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.:	43-7887
SRP Section:	7.1 - Instrumentation and Controls
Application Section:	7.1.2.3
Date of RAI Issue:	07/17/2015

Question No. 07.01-25

Provide adequate design information and accompanying analysis to demonstrate predictable and repeatable operation of the CPCS central processing unit (CPU) when processor loading exceeds 70 percent. Provide the basis and analysis for the 70 percent CPU loading criteria and describe how the particular tests and analyses proposed in the application will be conducted to verify predictable and repeatable behavior. Include an inspection, tests, analyses, and acceptance criteria (ITAAC) item to include the necessary analysis and test to ensure predictable and repeatable operation of the CPCS system once software development has been completed and for support of future software maintenance.

10 CFR 50.55a(h)(3) requires compliance with IEEE Std. 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," and the correction sheet dated January 30, 1995. Clause 5.5 of IEEE Std. 603-1991 requires the safety systems shall be designed to accomplish their safety functions under the full range of applicable conditions enumerated in the design basis. Clause 5.15, "Reliability," requires, in part, that for those systems for which either quantitative or qualitative reliability goals have been established, appropriate analysis of the design shall be performed in order to confirm that such goals have been achieved. 10 CFR 52.47(b)(1), requires that a design certification application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

Technical Report APR1400-A-J-NR-14004-P, Rev. 0, "Common Q Platform Supplemental Information in Support of the APR1400 Design Certification," states, in part, that the maximum load of the Common Q platform CPU (AC160) to be used for the APR1400 CPCS system needs to be raised to 75 percent, which exceeds the 70 percent CPU load limit as specified in the Common Q Topical Report, WCAP- 16097-P-A, Rev. 3. In addition, many restrictions for configuration and programming have been proposed in the above technical

report APR1400-A-J-NR-14004-P, so the task processing and communication in the CPCS could be deterministic. Particular tests are proposed to be conducted to ensure that the CPCS system will behave in a predictable and repeatable manner. However, the above Common Q Topical Report specifies that the maximum CPU load must not exceed a value of 70 percent to ensure the deterministic communication. Describe how the CPCS system will be able to reliably perform all scheduled CPU tasks when the CPU load exceeds 70 percent. The description should include the basis for the CPU loading criteria, analysis, and/or outline the analysis to be performed that demonstrates reliable performance for CPU loading once the software is completed. Also, describe how the proposed tests will be conducted to verify the deterministic communication and include an ITAAC to ensure that the necessary analysis and tests will be conducted to ensure the CPCS CPU tasks behave in a predictable and repeatable manner.

Response

The response is provided as Attachment 1.

Supplemental Response – (Rev. 1)

1. Conformance to the CPU Load restrictions.

The 75 % CPU load limit is incorporated into the CPCS application software for the APR1400. It is the same limit as the Palo Verde CPCS software based on the restrictions of the platform vendor.

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The CPCS design conformance to the CPU load restrictions and the software comparison between the Palo Verde CPCS and the APR1400 CPCS will be added into the Safety I&C System Technical Report as indicated in the Attachment 3.

An ITAAC item will be added to DCD Tier 1 to provide the commitment to satisfy the CPU load restrictions. The references to WCAP-17922 and WCAP-17926-P will also be added to IBR (incorporate by reference) in the DCD Tier 2 as indicated in Attachment 2.

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The additional statements will be added into the Safety I&C System Technical Report as indicated in Attachment 3.

In addition, the modification related to the addition design basis information supporting the "Alternative Request" is added to the Safety I&C System Technical Report as indicated in Attachment 3.

Impact on DCD

DCD Tier 1 Table 2.5.1-5 and Section 1.6 of DCD Tier 2 will be revised, as indicated in Attachment 2 associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Technical Report APR1400-Z-J-NR-14001, Rev. 0, "Safety I&C System" will be revised, as indicated in Attachment 3.

