REVISED 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.: **271-8290**

SRP Section: **SRP 19**

Application Section: **19.1**

Date of RAI Issued: **10/22/2015**

Question No. 19-15

Regulation 10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA. SRP Chapter 19, Revision 3 (Draft), Section I. "Areas of Review, Review Interfaces" states that the staff should "…confirm that: All common-cause failure (CCF) mechanisms for digital instrumentation and control (DI&C) systems have been accounted for in the PRA." The staff reviewed APR1400 DCD Section 19.1, "Probabilistic Risk Assessment," and did not find sufficient information describing the modeling of the DI&C system, including the hardware and software common-cause failures, to be able to make this conclusion. Therefore, in order for the staff to reach a reasonable assurance finding that the description of the PRA is adequate, please provide the following details of DI&C modeling in the PRA and include it in the DCD:

- System description (e.g., describe the functions, subsystem interfaces, operator actions, etc.)
- Key assumptions (e.g., modeling, uncertainties)
- CCF analysis of both the hardware and software, including the basis and/or justification of this information
- Failure effects, if modeled at the system/subsystem level

Response – (Rev. 5)

The digital plant protection system (PPS) consists of the digital reactor trip system (RTS) and the digital engineered safety features actuation system (ESFAS). The reactor trip system (RTS) analyses are documented in the Reactor Protection System Notebook (APR1400-K-P-NR-013218-P, Rev. 0), and the engineered safety features actuation system (ESFAS) analyses are documented in the Engineered Safety Features Actuation System Notebook (APR1400-K-P-NR-

013217-P, Rev. 0), which includes descriptions of the system functions, system interfaces, operator actions, hardware and software common cause failures and modeling uncertainties.

The failure modes and effects analysis of the reactor trip system (RTS) and the engineered safety features actuation system (ESFAS) are provided as Attachments 1 and 2.

The Digital I&C CCF coping analysis is described in APR1400-Z-A-NR-14019-NP. This Digital I&C CCF coping analysis assumed software CCF exists, but also credited the systems which are diverse from the safety I&C ("Diversity and Defense-in-Depth" Technical Report (APR1400-Z-J-NR-14002-P)). The "Diversity and Defense-in-Depth" Technical Report provides the design description of the diverse actuation system, and the diversity and defense-in-depth approach for I&C systems which are intended to be used for the application of the APR 1400 Design Certification.

The software reliability analysis specifically has not been evaluated in APR1400.
Also, SRP Appendix 7.1 -B Subsection 4.1 discusses protection system reliability, specifically in the second two paragraphs which state: "Staff acceptance of system reliability is based on the deterministic criteria described in IEEE Std. 279-1971 rather than on quantitative reliability goals. The NRC staff does not endorse the concept of quantitative reliability goals as the sole means of meeting the requirements for reliability of protection systems (see the response of RAI 356-7881, Q07-20, ML16154A870)."

Also, in the response of RAI 261-8253, COL item (COL 7.1(1)) is added as "The COL applicant is to provide… and the software operation and maintenance plan for the safety I&C systems, as described in the Software Program Manual Technical Report." The "Software Program Manual" Technical Report (APR1400-Z-J-NR-14003-P) contains the software management plan, software quality assurance plan, software verification, validation plan, etc.

The "Software Program Manual" Technical Report describes the method to reduce safety risk caused by software failure to an acceptable level, and the need to assess hazards at each stage of the software life cycle.

Although the APR1400 is designed with diversity to cope with software failure, the COL applicant needs evaluate software reliability. COL 7.1(2) will be added in DCD Subsection 7.1.4 (Attachment 3).

Regarding the reliability of the APR1400 digital I&C system, International Standard IEC 61226 (Revision 3), "Nuclear power plants - Instrumentation and control important to safety - Classification of instrumentation and control functions," classifies and provides specific requirements for I&C systems. These requirements include reliability assessments, and states that the reliability assessment "shall consider the effects of common cause failures, including hardware failures, software failures, and human errors during operation, maintenance, as well as modification and repair activities." In addition, IEC 61226 also states: "The techniques used to assess these effects range from purely qualitative engineering judgement to detailed quantitative analyses, which may themselves depend on qualitative estimates." Finally, when evaluating the reliability IEC 61226 states:

"For an individual system which is specified and designed in accordance with the highest quality criteria, a figure of the order of 10^{-4} failure/demand may be an appropriate overall limit to place on the reliability that may be claimed, when all of the potential sources of failure due to the

specification, design, manufacture, installation, operating environment, and maintenance practices, are taken into account. This figure includes the risk of common mode failure in the redundant channels of the system, and applies to the whole of the system, from sensors through processing to the outputs to the actuated equipment. Claims for better reliabilities than this are not precluded, but will need special justification, taking into account all of the factors mentioned. Alternatively, the design of independent I&C systems important to safety with an acceptable level of diversity may be applied."

Based on the above statements from IEC 61226, an assessment of the reliability of various RPS and ESF-CCS signals was made taking into account "all of the potential sources of failure due to the specification, design, manufacture, installation, operating environment, and maintenance practices" including "the whole of the system, from sensors through processing to the outputs to the actuated equipment." Hardware reliability values (including common cause) were derived from various industry sources. Software reliability of [ ]^{TS}/demand per application software common cause failure, and [ ]^{TS}/demand for operating system common cause failure based on a proprietary Westinghouse assessment performed to support the APR1400 PRA.

Using these hardware and software reliability values, and including other failure modes such as test and maintenance unavailability and miscalibration errors, an assessment of the reliability of various RPS and ESF-CCS signals was performed. The resultant reliabilities for RPS signals ranged from 1.02×10^{-4}/demand to 3.42×10^{-3}/demand for the RPS signals modeled in the PRA (i.e., P1 – Hi Pressurizer Pressure, P2 – Lo Pressurizer Pressure, P3 – Lo SG1 Level, P4 – Lo SG2 Level, P9 – Hi Containment Pressure and P14 – Lo DNBR). The resultant reliabilities for ESF-CCS signals (SIAS and AFAS) were both about 1.13×10^{-4}/demand.

Based on this reliability assessment, the hardware and software failure rates used within the APR1400 DC PRA are judged to be reasonable where no claims for better reliability are warranted to meet the requirements of IEC 61226.

Several sensitivity cases were performed to better understand the CDF sensitivity to the software reliability values used in the digital I&C system. These sensitivities were performed by cutset manipulation of the at-power internal events model. A total of 12 different cases were evaluated:

1. The PPS and DPS operating system software CCFs were increased by a factor of 10 resulting in a CDF of increase of 3%.

2. The PPS and DPS operating system and application software CCFs were increased by a factor of 10 resulting in a CDF increase of 43%.

3. The PPS and DPS operating system and application software CCFs were increased by a factor of 100 resulting in a CDF increase of 468%.

4. The DPS application software CCF was increased by a factor of 100 resulting in a CDF increase of 1%.

5. The DPS operating system software CCF was increased by a factor of 100 resulting in a negligible increase in CDF.

6. The PPS bistable processor module application software CCF was increased by a factor of 100 resulting in a CDF increase of 12%.

7. The PPS group controller application software CCF was increased by a factor of 100 resulting in a CDF increase of 94%.

8. The PPS loop controller application software CCF was increased by a factor of 100 resulting in a CDF increase of 315%.

9. The PPS LCL application software CCF was increased by a factor of 100 resulting in a CDF increase of 12%.

10. The PPS operating system software CCF was increased by a factor of 100 resulting in a CDF increase of 32%.

11. All DPS software was assumed to fail (i.e., failure probability =1) resulting in a CDF increase of 432%.

12. All PPS and DPS software was assumed to operate perfectly (i.e., failure probability = 0) resulting in a CDF decrease of about 5%.

These sensitivities reveal the following significant conclusions about the digital I&C system:

- Cases 1 – 3 demonstrate the relative insensitivity to the exact software CCF values used in the model up until a very large increase (between a factor of 10 and 100) is postulated.

- Although Case 11 demonstrates the importance of a diverse I&C system (DPS); Cases 4 and 5 demonstrate that even relatively large increases (e.g., factor of 100) in DPS software CCF has little impact on CDF.

- Cases 6 – 9 demonstrate the importance of operator action to overcome software CCF. The ability to manually trip the reactor from the MCR/RSR reduces the impact of bistable and LCL software CCF. Furthermore, the ability to start equipment remotely from the MCR/RSR minimizes the impact of software CCF in the group controllers. However, since these remote signals are input into either the group controller or loop controller, and the loop controller produces the final ESF-CCS output signal to the CIMs, software CCF in the loop controllers fails all remote signals.

- Case 12 reveals that limited benefit would be obtained from trying to justify lower software CCF values, since complete perfection (which is not credible) only results in about a 5% decrease in CDF.

In the above analyses, the software CCF accounted for approximately 20 percent of the RPS failures, and about 44 percent of the ESF-CCS failures. This is due to the fact that in addition to bistable and LCL software which are with both RPS and ESF-CCS, the ESF-CCS also include group controller and loop controller application software. In addition to the percent contribution described above (i.e., F-V importance), since software CCF fails the signal, the RAW value of the software CCF is simply the inverse of the signal's system unavailability. Therefore, the software CCF RAW for the RPS signals is between 292 (= 1 / 3.42×10^{-3}) and

9800 (= 1 / 1.02×10^{-4}), and the software CCF RAW for the ESF signals is about 8850 (= 1 / 1.13×10^{-4}). Note that in all cases, these F-V and RAW importance values demonstrate the risk significance of software.

Attachment 5 provides clarifications of RAW importance values for operating system software and application software.

Impact on DCD

Table 1.8-2 and Section 7.1.4 of DCD Tier 2 will be revised as indicated on Attachment 3.

Chapter 19 will be revised as indicated in Attachment 4 to include discussion on the modeling of digital I&C and software CCF, and the software CCF sensitivity analysis.

Subsection 19.1.4.1.1.4 will be revised as indicated in Attachment 4 (10/12).

