (36)	Percentage
SDP: Less Conservative	3	8.3%	2	5.5%
SDP: More Conservative	13	36.1%	7	19.5%
SDP: Matched	20	55.6%	27	75.0%

3. Proposed Revisions to Rev 0 SDP Notebook

Based on insights gained from the plant site visit, a set of revisions is proposed for the Rev 0 SDP notebook. The proposed revisions are based on licensee comments on the Rev 0 SDP notebook, better understanding of the current plant design features, consideration of additional recovery actions, use of revised Human Error Probabilities (HEPs) and initiator frequencies, and the results of benchmarking.

3.1 Specific Changes to the Rev 0 SDP Notebook for IP3

The licensee provided several comments for minor revisions to the SDP Notebook. The suggested changes mainly dealt with the dependency matrix, updated footnotes associated with the worksheets, and revised HEP values. All of these changes will be incorporated in the SDP worksheets. In addition, several major revisions that directly impacted the color assignments by the SDP evaluation were discussed with the licensee and their resolutions were identified in the meeting. The proposed revisions are discussed below:

1. Modify the success criteria for RCS depressurization in SLOCA when HPI is not available such that it requires operation of 2/4 accumulators. Similar sequences are also applicable to MLOCA.

2) Use the event tree in Attachment-1 for LOOP worksheet. The new event tree has two top events for EAC. One top event; EAC1 which describes the success of either EDG 31 or 32. The other top event; EAC2, which states the operation of EDG33 when EAC1 has failed. IF EAC1 is successful either MDAFW or TDAFW could be credited. If EAC2 is successful only extended operation of TDAFW can be credited. Furthermore, the credit for REC2 is increased from 1 to 2 to account for recovery of AC power using by restoring offsite power, operation of gas turbines, or use of Appendix-R EDG to prevent seal LOCA. The equivalent PSA HEP value is about 1.3E-2.

3) In SGTR the function of EQ is divided to EQE (stands for early equalization) with credit of 1 and EQL (stands for late equalization) with credit of 3. Make up to RWST would only be needed if both EQE and EQL have failed. The new event tree is included in Attachment 1.

4) In MSLB worksheet modify the format such that it first asks for closure of 4 out of 4 MSIVs and if failed it inquires the closure of 3 out of 4 MSIVs. This change of format consistent with other four loop Westinghouse PWRs would facilitate explicit evaluation of issues related to MSIVs.

5) ATWS were assigned in Row V from Row VI to reflect the initiator frequency in the latest licensee's PSA .

6) For LPR give a total of credit of 4 by dividing it an operator credit of 3 for 1/2 recirulation pumps and an operator credit of one for 1/2 RHR pumps (due to dependency between the two actions).

7) In both loss of non-essential service water (LNSW) and loss of component cooling water (LCCW) worksheets, credit both HPI and depressurization and use of LPI to mitigate scenarios involving RCP seal LOCAs. The new event tree for LNSW is included in Attachment 1

8) Make a note in Table 2 of the revised SDP notebook to reflect that the spare battery charger can be aligned to any of four DC bus (recent modification). Furthermore, indicate that the battery chargers could take SI loads even if the associated battery is not available.

9) Explicitly identify that PORVs and MSIVs have N2 back up in Table 2 of the SDP notebook. Furthermore, explicitly reflect that there are five levels of redundancy for instrument air during normal operation.

3.2 Generic Change in IMC 0609 for Guidance to NRC Inspectors

No specific recommendation for changes to IMC 0609 was identified as a result of this benchmarking exercise. However, two items were identified that can further improve the process. These are:

1. An inspection finding that involves the unavailability of an emergency battery bank should be evaluated by increasing 1) the special initiator associated with a loss of the associated DC bus by one order of magnitude, 2) by failing the DC bus and the associated EDG when requires DC to start from that bus in Loop scenarios, and 3) by disabling the associated DC bus as a mitigation during SI only if the battery chargers are not capable of picking up the loads.

2. The current counting rule allows the folding of green next to white and green-green next to white to arrive at a higher color. This practice was shown that in one case resulted in a more conservative results (HPI train), and in all other case did not change the SDP color assignment. It is recommended that the counting rule to be limited to counting green next to white (G/W) at most.