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Revision 1
SUBJECT: AC160 CPU Load to 75
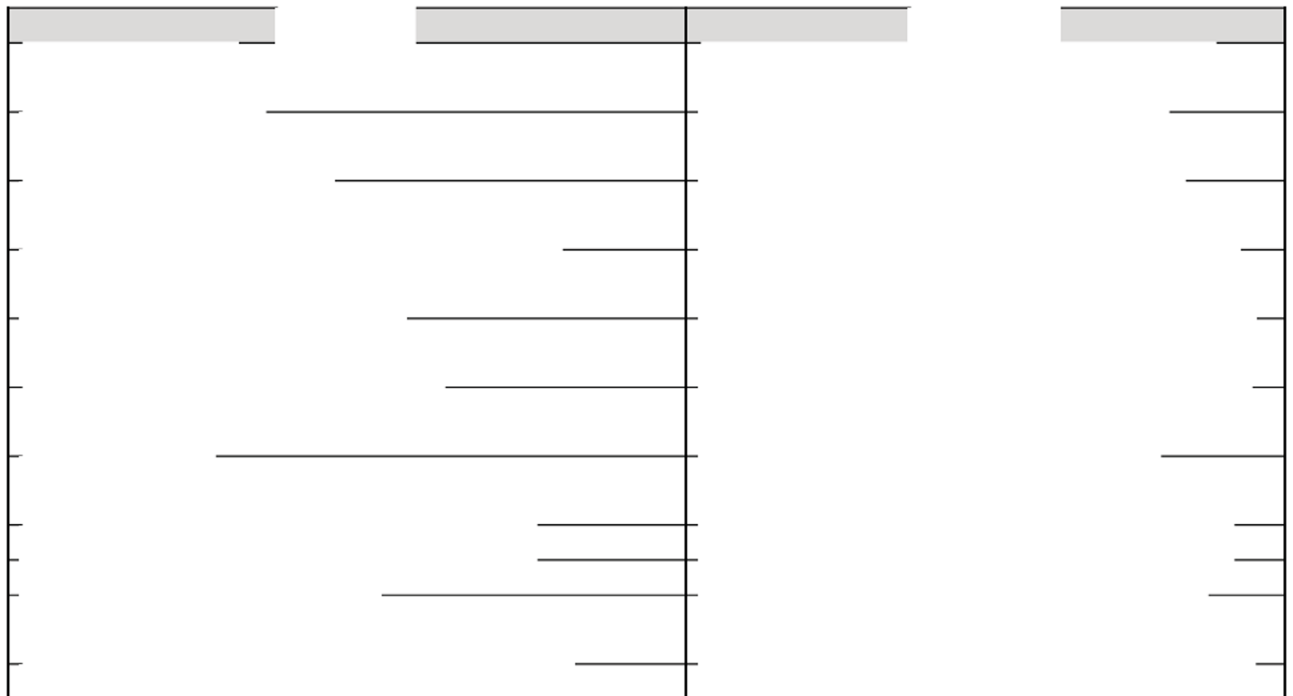Percent
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Appendix A

Westinghouse provides the following input to KHNP and KEPCO E&C to assist in the preparation of the response to RAI 43-7887, Question 07-01-25.

Per the ABB users guide(reference 1, section 3.2.2.1)the maximum load for an AC160 Controller shall not exceed 70%.There are applications in which this 70% limit is not sufficient, and a 75% load is required to execute the application. The CPC design is one of these applications. [

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*Note: These items will need verified upon final CPC design.

The load on a CPCS processor module will be verified to not exceed 75%. This is done via the PC Element SYSL. SYSL was qualified for use as part of the original AC160 software. SYSL allows the user to monitor the load on the system. Figure 1 describes the SYSL PC Element. Further information on the SYSL usage is described in the PC Element Reference Manual (Reference 6).