Impact on PRA

The PRA will be updated to include software CCF in both the PPS and DPS. The Reactor Protection System Notebook (APR1400-K-P-NR-013218-P) and the Engineered Safety Features Actuation System Notebook (APR1400-K-P-NR-013217-P) will be updated to include details of software CCF modeling.

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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Failure Mode Evaluation of Reactor Trip System (RP) (1/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
1	1-752-J-PA14A-R01-S01	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
2	1-752-J-PA14A-R01-S02	PPS cabinet, PA14A (CI631)	Operation	Fails to operate	Yes	- Communication Interface Module - No impacts
3	1-752-J-PA14A-R01-S03	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Bistable Logic Processor - Coincidence logic changes to two out of three
4	1-752-J-PA14A-R01-S04	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
5	1-752-J-PA14A-R01-S05	PPS cabinet, PA14A (AI688)	Operation	Fails to operate	No	- Analog Input Module - Coincidence logic changes to two out of three
6	1-752-J-PA14A-R01-S06	PPS cabinet, PA14A (DI620)	Operation	Fails to operate	No	- Digital Input Module - Coincidence logic changes to two out of three
7	1-752-J-PA14A-R01-S07	PPS cabinet, PA14A (AI688)	Operation	Fails to operate	No	- Analog Input Module - Coincidence logic changes to two out of three
8	1-752-J-PA14A-R01-S08	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module No impacts
9	1-752-J-PA14A-R01-S09	PPS cabinet, PA14A (DO620)	Operation	Fails to operate	Yes	- Digital Output Module - It is for SOE (Sequence Of Events). - No impacts
10	1-752-J-PA14A-R01-S10	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module No impacts
11	1-752-J-PA14A-R02-S01	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
12	1-752-J-PA14A-R02-S02	PPS cabinet, PA14A (CI631)	Operation	Fails to operate	Yes	- Communication Interface Module - No impacts
13	1-752-J-PA14A-R02-S03	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Bistable Logic Processor - Coincidence logic changes to two out of three
14	1-752-J-PA14A-R02-S04	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (2/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
15	1-752-J-PA14A-R02-S05	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Analog Input Module - Coincidence logic changes to two out of three
16	1-752-J-PA14A-R02-S06	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Digital Input Module - Coincidence logic changes to two out of three
17	1-752-J-PA14A-R02-S07	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	No	- Analog Input Module - Coincidence logic changes to two out of three
18	1-752-J-PA14A-R02-S08	PPS cabinet, PA14A (DO620)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
19	1-752-J-PA14A-R02-S09	PPS cabinet, PA14A (DO630)	Operation	Fails to operate	No	- Digital Output Module - It is for SOE (Sequence Of Events). - No impacts
20	1-752-J-PA14A-R02-S10	PPS cabinet, PA14A (DO630)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
21	1-752-J-PA14A-R03-S01	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
22	1-752-J-PA14A-R03-S02	PPS cabinet, PA14A (CI631)	Operation	Fails to operate	No	- Communication Interface Module - Coincidence logic changes to two out of three
23	1-752-J-PA14A-R03-S03	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
24	1-752-J-PA14A-R03-S04	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
25	1-752-J-PA14A-R03-S05	PPS cabinet, PA14A (AI688)	Operation	Fails to operate	No	- Analog Input Module Coincidence logic changes to two out of three
26	1-752-J-PA14A-R03-S06	PPS cabinet, PA14A (DI620)	Operation	Fails to operate	No	- Digital Input Module - Coincidence logic changes to two out of three
27	1-752-J-PA14A-R03-S07	PPS cabinet, PA14A (AI688)	Operation	Fails to operate	No	- Analog Input Module - Coincidence logic changes to two out of three
28	1-752-J-PA14A-R03-S08	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (3/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
29	1-752-J-PA14A-R03-S09	PPS cabinet, PA14A (DO620)	Operation	Fails to operate	Yes	- Digital Output Module - This is for SOE (Sequence Of Events) - Ni Impacts
30	1-752-J-PA14A-R03-S10	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
31	1-752-J-PA14A-R04-S01	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
32	1-752-J-PA14A-R04-S02	PPS cabinet, PA14A (CI631)	Operation	Fails to operate	No	- Communication Interface Module - Coincidence logic changes to two out of three
33	1-752-J-PA14A-R04-S03	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - Coincidence logic changes to two out of three
34	1-752-J-PA14A-R04-S04	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- Coincidence logic changes to two out of three
35	1-752-J-PA14A-R04-S05	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
36	1-752-J-PA14A-R04-S06	PPS cabinet, PA14A (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two ouf of three
37	1-752-J-PA14A-R04-S07	PPS cabinet, PA14A (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
38	1-752-J-PA14A-R04-S08	PPS cabinet, PA14A (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
39	1-752-J-PA14A-R04-S09	PPS cabinet, PA14A (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
40	1-752-J-PA14A-R04-S10	PPS cabinet, PA14A (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
41	1-752-J-PA14B-R01-S01	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (4/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
42	1-752-J-PA14B-R01-S02	PPS cabinet, PA14B (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
43	1-752-J-PA14B-R01-S03	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
44	1-752-J-PA14B-R01-S04	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
45	1-752-J-PA14B-R01-S05	PPS cabinet, PA14B (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
46	1-752-J-PA14B-R01-S06	PPS cabinet, PA14B (DI620)	Operation	Fails to operate	No	- Digital Input Module - No impacts - Coincidence logic changes to two out of three
47	1-752-J-PA14B-R01-S07	PPS cabinet, PA14B (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
48	1-752-J-PA14B-R01-S08	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
49	1-752-J-PA14B-R01-S09	PPS cabinet, PA14B (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
50	1-752-J-PA14B-R01-S10	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
51	1-752-J-PA14B-R02-S01	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
52	1-752-J-PA14B-R02-S02	PPS cabinet, PA14B (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
53	1-752-J-PA14B-R02-S03	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Reactor Trip System (RP) (5/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
54	1-752-J-PA14B-R02-S04	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
55	1-752-J-PA14B-R02-S05	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
56	1-752-J-PA14B-R02-S06	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
57	1-752-J-PA14B-R02-S07	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
58	1-752-J-PA14B-R02-S08	PPS cabinet, PA14B (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
59	1-752-J-PA14B-R02-S09	PPS cabinet, PA14B (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
60	1-752-J-PA14B-R02-S10	PPS cabinet, PA14B (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
61	1-752-J-PA14B-R03-S01	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
62	1-752-J-PA14B-R03-S02	PPS cabinet, PA14B (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
63	1-752-J-PA14B-R03-S03	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
64	1-752-J-PA14B-R03-S04	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
65	1-752-J-PA14B-R03-S05	PPS cabinet, PA14B (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Reactor Trip System (RP) (6/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
66	1-752-J-PA14B-R03-S06	PPS cabinet, PA14B (DI620)	Operation	Fails to operate	No	- Digital Input Module - No impacts - Coincidence logic changes to two out of three
67	1-752-J-PA14B-R03-S07	PPS cabinet, PA14B (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
68	1-752-J-PA14B-R03-S08	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
69	1-752-J-PA14B-R03-S09	PPS cabinet, PA14B (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
70	1-752-J-PA14B-R03-S10	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
71	1-752-J-PA14B-R04-S01	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
72	1-752-J-PA14B-R04-S02	PPS cabinet, PA14B (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
73	1-752-J-PA14B-R04-S03	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
74	1-752-J-PA14B-R04-S04	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
75	1-752-J-PA14B-R04-S05	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
76	1-752-J-PA14B-R04-S06	PPS cabinet, PA14B (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
77	1-752-J-PA14B-R04-S07	PPS cabinet, PA14B (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (7/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
78	1-752-J-PA14B-R04-S08	PPS cabinet, PA14B (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
79	1-752-J-PA14B-R04-S09	PPS cabinet, PA14B (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
80	1-752-J-PA14B-R04-S10	PPS cabinet, PA14B (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
81	1-752-J-PA14C-R01-S01	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
82	1-752-J-PA14C-R01-S02	PPS cabinet, PA14C (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
83	1-752-J-PA14C-R01-S03	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
84	1-752-J-PA14C-R01-S04	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
85	1-752-J-PA14C-R01-S05	PPS cabinet, PA14C (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
86	1-752-J-PA14C-R01-S06	PPS cabinet, PA14C (DI620)	Operation	Fails to operate	No	- Digital Input Module - No impacts - Coincidence logic changes to two out of three
87	1-752-J-PA14C-R01-S07	PPS cabinet, PA14C (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
88	1-752-J-PA14C-R01-S08	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
89	1-752-J-PA14C-R01-S09	PPS cabinet, PA14C (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)