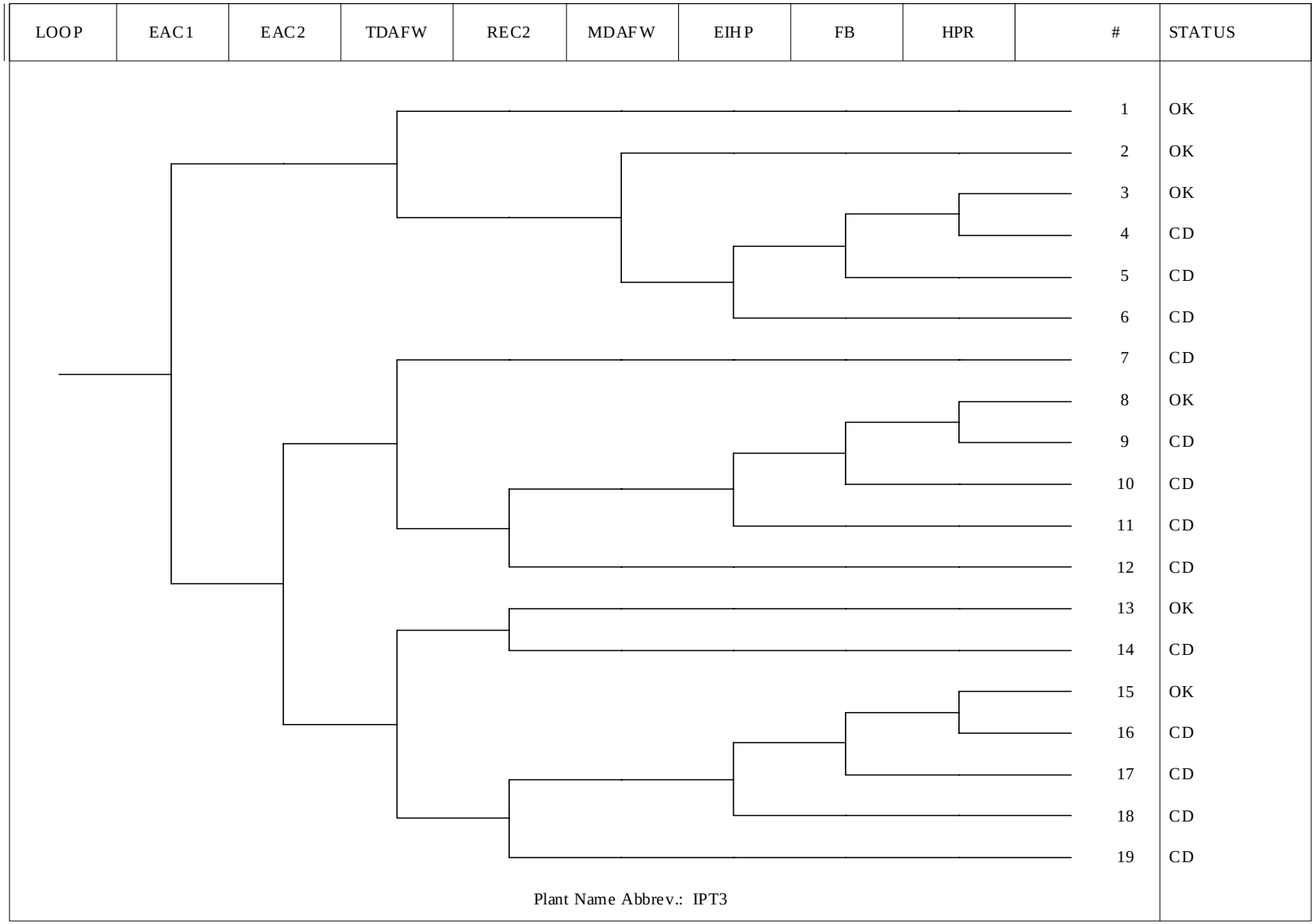
3.3 Generic Change to the SDP Notebook

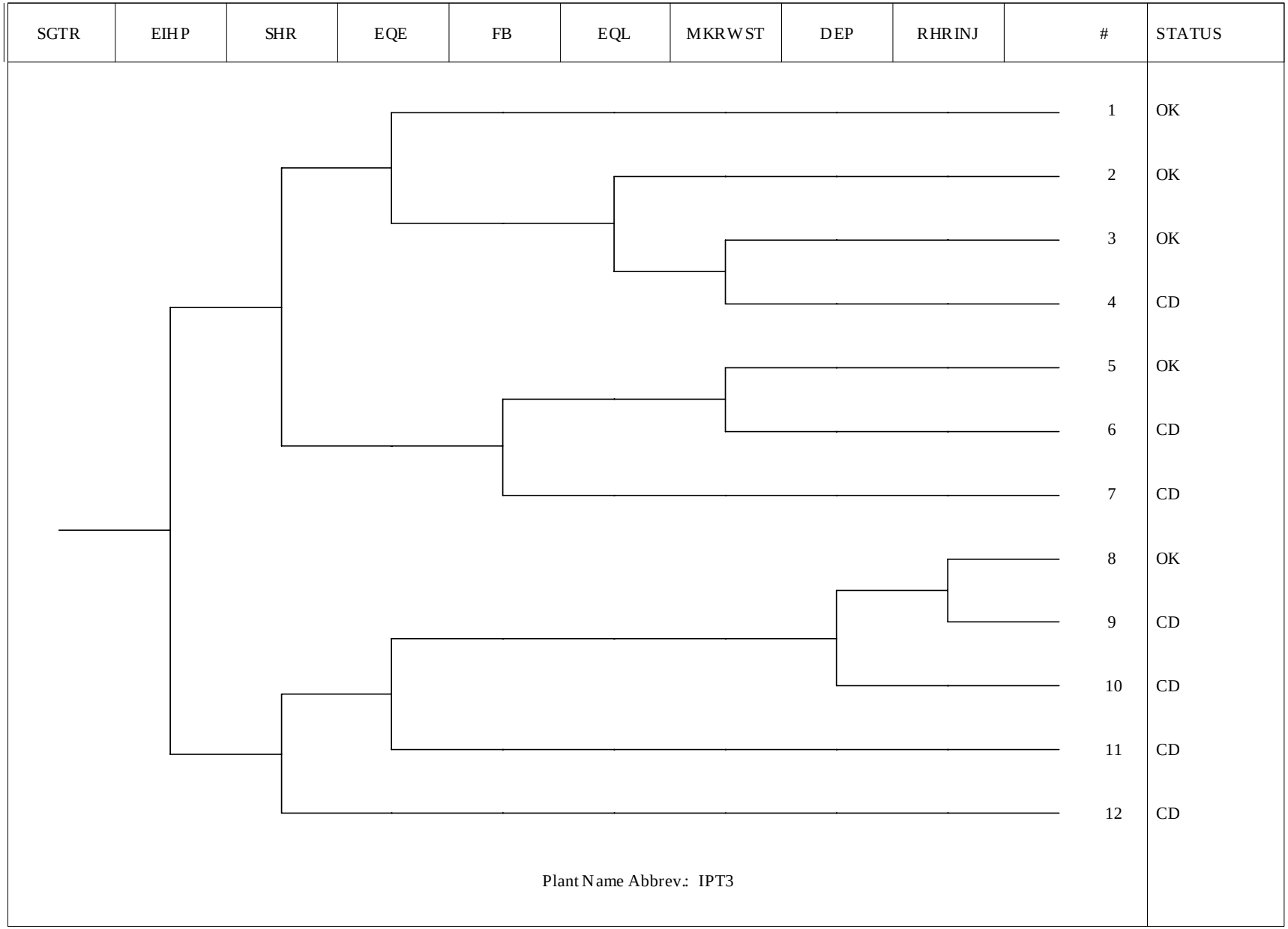
No generic change was identified.

4. Discussion on External Events

The PSA for IP3 currently does not integrate the external events; therefore no activity was performed on this item during the benchmarking site visit.