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Testing must conform to the guidelines specified [
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            ┌─────────────────────┐
            │      SYSL           │
            │      (C1)           │
 ──── 1 ──┤ MAXL        LOAD ├─ 5 ────
 ──── 2 ──┤ HYS         OVERL ├─ 6 ────
            │             L>ML ├─ 7 ────
            └─────────────────────┘
         PC Element SYSL
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Figure 1 SYSL PC Element

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References:
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Table 2.5.1-5 (10 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
21. A single channel of RTS and ESF initiation is bypassed to allow testing, maintenance or repair and this capability does not prevent the RTS and ESF initiation from performing its safety function.	21. A test will be performed on the 2-out-of-4 voting logic in the as-built RTS and ESF initiation by providing simulated process signals, identified in Tables 2.5.1-2 and 2.5.1-3, to at least two of three non-bypassed channels of the as-built RTS and ESF initiation input under the manual single division bypass operation from the as-built the maintenance and test panel (MTP) in the MCR.	21. When the 2-out-of-4 voting logic in the non-bypassed divisions of each as-built RTS and ESF initiation receives at least two of three actuation signals, identified in Tables 2.5.1-2 and Table 2.5.1-3, from the respective non-bypassed channels, the 2-out-of-4 voting logic in the non-bypassed divisions of each as-built RTS and ESF initiation provides the actuation signal for the reactor trip and automatic ESF functions identified in the tables.
22. Input sensors from each channel of the RTS and ESF initiation as identified in Tables 2.5.1-2 and 2.5.1-3 are compared continuously in the information processing system (IPS) to allow detection of out-of-tolerance sensors.	22. A test of the as-built IPS will be performed by providing The simulated inputs for each monitored variable identified in Tables 2.5.1-2 and 2.5.1-3 which includes one out-of-tolerance , at the as-built RTS and ESF initiation input.	22. An alarm for the out-of-tolerance sensor detection is displayed on the as-built IPS in the MCR when the IPS receives simulated input signals for each monitored variable identified in Tables 2.5.1-2 and 2.5.1-3 which includes one out-of-tolerance signal.
23. Two sets of RTSS which cons... dive...	23. Inspection of the as-built	23. Two sets of the as-built

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
27. The CPCS configuration restrictions and tests for the CPU load have been implemented.	27.a Inspection and analysis will be performed of the as-built CPCS equipment to verify that the CPCS configuration restrictions for the CPU load are designed into the final CPCS design.	27.a A report exists and concludes that the CPCS configuration restrictions for the CPU load are designed into the final CPCS design.
	27.b CPU load test of the as-built CPCS will be performed.	27.b The as-built CPCS equipment meets the restricted CPU load limit test acceptance criteria.

Table 1.6-2 (2 of 2)

Report Number [1]	Title	DCD Tier 2 Section
APR1400-F-A-NR-14002-P APR1400-F-A-NR-14002-NP	The Effect of Thermal Conductivity Degradation on APR1400 Design and Safety Analyses	15.4 15.6
APR1400-F-A-NR-14003-P APR1400-F-A-NR-14003-NP	Post-LOCA Long Term Cooling Evaluation Model	15.6
APR1400-H-N-NR-14012-P APR1400-H-N-NR-14012-NP	Mechanical Analysis for New and Spent Fuel Storage Racks	9.1.2
APR1400-K-I-NR-14005-P APR1400-K-I-NR-14005-NP	Staffing and Qualifications Implementation Plan	18.5
APR1400-K-I-NR-14009-P APR1400-K-I-NR-14009-NP	Design Implementation Plan	18.11
APR1400-Z-A-NR-14006-P APR1400-Z-A-NR-14006-NP	Non-LOCA Safety Analysis Methodology	15.0.2
APR1400-Z-A-NR-14007-P APR1400-Z-A-NR-14007-NP	LOCA Mass and Energy Release Methodology	6.2.1.3
APR1400-Z-J-NR-14001-P APR1400-Z-J-NR-14001-NP	Safety I&C System	7.1, 7.2, 7.3, 7.4, 7.5, 7.8, 7.9
APR1400-Z-J-NR-14003-P APR1400-Z-J-NR-14003-NP	Software Program Manual	7.1.4, 7.2.2.2, 7.3.1
APR1400-Z-J-NR-14004-P APR1400-Z-J-NR-14004-NP	Uncertainty Methodology and Application for Instrumentation	7.2.2.7, 7.3.2.7
APR1400-Z-J-NR-14005-P APR1400-Z-J-NR-14005-NP	Setpoint Methodology for Plant Protection System	7.2.2.7, 7.3.2.7
APR1400-Z-M-NR-14008-P APR1400-Z-M-NR-14008-NP	Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown	5.2, 5.3