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Failure Mode Evaluation of Reactor Trip System (RP) (8/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
90	1-752-J-PA14C-R01-S10	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
91	1-752-J-PA14C-R02-S01	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
92	1-752-J-PA14C-R02-S02	PPS cabinet, PA14C (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
93	1-752-J-PA14C-R02-S03	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
94	1-752-J-PA14C-R02-S04	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
95	1-752-J-PA14C-R02-S05	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
96	1-752-J-PA14C-R02-S06	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
97	1-752-J-PA14C-R02-S07	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
98	1-752-J-PA14C-R02-S08	PPS cabinet, PA14C (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
99	1-752-J-PA14C-R02-S09	PPS cabinet, PA14C (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
100	1-752-J-PA14C-R02-S10	PPS cabinet, PA14C (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
101	1-752-J-PA14C-R03-S01	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
102	1-752-J-PA14C-R03-S02	PPS cabinet, PA14C (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Reactor Trip System (RP) (9/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
103	1-752-J-PA14C-R03-S03	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
104	1-752-J-PA14C-R03-S04	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
105	1-752-J-PA14C-R03-S05	PPS cabinet, PA14C (AI688)	Operation	Fails to operate	No	Analog Input Module - No impacts - Coincidence logic changes to two out of three
106	1-752-J-PA14C-R03-S06	PPS cabinet, PA14C (DI620)	Operation	Fails to operate	No	- Digital Input Module - No impacts - Coincidence logic changes to two out of three
107	1-752-J-PA14C-R03-S07	PPS cabinet, PA14C (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
108	1-752-J-PA14C-R03-S08	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
109	1-752-J-PA14C-R03-S09	PPS cabinet, PA14C (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
110	1-752-J-PA14C-R03-S10	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
111	1-752-J-PA14C-R04-S01	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
112	1-752-J-PA14C-R04-S02	PPS cabinet, PA14C (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
113	1-752-J-PA14C-R04-S03	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
114	1-752-J-PA14C-R04-S04	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
115	1-752-J-PA14C-R04-S05	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Reactor Trip System (RP) (10/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
116	1-752-J-PA14C-R04-S06	PPS cabinet, PA14C (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
117	1-752-J-PA14C-R04-S07	PPS cabinet, PA14C (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
118	1-752-J-PA14C-R04-S08	PPS cabinet, PA14C (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
119	1-752-J-PA14C-R04-S09	PPS cabinet, PA14C (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
120	1-752-J-PA14C-R04-S10	PPS cabinet, PA14C (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
121	1-752-J-PA14D-R01-S01	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
122	1-752-J-PA14D-R01-S02	PPS cabinet, PA14D (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
123	1-752-J-PA14D-R01-S03	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
124	1-752-J-PA14D-R01-S04	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
125	1-752-J-PA14D-R01-S05	PPS cabinet, PA14D (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
126	1-752-J-PA14D-R01-S06	PPS cabinet, PA14D (DI620)	Operation	Fails to operate	No	- Digital Input Module - No impacts - Coincidence logic changes to two out of three
127	1-752-J-PA14D-R01-S07	PPS cabinet, PA14D (AI688)	Operation	Fails to operate	No	- Analog Input Module - No impacts - Coincidence logic changes to two out of three
128	1-752-J-PA14D-R01-S08	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (11/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
129	1-752-J-PA14D-R01-S09	PPS cabinet, PA14D (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
130	1-752-J-PA14D-R01-S10	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
131	1-752-J-PA14D-R02-S01	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
132	1-752-J-PA14D-R02-S02	PPS cabinet, PA14D (CI631)	Operation	Fails to operate	No	- Communication Interface Module - No impacts - Coincidence logic changes to two out of three
133	1-752-J-PA14D-R02-S03	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
134	1-752-J-PA14D-R02-S04	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
135	1-752-J-PA14D-R02-S05	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
136	1-752-J-PA14D-R02-S06	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
137	1-752-J-PA14D-R02-S07	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
138	1-752-J-PA14D-R02-S08	PPS cabinet, PA14D (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
139	1-752-J-PA14D-R02-S09	PPS cabinet, PA14D (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
140	1-752-J-PA14D-R02-S10	PPS cabinet, PA14D (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
141	1-752-J-PA14D-R03-S01	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts

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Failure Mode Evaluation of Reactor Trip System (RP) (12/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
142	1-752-J-PA14D-R03-S02	PPS cabinet, PA14D (CI631)	Operation	Fails to operate	No	Communication Interface Module - No impacts - Coincidence logic changes to two out of three
143	1-752-J-PA14D-R03-S03	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	Bistable Processor Logic - No impacts - Coincidence logic changes to two out of three
144	1-752-J-PA14D-R03-S04	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
145	1-752-J-PA14D-R03-S05	PPS cabinet, PA14D (AI688)	Operation	Fails to operate	No	Analog Input Module - No impacts - Coincidence logic changes to two out of three
146	1-752-J-PA14D-R03-S06	PPS cabinet, PA14D (DI620)	Operation	Fails to operate	No	Digital Input Module - No impacts - Coincidence logic changes to two out of three
147	1-752-J-PA14D-R03-S07	PPS cabinet, PA14D (AI688)	Operation	Fails to operate	No	Analog Input Module - No impacts - Coincidence logic changes to two out of three
148	1-752-J-PA14D-R03-S08	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
149	1-752-J-PA14D-R03-S09	PPS cabinet, PA14D (DO620)	Operation	Fails to operate	No	Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
150	1-752-J-PA14D-R03-S10	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
151	1-752-J-PA14D-R04-S01	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	Dummy Module - No impacts
152	1-752-J-PA14D-R04-S02	PPS cabinet, PA14D (CI631)	Operation	Fails to operate	No	Communication Interface Module - No impacts - Coincidence logic changes to two out of three
153	1-752-J-PA14D-R04-S03	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	ESF functions with HSL to group controller - No impacts - Coincidence logic changes to two out of three
154	1-752-J-PA14D-R04-S04	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	RT digital output - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Reactor Trip System (RP) (13/13)

No.	Component ID	Component Description	Normal Status	Failure Mode	Screening	Function
155	1-752-J-PA14D-R04-S05	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- COM HSL input only - No impacts - Coincidence logic changes to two out of three
156	1-752-J-PA14D-R04-S06	PPS cabinet, PA14D (PM646A)	Operation	Fails to operate	No	- RT digital output - No impacts - Coincidence logic changes to two out of three
157	1-752-J-PA14D-R04-S07	PPS cabinet, PA14D (RB601)	Operation	Fails to operate	No	- Dummy Module - No impacts
158	1-752-J-PA14D-R04-S08	PPS cabinet, PA14D (DO620)	Operation	Fails to operate	No	- Digital Output Module - No impacts - This is for SOE (Sequence Of Events)
159	1-752-J-PA14D-R04-S09	PPS cabinet, PA14D (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three
160	1-752-J-PA14D-R04-S10	PPS cabinet, PA14D (DO630)	Operation	Fails to operate	No	- Digital Output Module - No impacts - Coincidence logic changes to two out of three

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Failure Mode Evaluation of Engineered Safety Features Actuation System (EF)

No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	Group Controller – A1 DUMMY, CI631, PM646, PM646, PM646, PM646, PM646, DI621, DO620, DUMMY		Note) Add				
1	1-752-J-PA03A-R01-S01	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
2	1-752-J-PA03A-R01-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Component Interface Module -It causes the loss of ability to communication by AF1000 Internet network. -It impacts on when the coincidence failure of GC-2 CI631. -Redundant group controller has its own CI module which provides global memory and provides AF 100 access.
3	1-752-J-PA03A-R01-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	-Group Controller 1 Processor Module 1 (GC-1 PM1). -It causes the loss of the A and C ESF Initiation signals. -It causes the loss of the (A or C) coincidence logic performed by PM1. -Redundant component control signal is available in the redundant group controller.
4	1-752-J-PA03A-R01-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	-Group Controller 1 Processor Module 2 (GC-1 PM2). -It causes the loss of the B and D ESF Initiation signals. -It causes the loss of the (B or D) coincidence logic performed by PM2. -Redundant component control signal is available in the redundant group controller.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
5	1-752-J-PA03A-R01-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-1 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.
6	1-752-J-PA03A-R01-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-1 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.
7	1-752-J-PA03A-R01-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-1 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
8	1-752-J-PA03A-R01-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
9	1-752-J-PA03A-R01-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
10	1-752-J-PA03A-R01-S10	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Dummy Module - No impacts

No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	CCG – A1 DUMMY, CI631, PM646, DUMMY, DUMMY, DI621, DO620, DUMMY, DUMMY, CI631		Note) Add				Remove this column
11	1-752-J-PA03A-R02-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
12	1-752-J-PA03A-R02-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Component Interface Module -It impacts on when the coincidence failure of redundant CI631 module in CCG2 -It impacts on corresponding channel's ESCM control manual control
13	1-752-J-PA03A-R02-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Control Channel Gateway 1 Processor Module (CCG-1 PM) -It impact on when the coincidence failure of CCG-2 PM -It impacts corresponding channel's ESCM control
14	1-752-J-PA03A-R02-S04	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
15	1-752-J-PA03A-R02-S05	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
16	1-752-J-PA03A-R02-S06	Digital Input Module	Digital Input Module (DI621) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Digital Input Module -No impact, because no safety function depends on DI contact input. -It is for transfer switch status
17	1-752-J-PA03A-R02-S07	Digital Output Module	Digital Output Module (DO620) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Digital Output Module -No impact, because no safety function depends on DO contact input. -It is for transfer switch status
18	1-752-J-PA03A-R02-S08	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
19	1-752-J-PA03A-R02-S09	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
20	1-752-J-PA03A-R02-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control
Group Controller – A2 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY							
21	1-752-J-PA03A-R03-S01	N/A	Group Controller (RB601) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Dummy Module - No impacts
22	1-752-J-PA03A-R03-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-1 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.
23	1-752-J-PA03A-R03-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 1 (GC-2 PM1). - It causes the loss of the A and C ESF Initiation signals. - It causes the loss of the (A or C) coincidence logic performed by PM1. - Redundant component control signal is available in the redundant group controller.
24	1-752-J-PA03A-R03-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 2 (GC-2 PM2). - It causes the loss of the B and D ESF Initiation signals. - It causes the loss of the (B or D) coincidence logic performed by PM2. - Redundant component control signal is available in the redundant group controller.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
25	1-752-J-PA03A-R03-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-2 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.
26	1-752-J-PA03A-R03-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-2 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.
27	1-752-J-PA03A-R03-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-2 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
28	1-752-J-PA03A-R03-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
29	1-752-J-PA03A-R03-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
30	1-752-J-PA03A-R03-S10	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	CCG – A2 DUMMY, CI631, PM646, DUMMY, DUMMY, DI621, DO620, DUMMY, DUMMY, CI631		Note) Add				
31	1-752-J-PA03A-R04-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Dummy Module -No impacts
32	1-752-J-PA03A-R04-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Component Interface Module -It impacts on when the coincidence failure of redundant CI631 module in CCG1. -It impacts on corresponding channel's ESCM control manual control.
33	1-752-J-PA03A-R04-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Control Channel Gateway 1 Processor Module (CCG-2 PM) -It impact on when the coincidence failure of CCG-1 PM -It impacts corresponding channel's ESCM control
34	1-752-J-PA03A-R04-S04	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
35	1-752-J-PA03A-R04-S05	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
36	1-752-J-PA03A-R04-S06	Digital Input Module	Digital Input Module (DI621) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Digital Input Module -No impact, because no safety function depends on DI contact input. -It is for transfer switch status
37	1-752-J-PA03A-R04-S07	Digital Output Module	Digital Output Module (DO620) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Digital Output Module -No impact, because no safety function depends on DO contact input. -It is for transfer switch status
38	1-752-J-PA03A-R04-S08	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
39	1-752-J-PA03A-R04-S09	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
40	1-752-J-PA03A-R04-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	-Communication Interface Module -It impacts on when the coincidence failure of redundant CI631 module in CCG1. -It impacts on corresponding channel's ESCM control manual control

