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.:	**356-7881**
Review Section:	**07 – Instrumentation and Controls – Overview of Review Process**
Application Section:	**7.0**
Date of RAI Issue:	**01/04/2016**

Question No. 07-1

Provide a comprehensive list and description of self-test and self-diagnostic features that will be utilized in the APR1400 safety-related instrumentation and control (I&C) systems and how these features will be verified periodically.

As required in 10 CFR 50.55a(h)(3), IEEE Std. 603-1991, Clause 5.5, "System Integrity," states that safety systems shall be designed to accomplish their safety functions under the full range of applicable conditions enumerated in the design basis. IEEE Std. 7-4.3.2-2003, endorsed by Regulatory Guide (RG) 1.152, provides specific guidance on self-test/self-diagnostic features and their application to computer system integrity. With regard to self-testing features, the Technical Report APR1400-Z-J-NR-14001-P, Rev.0, “Safety I&C System,” Appendix B, section B.5.5.3, "Fault Detection and Self-Diagnostics," states, in part, the following:

"A typical set of self-diagnostic functions includes the following:

• Memory functionality and integrity tests (e.g., programmable read-only memory (PROM) checksum and random access memory (RAM) tests)

• Computer system instruction set (e.g., calculation tests)

• Computer peripheral hardware tests (e.g., watchdog timers and keyboards)

• Computer architecture support hardware (e.g., address lines and shared memory interfaces)

• Communication link diagnostics (e.g., cyclic redundancy checksum (CRC) verification)"

The above-quoted information is referred to as "typical" in terms of features but does not address what are the specific set of functions that will be utilized for the APR1400 as a whole,

specifically for the safety I&C systems. For example, neither the final safety analysis report (FSAR) (Tier 1 or Tier 2) nor Technical Report APR1400-Z-J-NR-14003-P, Rev.0, “Software Program Manual,” provide a comprehensive listing and description of all self-testing features in the APR1400 design. The design documentation does not provide a comprehensive description of these features.

1. What are the specific self-test/self-diagnostic features that will be incorporated in the safety I&C systems?

2. Are self-testing/self-monitoring software, as well as any other software-based diagnostic tools, designed under the same controls as the software life-cycle process detailed in the Software Program Manual?

3. Do the FSAR Tier 1 Inspection, Tests, Analyses, and Acceptance Criteria (ITAAC) for the safety I&C systems provide testing and validation for the self-testing and self-diagnostic functions? If not, explain why.

4. Does the applicant intend to provide a FSAR Tier 1 ITAAC for the safety I&C systems that verifies the fail-safe behaviors (e.g. control output to safety actuators fail to a predefined state and a restoration of power or system re-initialization, does not cause a change of state in the actuators) of the Plant Protection System (PPS) and Engineered Safety Features – Component Control System (ESF-CCS) that would demonstrate system integrity is maintained during such events as a loss of power or component failures?

Response

1. The self-test/self-diagnostic features incorporated in the safety I&C systems are provided in Subsection 5.2.1.1.1 of WCAP-16097-P-A, “Common Qualified Platform Topical Report”, which is listed as Reference 12 in Section 9 of the Safety I&C System technical report. The Common Q Platform Topical Report describes the diagnostic functions provided by the Processor Module (PM) of the Common Q Platform. Subsection 5.2.1.2.1 of the report identifies the standard AC160 system software developed by ABB Automation Products, which executes the application program, performs diagnostics, and provides communication interfaces. Also, detailed information regarding the Common Q diagnostics is provided in Section 5.4.1 of the Common Q Platform Topical Report.

   The Common Q diagnostics are provided by the internal diagnostics included in the AC160 base software, the self-contained diagnostics included with each input/output (I/O) and Communication Interface Module, and the application program collection and reporting of this information. The self-contained diagnostics of each I/O module and Communication Interface Module are used to report error conditions associated with module operation to the PM, which are then collected and reported by the application program.

   DCD Tier 2 Table 7.2-7, “Failure Modes and Effects Analysis for the Plant Protection System”, identifies that failures associated with application program memory failures can be detected based on a cyclic redundancy checksum (CRC) check performed on the

memory. This automatic self-checking feature is accomplished by the application program CRC calculations and checks.