Revised Event Trees for Loop, SGTR, and LNSW

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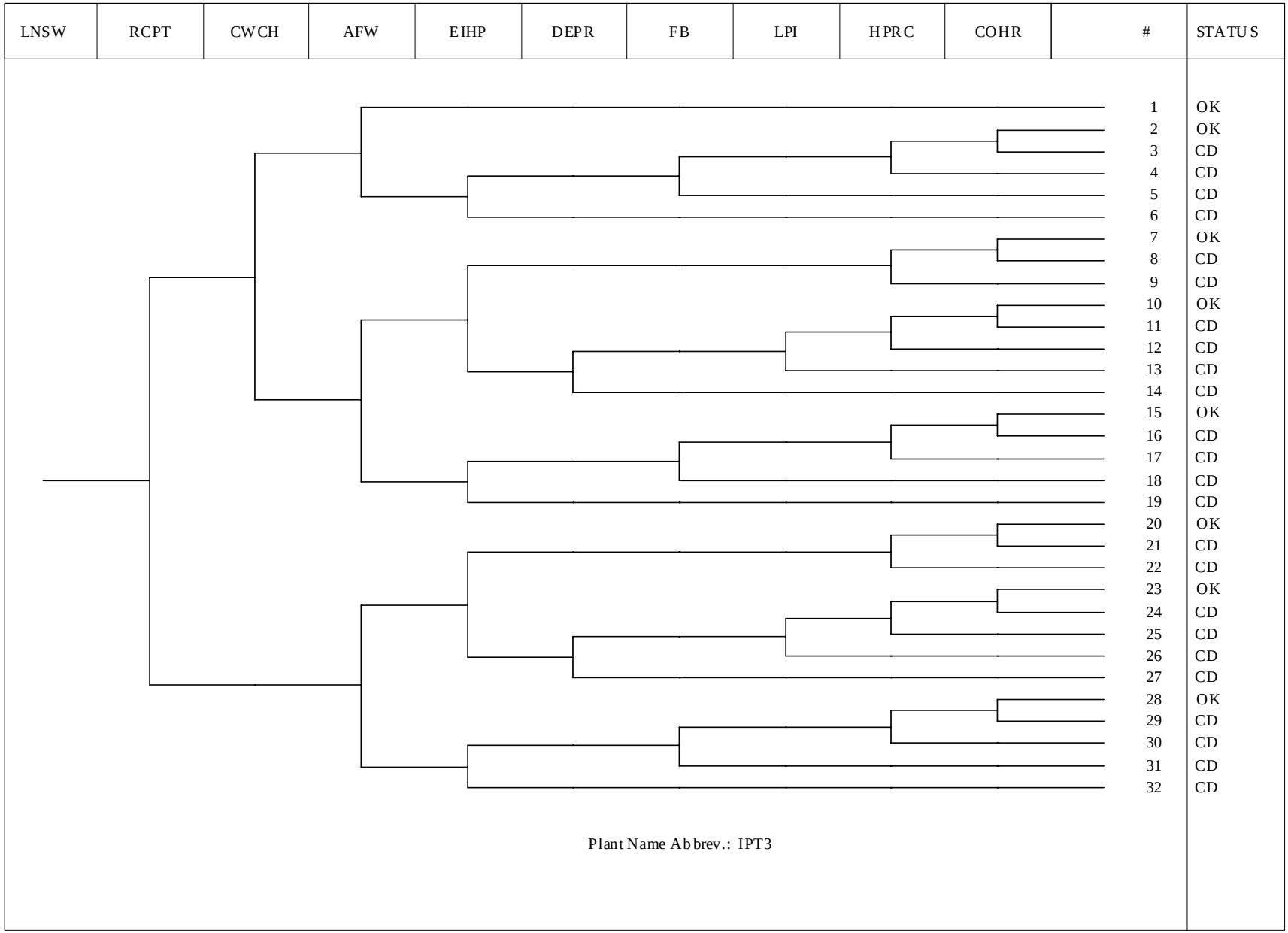
Plant Name Abbrev.: IPT3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Plant Name Abbrev.: IPT3

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