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
Group Controller – A3 CI631 CI631 PM646 PM646 DI621 DO620 DUMMY DUMMY DUMMY CI631			Note) Add				
41	1-752-J-PA03A-R05-S01	CI Interface Processor	Component Interface Module (CI631) 1 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss global memory. - Redundant CI module provides redundant global memory for the chassis.
42	1-752-J-PA03A-R05-S02	CI Interface Processor	Component Interface Module (CI631) 2 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss global memory. - Redundant CI module provides redundant global memory for the chassis.
43	1-752-J-PA03A-R05-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Primary Processor Module - It causes the loss of Actuation of BOP ESF or Load Sequencing. - Redundant GC-3 secondary processor module provides the logic for actuation of BOP ESF and Load Sequencing. - The redundant PM acquires the RMS and Loss of Offsite Power (LOOP) input signals, performs the BOP ESF and Load Sequencing Logic and transmits the corresponding initiation signals.
44	1-752-J-PA03A-R05-S04	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Secondary Processor Module - It causes the loss of Actuation of BOP ESF or Load Sequencing. - Redundant GC-3 secondary processor module provides the logic for actuation of BOP ESF and Load Sequencing. - The redundant PM acquires the RMS and Loss of Offsite Power (LOOP) input signals, performs the BOP ESF and Load Sequencing Logic and transmits the corresponding initiation signals.
45	1-752-J-PA03A-R05-S05	Digital Input Module	Digital Input Module (DI621) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Digital Input Module - It causes the loss of internal cabinet status information, and it causes the loss of Actuation of BOP ESF or Load Sequencing. - Redundant GC-3's are provided by ESF-CCS Channels A and B, thus the redundant GC-3 maintains the function.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
46	1-752-J-PA03A-R05-S06	Digital Output Module	Digital Output Module (DO620) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	No	- Digital Output Module - It causes the loss of internal cabinet status information, and it causes the loss of Actuation of BOP ESF or Load Sequencing. - Redundant GC-3's are provided by ESF-CCS Channels A and B, thus the redundant GC-3 maintains the function.
47	1-752-J-PA03A-R05-S07	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
48	1-752-J-PA03A-R05-S08	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
49	1-752-J-PA03A-R05-S09	N/A	ESF-CCS group controller cabinet, PA03A (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
50	1-752-J-PA03A-R05-S10	CI Interface Processor	Component Interface Module (CI631) 3 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03A	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on the actuation of BOP-ESF and load sequencing. - Redundant GC-3's are provided by ESF-CCS channel A and B, thus the redundant GC-3 maintains the function.
Group Controller – A1 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY							
51	1-752-J-PA03B-R01-S01	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
52	1-752-J-PA03B-R01-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-2 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.

Note)

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	-Remark
53	1-752-J-PA03B-R01-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Group Controller 1 Processor Module 1 (GC-1 PM1). -It causes the loss of the A and C ESF Initiation signals. -It causes the loss of the (A or C) coincidence logic performed by PM1. -Redundant component control signal is available in the redundant group controller.
54	1-752-J-PA03B-R01-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Group Controller 1 Processor Module 2 (GC-1 PM2). -It causes the loss of the B and D ESF Initiation signals. -It causes the loss of the (B or D) coincidence logic performed by PM2. -Redundant component control signal is available in the redundant group controller.
55	1-752-J-PA03B-R01-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Group Controller 1 Processor Module 3 (GC-1 PM3). -It causes the loss of the selective two out of four coincidence logic performed by PM 3. -It causes the loss of MCR CPM signals. -Redundant component control signal is available in the redundant group controller.
56	1-752-J-PA03B-R01-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Group Controller 1 Processor Module 4 (GC-1 PM4). -It causes the loss of RSR CPM signals. -Redundant RSR CPM signal is available in the redundant group controller.
57	1-752-J-PA03B-R01-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	-Group Controller 1 Processor Module 5 (GC-1 PM5). -It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. -Redundant RSR CPM signal is available in the redundant group controller.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
58	1-752-J-PA03B-R01-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
59	1-752-J-PA03B-R01-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
60	1-752-J-PA03B-R01-S10	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
CCG – A1 DUMMY | CI631 | PM646 | DUMMY | DUMMY | DI621 | DO620 | DUMMY | DUMMY | CI631							
61	1-752-J-PA03B-R02-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
62	1-752-J-PA03B-R02-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control
63	1-752-J-PA03B-R02-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-1 PM) - It impact on when the coincidence failure of CCG-2 PM - It impacts corresponding channel's ESCM control
64	1-752-J-PA03B-R02-S04	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
65	1-752-J-PA03B-R02-S05	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
66	1-752-J-PA03B-R02-S06	Digital Input Module	Digital Input Module (DI621) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
67	1-752-J-PA03B-R02-S07	Digital Output Module	Digital Output Module (DO620) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status
68	1-752-J-PA03B-R02-S08	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
69	1-752-J-PA03B-R02-S09	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
70	1-752-J-PA03B-R02-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control
Group Controller – A2 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY							
71	1-752-J-PA03B-R03-S01	N/A	Group Controller (RB601) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
72	1-752-J-PA03B-R03-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-I CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.

Note)

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
73	1-752-J-PA03B-R03-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	- Group Controller 1 Processor Module 1 (GC-2 PM1). - It causes the loss of the A and C ESF Initiation signals. - It causes the loss of the (A or C) coincidence logic performed by PM1. - Redundant component control signal is available in the redundant group controller.
74	1-752-J-PA03B-R03-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	- Group Controller 1 Processor Module 2 (GC-2 PM2). - It causes the loss of the B and D ESF Initiation signals. - It causes the loss of the (B or D) coincidence logic performed by PM2. - Redundant component control signal is available in the redundant group controller.
75	1-752-J-PA03B-R03-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-2 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.
76	1-752-J-PA03B-R03-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-2 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.
77	1-752-J-PA03B-R03-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-2 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
78	1-752-J-PA03B-R03-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
79	1-752-J-PA03B-R03-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
80	1-752-J-PA03B-R03-S10	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
	CCG – A2 DUMMY | CI631 | PM646 | DUMMY | DUMMY | DI621 | DO620 | DUMMY | DUMMY | CI631	Note) Add					
81	1-752-J-PA03B-R04-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Dummy Module - No impacts
82	1-752-J-PA03B-R04-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control.
83	1-752-J-PA03B-R04-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-2 PM) - It impact on when the coincidence failure of CCG-1 PM - It impacts corresponding channel's ESCM control
84	1-752-J-PA03B-R04-S04	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
85	1-752-J-PA03B-R04-S05	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
86	1-752-J-PA03B-R04-S06	Digital Input Module	Digital Input Module (DI621) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
87	1-752-J-PA03B-R04-S07	Digital Output Module	Digital Output Module (DO620) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
88	1-752-J-PA03B-R04-S08	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
89	1-752-J-PA03B-R04-S09	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
90	1-752-J-PA03B-R04-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control
Group Controller – A3 CI631 CI631 PM646 PM646 DI621 DO620 DUMMY DUMMY DUMMY CI631							
91	1-752-J-PA03B-R05-S01	CI Interface Processor	Component Interface Module (CI631) 1 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss global memory. - Redundant CI module provides redundant global memory for the chassis.
92	1-752-J-PA03B-R05-S02	CI Interface Processor	Component Interface Module (CI631) 2 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss global memory. - Redundant CI module provides redundant global memory for the chassis.
93	1-752-J-PA03B-R05-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	- Primary Processor Module - It causes the loss of Actuation of BOP ESF or Load Sequencing. - Redundant GC-3 secondary processor module provides the logic for actuation of BOP ESF and Load Sequencing. - The redundant PM acquires the RMS and Loss of Offsite Power (LOOP) input signals, performs the BOP ESF and Load Sequencing Logic and transmits the corresponding initiation signals.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
94	1-752-J-PA03B-R05-S04	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Secondary Processor Module -It causes the loss of Actuation of BOP ESF or Load Sequencing. -Redundant GC-3 secondary processor module provides the logic for actuation of BOP ESF and Load Sequencing. -The redundant PM acquires the RMS and Loss of Offsite Power (LOOP) input signals, performs the BOP ESF and Load Sequencing Logic and transmits the corresponding initiation signals.
95	1-752-J-PA03B-R05-S05	Digital Input Module	Digital Input Module (DI621) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Digital Input Module -It causes the loss of internal cabinet status information, and it causes the loss of Actuation of BOP ESF or Load Sequencing. -Redundant GC-3's are provided by ESF-CCS Channels A and B, thus the redundant GC-3 maintains the function.
96	1-752-J-PA03B-R05-S06	Digital Output Module	Digital Output Module (DO620) at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	No	-Digital Output Module -It causes the loss of internal cabinet status information, and it causes the loss of Actuation of BOP ESF or Load Sequencing. -Redundant GC-3's are provided by ESF-CCS Channels A and B, thus the redundant GC-3 maintains the function.
97	1-752-J-PA03B-R05-S07	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
98	1-752-J-PA03B-R05-S08	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
99	1-752-J-PA03B-R05-S09	N/A	ESF-CCS group controller cabinet, PA03B (RB601)	Operation	Fails to operate	Yes	-Dummy Module -No impacts
100	1-752-J-PA03B-R05-S10	CI Interface Processor	Component Interface Module (CI631) 3 at Group Controller 3 in ESF-CCS Group Controller Cabinet, PA03B	Operation	Fails to operate	Yes	-Component Interface Module -It causes the loss of ability to communication by AF1000 Internet network. -It impacts on the actuation of BOP-ESF and load sequencing. -Redundant GC-3's are provided by ESF-CCS channel A and B, thus the redundant GC-3 maintains the function.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	Group Controller – A1 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY		Note) Add				
101	1-752-J-PA03C-R01-S01	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
102	1-752-J-PA03C-R01-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-2 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.
103	1-752-J-PA03C-R01-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 1 (GC-1 PM1). - It causes the loss of the A and C ESF Initiation signals. - It causes the loss of the (A or C) coincidence logic performed by PM1. - Redundant component control signal is available in the redundant group controller.
104	1-752-J-PA03C-R01-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 2 (GC-1 PM2). - It causes the loss of the B and D ESF Initiation signals. - It causes the loss of the (B or D) coincidence logic performed by PM2. - Redundant component control signal is available in the redundant group controller.
105	1-752-J-PA03C-R01-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-1 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
106	1-752-J-PA03C-R01-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-1 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.
107	1-752-J-PA03C-R01-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-1 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
108	1-752-J-PA03C-R01-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
109	1-752-J-PA03C-R01-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
110	1-752-J-PA03C-R01-S10	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
CCG – A1 DUMMY, CI631, PM646, DUMMY, DUMMY, DI621, DO620, DUMMY, DUMMY, CI631							
111	1-752-J-PA03C-R02-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
112	1-752-J-PA03C-R02-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
113	1-752-J-PA03C-R02-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-1 PM) - It impact on when the coincidence failure of CCG-2 PM - It impacts corresponding channel's ESCM control
114	1-752-J-PA03C-R02-S04	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
115	1-752-J-PA03C-R02-S05	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
116	1-752-J-PA03C-R02-S06	Digital Input Module	Digital Input Module (DI621) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
117	1-752-J-PA03C-R02-S07	Digital Output Module	Digital Output Module (DO620) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status
118	1-752-J-PA03C-R02-S08	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
119	1-752-J-PA03C-R02-S09	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
120	1-752-J-PA03C-R02-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control