1) P – denotes document is proprietary.
NP –

APR1400−A−J−NR−14003−P APR1400−A−J−NR−14003−NP	APR1400 Disposition of Common Q Topical Report NRC Generic Open Items and Plant Specific Action Items	7.1
APR1400−A−J−NR−14004−P APR1400−A−J−NR−14004−NP	Common Q Platform Supplemental Information in Support of the APR1400 Design Certification	7.1

LIST OF TABLES
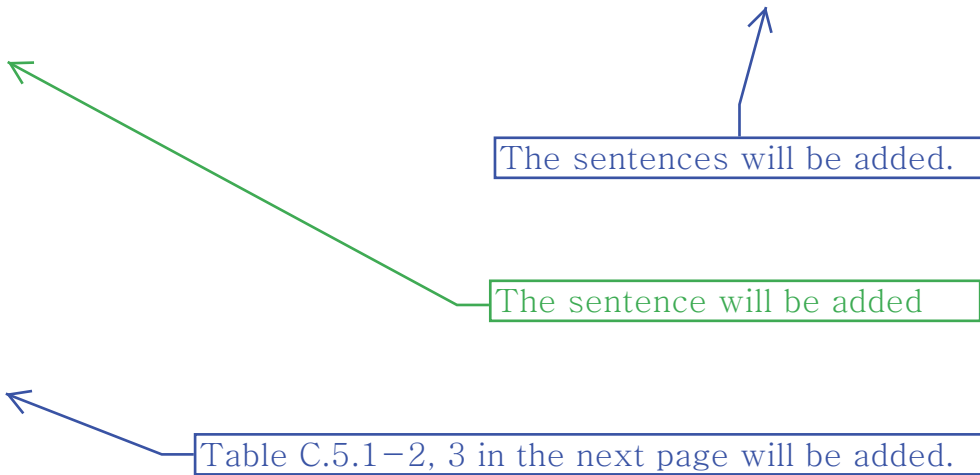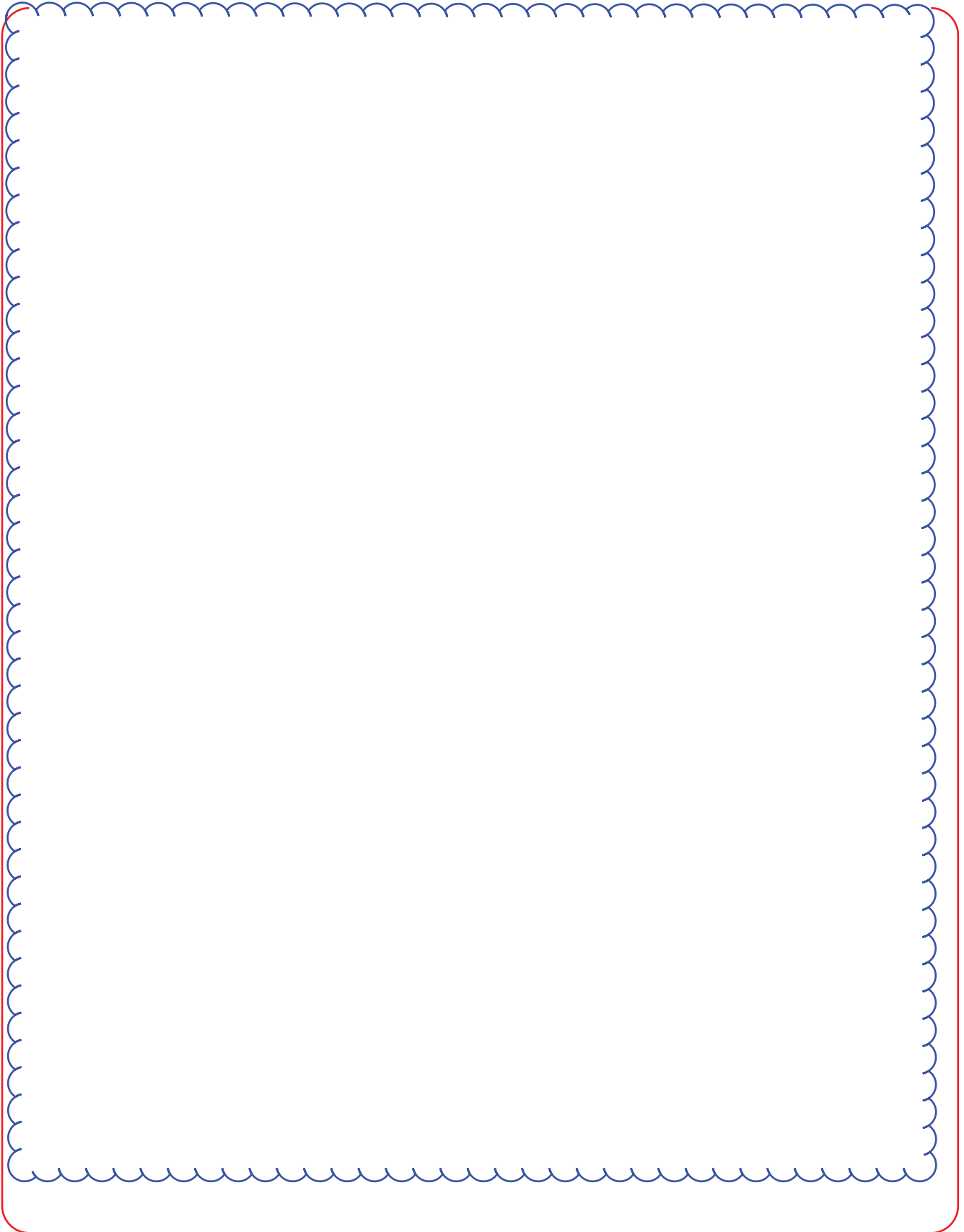
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9 REFERENCES