Group Controller – A2

DUMMY	CI631	PM646	PM646	PM646	PM646	PM646	DI621	DO620	DUMMY

Note)

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121	1-752-J-PA03C-R03-S01	N/A	Group Controller (RB601) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
122	1-752-J-PA03C-R03-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-1 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.
123	1-752-J-PA03C-R03-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 1 (GC-2 PM1). - It causes the loss of the A and C ESF Initiation signals. - It causes the loss of the (A or C) coincidence logic performed by PM1. - Redundant component control signal is available in the redundant group controller.
124	1-752-J-PA03C-R03-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 2 (GC-2 PM2). - It causes the loss of the B and D ESF Initiation signals. - It causes the loss of the (B or D) coincidence logic performed by PM2. - Redundant component control signal is available in the redundant group controller.
125	1-752-J-PA03C-R03-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-2 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.
126	1-752-J-PA03C-R03-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-2 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
127	1-752-J-PA03C-R03-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-2 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
128	1-752-J-PA03C-R03-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
129	1-752-J-PA03C-R03-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
130	1-752-J-PA03C-R03-S10	N/A	ESF-CCS group controller cabinet, PA03C(RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
CCG – A2 DUMMY | CI631 | PM646 | DUMMY | DUMMY | DI621 | DO620 | DUMMY | DUMMY | CI631							
131	1-752-J-PA03C-R04-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Dummy Module - No impacts
132	1-752-J-PA03C-R04-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control.
133	1-752-J-PA03C-R04-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-2 PM) - It impact on when the coincidence failure of CCG-1 PM - It impacts corresponding channel's ESCM control

Note)

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
134	1-752-J-PA03C-R04-S04	N/A	ESF-CCS group controller cabinet, PA03C (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
135	1-752-J-PA03C-R04-S05	N/A	ESF-CCS group controller cabinet, PA03C (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
136	1-752-J-PA03C-R04-S06	Digital Input Module	Digital Input Module (DI621) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
137	1-752-J-PA03C-R04-S07	Digital Output Module	Digital Output Module (DO620) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status
138	1-752-J-PA03C-R04-S08	N/A	ESF-CCS group controller cabinet, PA03C (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
139	1-752-J-PA03C-R04-S09	N/A	ESF-CCS group controller cabinet, PA03C (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
140	1-752-J-PA03C-R04-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03C	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control
Group Controller – A1 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY							
141	1-752-J-PA03D-R01-S01	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
142	1-752-J-PA03D-R01-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-2 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.

Note)

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
143	1-752-J-PA03D-R01-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	-Group Controller 1 Processor Module 1 (GC-1 PM1). -It causes the loss of the A and C ESF Initiation signals. -It causes the loss of the (A or C) coincidence logic performed by PM1. -Redundant component control signal is available in the redundant group controller.
144	1-752-J-PA03D-R01-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	-Group Controller 1 Processor Module 2 (GC-1 PM2). -It causes the loss of the B and D ESF Initiation signals. -It causes the loss of the (B or D) coincidence logic performed by PM2. -Redundant component control signal is available in the redundant group controller.
145	1-752-J-PA03D-R01-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	-Group Controller 1 Processor Module 3 (GC-1 PM3). -It causes the loss of the selective two out of four coincidence logic performed by PM 3. -It causes the loss of MCR CPM signals. -Redundant component control signal is available in the redundant group controller.
146	1-752-J-PA03D-R01-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	-Group Controller 1 Processor Module 4 (GC-1 PM4). -It causes the loss of RSR CPM signals. -Redundant RSR CPM signal is available in the redundant group controller.
147	1-752-J-PA03D-R01-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	-Group Controller 1 Processor Module 5 (GC-1 PM5). -It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. -Redundant RSR CPM signal is available in the redundant group controller.
148	1-752-J-PA03D-R01-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	-Digital Input Module -It is no impact on the safety function. -It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. -Redundant group controller and redundant initiation signals are provided within the channel.

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
149	1-752-J-PA03D-R01-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
150	1-752-J-PA03D-R01-S10	N/A	Dummy at Group Controller 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
CCG – A1 DUMMY / CI631 / PM646 / DUMMY / DUMMY / DI621 / DO620 / DUMMY / DUMMY / CI631							
151	1-752-J-PA03D-R02-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
152	1-752-J-PA03D-R02-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control
153	1-752-J-PA03D-R02-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-1 PM) - It impact on when the coincidence failure of CCG-2 PM - It impacts corresponding channel's ESCM control
154	1-752-J-PA03D-R02-S04	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
155	1-752-J-PA03D-R02-S05	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
156	1-752-J-PA03D-R02-S06	Digital Input Module	Digital Input Module (DI621) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
157	1-752-J-PA03D-R02-S07	Digital Output Module	Digital Output Module (DO620) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status
158	1-752-J-PA03D-R02-	N/A	Dummy at CCG 1 in ESF-CCS	Operation	Fails to	Yes	- Dummy Module

Note) Add

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	S08		Group Controller Cabinet, PA03D		operate		- No impacts
159	1-752-J-PA03D-R02-S09	N/A	Dummy at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
160	1-752-J-PA03D-R02-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 1 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG2 - It impacts on corresponding channel's ESCM control manual control
Group Controller – A2 DUMMY / CI631 / PM646 / PM646 / PM646 / PM646 / PM646 / DI621 / DO620 / DUMMY							
161	1-752-J-PA03D-R03-S01	N/A	Group Controller (RB601) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
162	1-752-J-PA03D-R03-S02	CI Interface Processor	Component Interface Module (CI631) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Component Interface Module - It causes the loss of ability to communication by AF1000 Internet network. - It impacts on when the coincidence failure of GC-1 CI631. - Redundant group controller has its own CI module which provides global memory and provides AF 100 access.
163	1-752-J-PA03D-R03-S03	Processor Module	PM Processor Module 1 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	- Group Controller 1 Processor Module 1 (GC-2 PM1). - It causes the loss of the A and C ESF Initiation signals. - It causes the loss of the (A or C) coincidence logic performed by PM1. - Redundant component control signal is available in the redundant group controller.

Note)

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
164	1-752-J-PA03D-R03-S04	Processor Module	PM Processor Module 2 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	- Group Controller 1 Processor Module 2 (GC-2 PM2). - It causes the loss of the B and D ESF Initiation signals. - It causes the loss of the (B or D) coincidence logic performed by PM2. - Redundant component control signal is available in the redundant group controller.
165	1-752-J-PA03D-R03-S05	Processor Module	PM Processor Module 3 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	- Group Controller 1 Processor Module 3 (GC-2 PM3). - It causes the loss of the selective two out of four coincidence logic performed by PM 3. - It causes the loss of MCR CPM signals. - Redundant component control signal is available in the redundant group controller.
166	1-752-J-PA03D-R03-S06	Processor Module	PM Processor Module 4 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	No	- Group Controller 1 Processor Module 4 (GC-2 PM4). - It causes the loss of RSR CPM signals. - Redundant RSR CPM signal is available in the redundant group controller.
167	1-752-J-PA03D-R03-S07	Processor Module	PM Processor Module 5 (PM646A) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Group Controller 1 Processor Module 5 (GC-2 PM5). - It causes the loss of component control signal propagation (ESCM signals and MI signals) from CCG to LC via PM5. - Redundant RSR CPM signal is available in the redundant group controller.
168	1-752-J-PA03D-R03-S08	Digital Input Module	Digital Input Module (DI621) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Input Module - It is no impact on the safety function. - It causes the loss of local manual actuation in one GC in that channel, but the redundant GC is still functional. - Redundant group controller and redundant initiation signals are provided within the channel.
169	1-752-J-PA03D-R03-S09	Digital Output Module	Digital Output Module (DO620) at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Output Module - It is no impact on the safety function. - It causes the loss of transmission the Transfer Switch status to the PPS.
170	1-752-J-PA03D-R03-S10	N/A	ESF-CCS group controller cabinet, PA03D(RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts

Remove this column

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No.	Component ID	Component Type	Component Description	Normal	Failure Mode	Screening	Remark
	CCG – A2 DUMMY, CI631, PM646, DUMMY, DUMMY, DI621, DO620, DUMMY, DUMMY, CI631		Note) Add				
171	1-752-J-PA03D-R04-S01	N/A	Dummy at Group Controller 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Dummy Module - No impacts
172	1-752-J-PA03D-R04-S02	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Component Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control.
173	1-752-J-PA03D-R04-S03	Processor Module	PM Processor Module 1 (PM646A) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Control Channel Gateway 1 Processor Module (CCG-2 PM) - It impact on when the coincidence failure of CCG-1 PM - It impacts corresponding channel's ESCM control
174	1-752-J-PA03D-R04-S04	N/A	ESF-CCS group controller cabinet, PA03D (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
175	1-752-J-PA03D-R04-S05	N/A	ESF-CCS group controller cabinet, PA03D (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
176	1-752-J-PA03D-R04-S06	Digital Input Module	Digital Input Module (DI621) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Input Module - No impact, because no safety function depends on DI contact input. - It is for transfer switch status
177	1-752-J-PA03D-R04-S07	Digital Output Module	Digital Output Module (DO620) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Digital Output Module - No impact, because no safety function depends on DO contact input. - It is for transfer switch status
178	1-752-J-PA03D-R04-S08	N/A	ESF-CCS group controller cabinet, PA03D (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
179	1-752-J-PA03D-R04-S09	N/A	ESF-CCS group controller cabinet, PA03D (RB601)	Operation	Fails to operate	Yes	- Dummy Module - No impacts
180	1-752-J-PA03D-R04-S10	CI Interface Processor	Component Interface Module (CI631) at CCG 2 in ESF-CCS Group Controller Cabinet, PA03D	Operation	Fails to operate	Yes	- Communication Interface Module - It impacts on when the coincidence failure of redundant CI631 module in CCG1. - It impacts on corresponding channel's ESCM control manual control

Add

Note)

The Group Controller Cabinets (GCCs) contain two Control Channel Gateways (CCGs) and two Group Controllers. For Channel A and B, they have also contain third GC. The CCG 1 and CCG 2 are on racks R02 and R04. The GC1, GC2 and GC3 are on rack R01, R03 and R05.

The table summarizes the rack configurations and component ID.

Slot	R01 (GC1)		R02 (CCG1)		R03 (GC2)		R04 (CCG2)		R05 (GC3) (Only Channel A and B)	
	Component	ID	Component	ID	Component	ID	Component	ID	Component	ID
1	RB601 (Dummy)	R01-S01	RB601 (Dummy)	R02-S01	RB601 (Dummy)	R03-S01	RB601 (Dummy)	R04-S01	CI631	
2	CI631	R01-S02	CI631			R03-S02	CI631	R		
3	PM646	R01-S03	PM646	R02-S03		03-S03	PM646	R		
4	PM646	R01-S04	RB601 (Dummy)	R02-S04	PM646		RB601 (Dummy)	R04-S04	PM646	
5	PM646	R01-S05	RB601 (Dummy)	R02-S05	PM646		RB601 (Dummy)	R04-S05	DI621	
6	PM646	R01	DI621	R02-S06	PM646	03-S06	DI621	R04-S06		R05-S06
7	PM646	R01-S07	DO620	R02-S07	PM646	R03	DO620	R04	RB601 (Dummy)	R05-S07
8	DI621	R01-S08	RB601 (Dummy)	R02-S08	DI621		RB601 (Dummy)	R04-S08	RB601 (Dummy)	R05-S08
9	DO620	R01-S09	RB601 (Dummy)	R02-S09	DO620	R03-S09	RB601 (Dummy)	R04-S09	RB601 (Dummy)	R05-S09
10	RB601 (Dummy)	R01-S10	CI631	R02-S10	RB601 (Dummy)	R03-S10	CI631	R04-S10		

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Note)

The Group Controller Cabinets (GCCs) contain two Control Channel Gateways (CCGs) and two Group Controllers. For Channel A and B, they have also contain third GC. The CCG 1 and CCG 2 are on racks R02 and R04. The GC1, GC2 and GC3 are on rack R01, R03 and R05.

The table summarizes the rack configurations and component ID.

Slot	R01 (GC1)		R02 (CCG1)		R03 (GC2)		R04 (CCG2)		R05 (GC3) (Only Channel A and B)	
	Component	ID	Component	ID	Component	ID	Component	ID	Component	ID
1	RB601 (Dummy)	R01-S01	RB601 (Dummy)	R02-S01	RB601 (Dummy)	R03-S01	RB601 (Dummy)	R04-S01	CI631	R05-S01
2	CI631	R01-S02	CI631	R02-S02	CI631	R03-S02	CI631	R04-S02	CI631	R05-S02
3	PM646	R01-S03	PM646	R02-S03	PM646	R03-S03	PM646	R04-S03	PM646	R05-S03
4	PM646	R01-S04	RB601 (Dummy)	R02-S04	PM646	R03-S04	RB601 (Dummy)	R04-S04	PM646	R05-S04
5	PM646	R01-S05	RB601 (Dummy)	R02-S05	PM646	R03-S05	RB601 (Dummy)	R04-S05	DI621	R05-S05
6	PM646	R01-S06	DI621	R02-S06	PM646	R03-S06	DI621	R04-S06	DO620	R05-S06
7	PM646	R01-S07	DO620	R02-S07	PM646	R03-S07	DO620	R04-S07	RB601 (Dummy)	R05-S07
8	DI621	R01-S08	RB601 (Dummy)	R02-S08	DI621	R03-S08	RB601 (Dummy)	R04-S08	RB601 (Dummy)	R05-S08
9	DO620	R01-S09	RB601 (Dummy)	R02-S09	DO620	R03-S09	RB601 (Dummy)	R04-S09	RB601 (Dummy)	R05-S09
10	RB601 (Dummy)	R01-S10	CI631	R02-S10	RB601 (Dummy)	R03-S10	CI631	R04-S10	CI631	R05-S10

Table 1.8-2 (9 of 29)

Item No.	Description
COL 6.1(1)	The COL applicant is to identify the implementation milestones for the coatings program.
COL 6.2(1)	The COL applicant is to identify the implementation milestone for the CILRT program.
COL 6.3(1)	The COL applicant is to prepare operational procedures and maintenance programs as related to leak detection and contamination control.
COL 6.3(2)	The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.4(1)	The COL applicant is to provide automatic and manual operating procedures for the control room HVAC system, which are required in the event of a postulated toxic gas release.
COL 6.4(2)	The COL applicant is to provide the details of specific toxic chemicals of mobile and stationary sources and evaluate the MCR habitability based on the recommendations in NRC RG 1.78 to meet the requirements of TMI Action Plan Item III.D.3.4 and GDC 19.
COL 6.4(3)	The COL applicant is to identify and develop toxic gas detection requirements to protect the operators and provide reasonable assurance of the MCR habitability. The number, locations, sensitivity, range, type, and design of the toxic gas detectors are to be developed by the COL applicant.
COL 6.5(1)	The COL applicant is to provide the operational procedures and maintenance program as related to leak detection and contamination control.
COL 6.5(2)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.6(1)	The COL applicant is to identify the implementation milestones for ASME Section Xl inservice inspection program for ASME Code Section III Class 2 and 3 components.
COL 6.6(2)	The COL applicant is to identify the implementation milestone for the augmented inservice inspection program.
COL 6.8(1)	The COL applicant is to provide the operational procedures and maintenance program for leak detection and contamination control.
COL 6.8(2)	The COL applicant is to provide the preparation of cleanliness, housekeeping, and foreign materials exclusion program.
COL 6.8(3)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.
COL 6.8(4)	The COL applicant is responsible for the establishment and implementation of the Maintenance Rule program in accordance with 10 CFR 50.65.
COL 7.5(1)	The COL applicant is to provide a description of the site-specific AMI variables such as wind speed, and atmosphere stability temperature difference.
COL 7.5(2)	The COL applicant is to provide a description of the site-specific EOF.
COL 7.1(2)	~~The COL applicant is to provide the feasibility of software reliability.~~

Add

The COL applicant is to provide justifiable software reliability data for software used in the digital I&C systems (i.e., PPS and DPS).

Compliance with safety criteria for software is described in the Software Program Manual Technical Report.

The software design throughout the software life cycle is implemented in accordance with various software development plan documents described in the Software Program Manual Technical Report. The software development process is carried out throughout the software life cycle, which consists of the following:

a. Concept phase

b. Requirements phase

c. Design phase

d. Implementation phase

e. Test phase

f. Installation and checkout phase

g. Operation and maintenance phase

Software is classified based on the functionality and importance related to safety, as described in the Software Program Manual Technical Report. The software that is used within the APR1400 I&C systems is assigned to one of the following classes:

a. SC (Protection)

b. ITS

c. Important-to-availability (ITA)

d. General purpose

7.1.4 Combined License Information

~~No combined license (COL) information is required with regard to Section 7.1.~~

COL 7.1(2) ~~The COL applicant is to provide the feasibility of software reliability.~~

The COL applicant is to provide justifiable software reliability data for software used in the digital I&C systems (i.e., PPS and DPS).

19.1.3 Special Design/Operational Features

Design and operational characteristics of the APR1400 that result in improved plant safety as compared to currently operating nuclear power plants, include the following:

a. An in-containment refueling water storage tank (IRWST)

b. A four-train safety injection system (SIS) that injects borated water directly into the reactor vessel (RV) through direct vessel injection (DVI) nozzles

c. Four pumps for component cooling water and essential service water systems (CCWS and ESWS)

d. An emergency containment spray backup system (ECSBS)

e. A cavity flooding system (CFS)

f. A hydrogen control system (HG)

g. A Diverse Protection System (DPS) which, in addition to generation of a reactor trip, turbine trip and auxiliary feedwater actuation signals, also initiates a diverse safety injection actuation signal (SIAS) upon low pressurizer pressure.