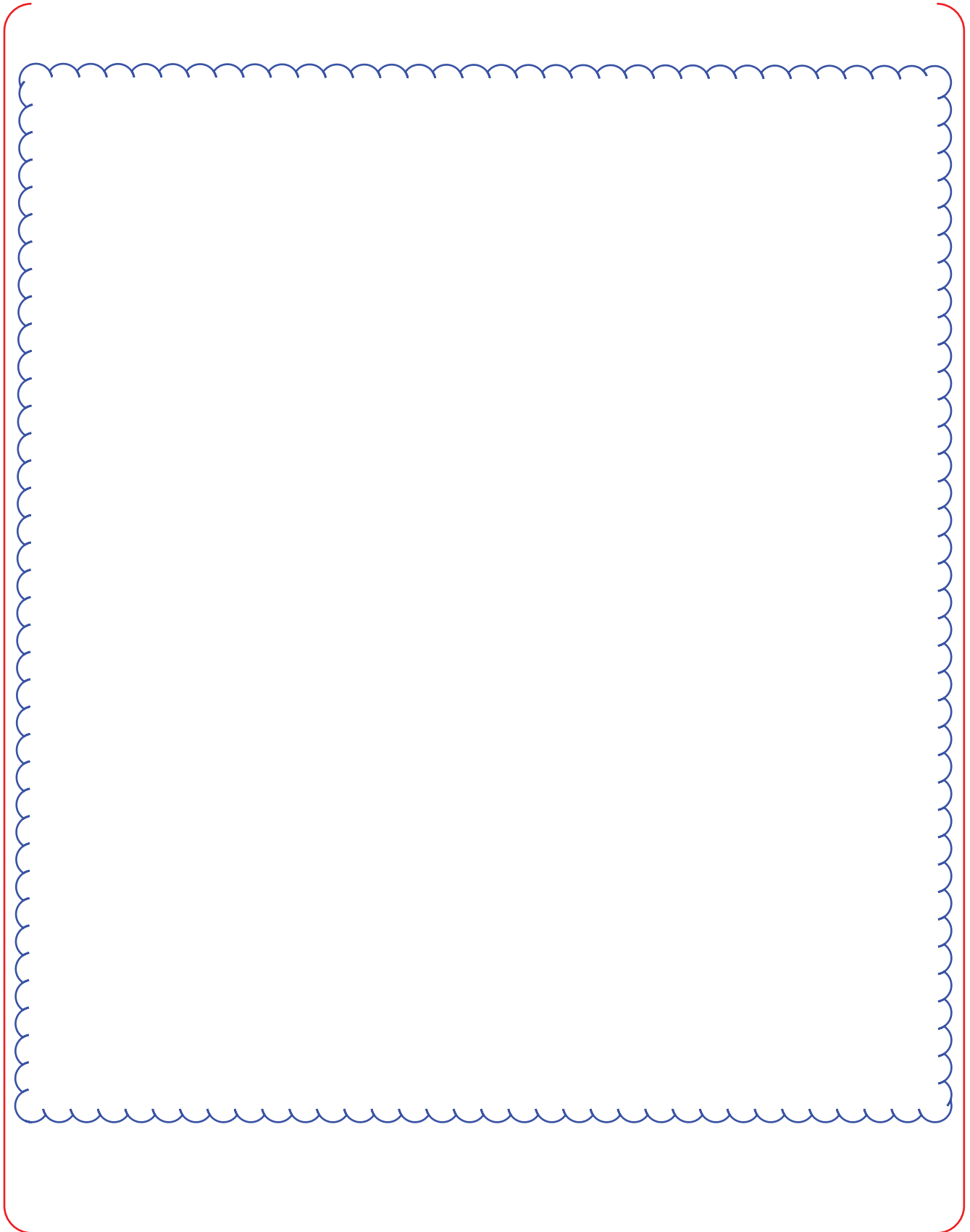Sup. RAI 43−7887, 07.01−25 Rev.1

1. APR1400-Z-J-NR-14002-P, "Diversity and Defense-in-Depth," November 2014

2. APR1400-Z-A-NR-14019-P, "CCF Coping Analysis", November 2014

3. APR1400-E-J-NR-14001-P, "Component Interface Module," November 2014

4. DI&C-ISG-04,Rev.1, "Highly Integrated Control Rooms – Communications Issues," 2009

5. APR1400-K-Q-TR-11005-N, "KHNP Quality Assurance Program Description (QAPD) for the APR1400 Design Certification"

6. APR1400 DC Quality Assurance Manual (QAM)

7. APR1400-Z-J-NR-14004-P, " Uncertainty Methodology and Application for Instrumentation," November 2014

8. APR1400-Z-J-NR-14005-P, "Setpoint Methodology for Plant Protection System," November 2014

9. APR1400-F-C-NR-14001-P, "CPC Setpoint Analysis Methodology for APR1400," July 2014.

10. APR1400-Z-J-NR-14003-P, Rev. 0, "Software Program Manual", November 2014

11. Design Control Document for the APR1400

12. WCAP-16097-P-A, "Common Qualified Platform Topical Report", Rev. 3, February 2013

13. APR1400-Z-J-NR-14013-P, "Response Time Analysis of Safety I&C System," November 2014

14. APR1400-Z-J-NR-14012-P, "Control System CCF Analysis," November 2014

15. APR1400-F-C-NR-14003-P, "Functional Design Requirements for a Core Protection Calculator System for APR1400," August 2014

16. APR1400-E-I-NR-14012-P, "Style Guide," December 2014

17. APR1400-A-J-NR-14004-P (WCAP-17922-P, "Common Q Platform Supplemental Information in Support of the APR1400 Design Certification, " ~~Rev. 0, August 2014~~ Rev. 2, May 2017

18. APR1400-A-J-NR-14003-P (WCAP-17926-P), "APR1400 Disposition of Common Q Topical Report NRC Generic Open Item and Plant Specific Action Items," Rev.0, October 2014

19. AN03007Sp, "AC160 CPU Loading Restrictions", ABB

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The sentences will be added.

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Table C.5.1-2, 3 in the next page will be added.

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APPENDIX D   ALTERNATIVE TO INDEPENDENCE REQUIREMENTS OF IEEE STD. 603-1991

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The sentence will be added