The PRA has influenced the selection of design changes such as:

a. Four emergency diesel generators (EDGs)

b. The inclusion of an alternate ac source (AAC) gas turbine generator (GTG), which can be used as an independent ac source to cope with station blackout (SBO) scenarios following loss of offsite power (LOOP)

Table 19.1-2 provides a summary of the APR1400 systems. The table includes the system's key structures, systems, and components (SSCs) and the key functional descriptions with respect to the design features for preventing core damage, mitigating the consequences of core damage and preventing releases from containment, and mitigating the consequences of releases from containment.

19.1.3.1 Design/Operational Features for Preventing Core Damage

Key preventive features that are intended to minimize initiation of plant transients, mitigate the progression of plant transients, and prevent severe accidents include the following safety systems:

a. Safety Injection System (SIS)

injection water when RCP seal injection is not available through the two centrifugal charging pumps. The ACP takes suction from the VCT or the BAST and supplies seal injection water to the RCPs through the normal CVCS seal injection flow path. The ACP is considered as a diverse capability from the two centrifugal pumps.

The charging pumps are powered by the safety-related buses which are normally supplied by Class 1E onsite or offsite power. Following a loss of offsite power (LOOP), the buses will be re-energized by the emergency diesel generators. However, the charging pumps will not automatically restart. It needs to be manually re-started by the operators after bus voltage has been restored (COL 19.1(7)).

g. ~~Reactor Protection System (RPS)~~ Insert from 'A.'

The RPS is a part of the plant protection system (PPS). Nuclear steam supply system (NSSS) parameters and containment conditions are monitored by the PPS continuously. If monitored conditions approach specific safety limits, the PPS through the RPS rapidly shuts down the reactor to protect the fuel design limits and prevent a breach of the RCS pressure boundary. The PPS also communicates with the engineered safety features – component control system (ESF-CCS), which actuates mitigating systems.

The PPS is based on a digital I&C that includes plant parameter bistable comparator functions, coincidence logic functions, and initiation logic functions to actuate a reactor trip and operation of engineered safety features.

The coincidence trip signals are used in the initiation of the reactor trip switchgear system (RTSS) and the ESF-CCS. A coincidence of two-out-of-four like trip signals is required to generate a reactor trip signal.

A trip is generated when a coincidence of two like trip signals of the monitored plant parameters or containment conditions reach a preset safety limit. The RPS initiates a reactor trip for the following conditions:

1) Variable overpower trip signal (VOPT)

2) High logarithmic power level trip signal

A

g. Plant Protection System (PPS)

The PPS is a safety system that includes electrical, electronic, network, mechanical devices, and circuits. The PPS is based on a digital I&C platform that includes plant parameter bistable comparator functions, coincidence logic functions, and initiation logic functions to actuate a reactor trip and engineered safety features. The safety systems are implemented by safety-grade hardware and previously developed software components that are dedicated or qualified for use in nuclear power plants. The programmable logic controller (PLC) platform is loaded with the APR1400-specific application software to implement various safety functions. The PPS performs the following protective functions:

- Reactor protection system (RPS) - the RPS is that portion of the PPS that acts to trip the reactor when required. The RPS is described in Chapter 7, Section 7.2.
- Engineered safety features actuation system (ESFAS) - the ESFAS is that portion of the PPS that activates the engineered safety features (ESF) systems described in Chapter 7, Section 7.3.

3) High local power density (LPD) trip signal

4) Low departure from nucleate boiling ratio (DNBR) trip signal

5) High pressurizer pressure trip signal

6) Low pressurizer pressure trip signal

7) Low steam generator water level trip signal

8) High steam generator water level trip signal

9) Low steam generator pressure trip signal

10) High containment pressure trip signal

11) Low reactor coolant flow trip signal

12) Manual trip

The APR1400 design includes the diverse actuation system (DAS). The DAS consists of the diverse protection system (DPS), the diverse manual ESF actuation (DMA) switches, and the diverse indication system (DIS). The DPS provides additional trip capability to the RPS.

h. Engineered Safety Features Actuation System (ESFAS)

~~The engineered safety features (ESF) I&C consists of sensors, auxiliary process cabinet safety (APC-S), the ESFAS portion of the PPS, and ESF-CCS.~~

Insert from 'B.'

The ESFAS monitors selected parameters to initiate the operation of necessary ESF systems to prevent damage to the core and the RCS components. It also provides reasonable assurance of containment integrity and prevents unacceptable levels of radioactivity release to the environment as well as protecting the control room operators during fuel handling accidents. The system uses bistable trip functions and coincidence logic in the PPS and component control logic in the ESF-CCS to generate actuation signals. The following actuation signals are generated by the ESFAS:

1) Safety injection actuation signal (SIAS)

B

The engineered safety features (ESF) system consists of four channels of sensors, the auxiliary process cabinet-safety (APC-S), four divisions of the engineered safety features actuation system (ESFAS) portion of the plant protection system (PPS), and the engineered safety features-component control system (ESF-CCS).

The ESFAS portion of the PPS includes the following functions: bistable trip logic, local coincidence logic (LCL), ESFAS initiation, and testing functions.

The ESF-CCS receives ESFAS initiation signals from the PPS, electrical panel, or from the operators. The ESF-CCS generates ESF actuation signals to actuate the ESF system equipment. The ESF-CCS also generates emergency diesel generator (EDG) loading sequencer signals following loss of offsite power. The control circuitry for the components provides the proper sequencing and operation of the ESF systems.

2) Containment isolation actuation signal (CIAS)

3) Containment spray actuation signal (CSAS)

4) Main steam isolation signal (MSIS)

5) Auxiliary feedwater actuation signal (AFAS)

Insert from 'C.'

Insert from 'D.'

i. AC Power System

The ac power system comprises two qualified circuits from the offsite transmission network to the switchyard, two qualified circuits from the switchyard to the onsite Class 1E distribution system, four diesel generators (each capable of supplying one train of the onsite Class 1E ac distribution system, and automatic load sequencing for four trains of supported equipment that must be operable in Modes 1, 2, 3, and 4).

The non-Class 1E 13.8 kV power system consists of four non-safety switchgears. Each of two unit auxiliary transformers (UATs) normally supplies two of the 13.8 kV switchgears. The non-Class 1E 13.8 kV power system furnishes power to large motors such as the RCP motors, condensate pump motors, circulating water pump motors, and associated 480V load centers.

The Class 1E safety systems are divided into four redundant and independent distribution systems. Each distribution system can be powered from the following sources:

1) Unit auxiliary transformer (UAT)

2) Standby auxiliary transformer (SAT)

3) Emergency diesel generator (EDG)

4) Alternate AC (AAC)

If both the offsite power sources and the standby EDGs are unavailable, 4.16 kVac buses may be powered from the AAC power source. The AAC provides an independent and diverse power source, which is furnished with a battery and charger to provide power to its associated dc loads.

C

The ESF-CCS is a digital system that controls and actuates ESF system components. The ESF-CCS provides interface and signal fan out capability for the ESF actuation signals via the component control logic within the ESF-CCS. The logic produces digital output signals to control the component through the component interface module (CIM), which performs signal prioritization. The CIM transmits signals to the final actuated device (e.g., switchgear, motor control center, solenoids).

The CIM is a qualified safety module that uses hardware logic devices to cope with a CCF of the digital protection and safety systems. The CIM receives component control signals from the ESF-CCS, DPS, DMA (see paragraph h. below for DPS and DMA) switches, and front panel control (FPC) switch. The CIM combines these control signals through conventional hardware priority logic and then sends the resulting signal to the controlled component.

D

h. Diverse Actuation System (DAS)

The diverse actuation system (DAS) consists of the diverse instrumentation and control (I&C) systems that are provided to protect against potential common-cause failure (CCF) of PPS digital safety I&C systems including the RPS and the ESF-CCS. The DAS consists of the diverse protection system (DPS), the diverse manual engineered safety features (ESF) actuation (DMA) switches, and the diverse indication system (DIS).

The DPS and DIS are not installed on the same qualified PLC platform as is the PPS, but rather are implemented on non-safety independent platforms. In addition, DMA is hardwired, and not software based. Therefore, the DAS subsystems (DPS, DIS and DMA) are all unaffected by software CCF of the PPS. Likewise, software CCF within the DAS (DPS and DIS subsystems) will not impact the PPS subsystems (i.e., RPS and ESFAS).

Sensors and analog signal processing equipment (e.g., pressurizer pressure transmitter) are shared by the DPS and PPS; however, these are analog equipment, and are not affected by the software CCF. (The linked fault tree methodology employed in the APR1400 PRA ensures that failures of the sensors and analog signal processing equipment impacts both the PPS and DPS systems.)

The DPS design includes reactor trip, turbine trip, auxiliary feedwater actuation, and safety injection actuation functions. The DPS reactor trip provides a simple and diverse mechanism to decrease the risk from ATWS events and mitigates the effects of a postulated software CCF of the digital computer logic within the RPS and/or ESF-CCS. The DPS turbine trip is automatically initiated whenever the DPS reactor trip conditions are met (with 3 second time delay). The DPS auxiliary feedwater system actuation provides additional reasonable assurance that an ATWS event could be mitigated if it occurred. The DPS safety injection system actuation assists the mitigation of the effects of a large break loss of coolant accident (LOCA) event with a concurrent software CCF within the PPS and ESF-CCS.

The DMA switches permit the operator to manually actuate ESF trains from the MCR safety console after postulated failures (including software CCF) of both the PPS and DPS. The DMA switches include SIAS, CIAS, CSAS, MSIS, and AFAS. The functions of the DMA switches are enabled by the DMA enable switch on the safety console. The DMA switches are hardwired to the component interface module (CIM) through isolation devices and are independent and diverse from the safety system. Each signal of the DMA switches actuates necessary ESF systems to perform the ESF functions.

The DPS and DMA signals are routed directly to the CIM. Isolation is provided at the ESF-CCS loop controller cabinet to maintain electrical isolation between the DPS/DMA and the CIM.

The DIS provides functions to monitor critical variables following a postulated software CCF of safety I&C systems. Because the DIS receives hardwired signal inputs via isolation devices in the auxiliary process cabinet-safety (APC-S) as well as in qualified indication and alarm system - P (QIAS-P), the DIS is independent from the APC-S and QIAS-P. The DIS is diverse from the QIAS-P.

d) Flow diversion (SY-A13) is considered a potential system failure if the flow diversion pathway occurs due to failures that do not meet the screening criteria of SY-A15 and can result in failure to meet the system success criteria. The flow diversion paths that are excluded are documented.

Insert from 'E.'

Dependency Analysis

The systems that are included in the systems analysis for internal events are provided in Table 19.1-9. Simplified diagrams of major systems are shown in Figures 19.1-1 through 19.1-14. Tables are provided to summarize the initiator-to-system and system-to-system dependencies.

a. Dependency between Initiating Events and Front Line Systems (Table 19.1-10a)

b. Dependency between Initiating Events and Support Systems (Table 19.1-10b)

c. Dependency between Front Line System and Supporting Systems (Table 19.1-11a)

d. Dependency between Supporting System and Other Supporting Systems (Table 19.1-11b)

19.1.4.1.1.5 Data Analysis

The purpose of the data analysis task is to tabulate estimates of the failure rates, demand failure probabilities, and unavailability data for basic events in the PRA model. The data developed during this task include:

a. Component unreliability data

b. Component unavailability data due to test and maintenance

c. CCF data

d. Special event data including recovery action failures

For each component type and failure mode identified in the system analysis, the failure rates are extracted from available generic data sources. Potential sources of generic failure data are:

E

8) Common cause failures within Digital I&C systems (PPS and DPS) are implemented as follows:

a) The PPS and the DPS are designed using different hardware to address postulated common-cause failures. Hence, hardware CCFs of PPS components only include PPS components of the same type (e.g., bistable, LCL processor, etc.) within the common cause component group (CCCG). Likewise, hardware CCFs of DPS components only include DPS components of the same type with the CCCG.

b) The PPS and the DPS are designed using different software platforms to address postulated software common-cause failures. Hence, PPS software CCFs only impact PPS, and DPS software CCFs only impact DPS.

c) Both the PPS and DPS are assumed to be susceptible to both operating system and application software CCFs.

d) Operating system software CCF and application software CCF are assumed based on a similar software platform as with APR1400 (Reference 65). System reliability analyses were performed which demonstrated that these software CCF probabilities result in an overall system reliability that is consistent with the $1x10^{-4}$ limit stated in IEC 61226 (Reference XX).

e) PPS software CCF includes operating system CCF, and individual application software CCFs for bistables, LCL modules, group controllers (GC) and loop controllers (LC).

1) PPS operating system CCF is assumed to fail all PPS bistables, LCL modules, GCs and LCs. Hence, PPS operating software CCF is assumed to fail all RPS and ESFAS signals generated by PPS.
2) Each PPS application software CCF only fails the components it supports (e.g., PPS GC software CCF fails all PPS GCs).
3) Two pairs of manual trip switches are provided in the MCR, and one pair of manual trip switches is provided in the remote shutdown room (RSR) for reactor trip. These manual reactor trip switch signals are connected directly to the undervoltage trip device of the trip circuit breaker (TCB) in each reactor trip switchgear (RTSG). Hence, manual action can over-ride PPS software CCF.
4) Local and remote (MCR) manual ESF-CCS initiation signals are implemented at the GC level. Hence, software or hardware failures in the PPS bistables or LCL modules can be over-ridden by operator action. However, PPS GC and LC CCF result in failure of ESF-CCS signals to all associated equipment.

f) DPS software CCF includes operating system CCF, and application software CCF. Failure of either results in failure of all DPS signals.

g) The component interface module (CIM) is a hardware based device associated with a specific component, and is include in the boundary of the component. This is consistent with NUREG/CR-6928 (Reference 11), and its successive updates, which state that component boundaries used in the data collection include the local instrumentation and control circuitry. The CIM receives component control signals from the ESF-CCS, DPS, DMA switches, and front panel control (FPC) switch. The CIM combines these control signals through conventional hardware priority logic and then sends the resulting signal to the controlled component (e.g., MOV, pump motor, SOV). The CIM is not subject to software CCF.

is only a minor decrease in CDF. This sensitivity case impacts only SBO sequences.

e. Hot Leg Injection Sensitivity Case: For medium break LOCA, a hot leg injection (HLI) is assumed not needed. A sensitivity case was performed that required HLI for a medium break LOCA, and the result showed the CDF increases by 10 percent to 1.4×10^{-6}/year.

Insert from 'F.'

19.1.4.1.2.8 Risk Insights

The APR1400 is an evolutionary PWR plant, and CDF is dominated by LOOP events (approximately 39 percent). Still, total LOOP CDF is small at less than 1.5×10^{-7}/year, which is a result of the high redundancy in trains and diversity in emergency power supplies.

Loss of cooling systems (CCWS and ESWS) and seal LOCA contributions to CDF are approximately 26 percent, which includes the total/partial losses of CCW or ESW. This relatively large contribution, which contributes to RCP seal LOCA, is a result of the lack of diversity in the redundant cooling trains.

The top cutsets show that the plant risk is strongly influenced by the performance of support systems (i.e., CCWS and ESWS). This is because the support systems are common dependencies of highly redundant safety systems.

19.1.4.2 Level 2 Internal Events PRA for Operations at Power

A description of the Level 2 internal events PRA for operations at-power, including the results of the analysis, is provided in the following subsections.

19.1.4.2.1 Description of Level 2 Internal Events PRA for Operations at Power

The PRA comprises two major areas of analysis: 1) identification of sequences of events that could lead to core damage and estimation of their frequencies of occurrence (the Level 1 analysis); and 2) evaluation of the potential response of the containment to these sequences, with emphasis on the possible modes of containment failure and the corresponding radionuclide source terms (the Level 2 analysis).

F

f. Several sensitivity cases were performed to better understand the CDF sensitivity to the software reliability values used in the digital I&C system. These sensitivities were performed by cutset manipulation of the at-power internal events model. These sensitivities reveal the following significant conclusions about the digital I&C system:

· The relative insensitivity to the exact software CCF values used in the model up until a very large increase (between a factor of 10 and 100) is postulated.
· Relatively large increases (e.g., factor of 100) in DPS software CCF has little impact on CDF.
· The importance of operator action to overcome software CCF was also evaluated. The ability to manually trip the reactor from the MCR/RSR reduces the impact of bistable and LCL software CCF. Furthermore, the ability to start equipment remotely from the MCR/RSR minimizes the impact of software CCF in the group controllers. However, since these remote signals are input into either the group controller or loop controller, and the loop controller produces the final ESF-CCS output signal to the CIMs, software CCF in the loop controllers fails all remote signals.
· Another sensitivity case showed that limited benefit would be obtained from trying to justify lower software CCF values, since complete perfection (which is not credible) only results in about a 5% decrease in CDF.

The purpose of this attachment is to provide additional explanation regarding the "CCF of operating software and application software RAWs are almost the same in Table 19.1-22".

From Table 19.1-22:

CCF Event	Description	RAW
PPSO-OS-PPS	CCF OF PPS OPERATING SYSTEM SOFTWARE	2426
PPSO-AP-LC	CCF OF PPS LC APPLICATION SOFTWARE	2376
PPSO-AP-GC	CCF OF PPS GC APPLICATION SOFTWARE	771
PPSO-AP-BPM	CCF OF PPS BPM APPLICATION SOFTWARE	87
PPSO-AP-LCL	CCF OF PPS LCL APPLICATION SOFTWARE	87

Based on these results it is clear that the operating system software CCF (which fails all applications), and each application software CCF are all risk significant with respect to RAW since RAW >> 2 for each CCF event. The "amount" of importance with respect to RAW is based on both the base failure probability of the event as well as its impact on the model. If the impact on the model is the same, the event with the smaller failure probability will have a higher RAW. If the events have the same probability, but one event is involved in more sequences, the more involved event will have a higher RAW. If both the model impact and failure probability are the same, we would expect to see the same RAW value.

Recall that the failure probability of the operating system software is [ ]^{TS}/demand, and the failure probability of all application software is [ ]^{TS}/demand. Also, recall that a failure of the operating system fails all applications. For example, all bistables are assumed to fail if either the bistable processor module application software fails (PPSO-AP-BPM) or if the operating system software fails. Hence, one would expect to see that the operating system CCF has a higher RAW than any individual application software CCF (which we see).

Regarding the application software, the bistable (PPSO-AP-BPM) and LCL module (PPSO-AP-LCL) have the same function (i.e., develop output signals to both RPS and ESF), and the same failure probability; hence, their RAWs should be identical (which we see). Note that for RPS, both of these application software failures can be compensated for by DPS, or manual reactor trip. In addition, recall that all LOOP/SBO events (which represent about 35% of the CDF) result in automatic trip, so failure of LCL or BPM software has no impact on 35% of all CDF. For ESF, both of these application system failures can be compensated for by remote manual ESF actuation, remote manual component control via ESCM (ESF-CCS soft control module), DPS and DMA. Therefore, although they support both RPS and ESF, there are several methods to compensate for their failures, and they end up having the lowest RAW.

Group controller software CCF only fails ESF equipment (i.e., does not impact reactor trip), but their failure also fails remote manual ESF signals (e.g., manual SI or AFAS from the MCR). However, signals to individual components can still be actuated via signals sent to the Loop Controllers from the ESCM. In addition, DPS and DMA can still actuate equipment.

For LC software failure, all ESF and ESCM signals are failed, and only DPS and DMA are available to start ESF equipment.

Hence, we would expect that the LCs are more important than the GCs which are more important than the LCLs or BPMs (which we see).

Finally, as previously stated, failure of the operating system fails all application software; hence, it has to have the highest RAW of all (which we see).