2. Section 8, “Safety I&C System Platform”, of the Safety I&C System technical report identifies that the safety I&C system is implemented on the Common Q Platform, which is dedicated and qualified for nuclear power plants, as referenced in Common Qualified Platform Topical Report (Reference 12 listed in Section 9 of the Safety I&C System technical report). It also identifies that the application software is developed according to the life cycle process, as described in the Software Program Manual technical report.

   The diagnostics which are part of the AC160 base software, and the self-contained diagnostics of each I/O module and Communications Interface module, are provided by previously developed software (PDS). Section 4.2, “Evaluation of the Commercial Grade Dedication of the Common Q Platform”, of the Safety Evaluation within Reference 12, as listed in Section 9 of the Safety I&C System technical report, identifies the evaluation of the commercial-grade dedication performed on the PDS and identifies the NRC staff’s acceptance as an acceptable program.

   The application automatic self-checking functions are part of the application software and are developed using the software life cycle process defined in the Software Program Manual technical report.

3. As stated in Responses 1 and 2 above, the self-testing and self-diagnostic functions are part of the AC160 base software. The testing and validation for those functions are provided in the Common Q Topical Report. RAI 301-8280 07.01-44 has been submitted by the applicant; the response adds ITAAC Item 24 in DCD Tier 1, Sections 2.5.1, 2.5.3, and 2.5.4, and Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, which ensure the safety grade protection systems are installed in accordance with the dedicated process of commercial grade hardware and software.

4. Item 13 of Section 2.5.1.1 and Table 2.5.1-5, and Item 10 of Section 2.5.4.1 and Table 2.5.4-4 in DCD Tier 1 are provided to ensure system integrity is maintained during such events as a loss of power or component failure.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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

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Question No. 07-2

Clarify whether automated self-testing/self-monitoring features in APR1400 I&C systems is being credited in the Technical Specifications in lieu of performing periodic surveillance testing.

As required in 10 CFR 50.55a(h)(3), IEEE Std. 603-1991, Clause 5.7, states, in part, that capability for testing and calibration of safety system equipment shall be provided while retaining the capability of the safety systems to accomplish their safety functions. In the Technical Specification Bases, Section B 3.3.1 for reactor protection system (RPS) Instrumentation, states, in part, that channel functional test surveillance requirement (SR) 3.3.1.10 for the core protection calculator system (CPCS) testing frequency will be 18 months and the basis for the 18-month frequency is the CPCs perform a continuous self-monitoring function that eliminates the need for more frequent testing. This section also states the channel functional test essentially validates self-monitoring function and checks for, "....a small set of failure modes that are undetectable by the self-monitoring function." This would imply that automated fault detection features are being used to justify a lowered frequency of surveillance testing for the CPCs but there is no technical basis provided for why this is an acceptable approach, such as tying the bases to the CPCS watchdog timer implementation shown in Figure 4-11 in Technical Report APR1400-Z-J-NR-14001-P, Rev.0, "Safety I&C System." In addition, APR1400-Z-J-NR-14001-P, Rev.0, Section A.5.7, "Capability for Test and Calibration," states, in part, that diagnostics functions check hardware integrity through CRC checksum comparison but does not specifically state that memory containing the self-testing software is verified by this functionality.

1. Clarify whether the applicant is actually crediting automated self-testing/self-monitoring features to reduce maintenance/surveillance frequencies for any I&C components or systems?

If so, identify the specific I&C systems/components and the maintenance/surveillance activities that are reduced in frequency due to the presence of automated self-testing/self-monitoring features.

2. For the self-testing/self-monitoring features being credited for testing in lieu of periodic surveillance testing, identify these functions, what purpose they achieve, their limitations, and the basis for why this is an acceptable approach. In other words, describe the degree of self- testing coverage for potential failures and why using the self-testing in lieu of periodic surveillance testing provides as good or better identification and resolution I&C system failures.

3. How does the applicant intend to periodically verify the self-testing feature functionality per the guidance in Branch Technical Position (BTP) 7-17? Would the self-testing features be verified in conjunction with other forms of periodic testing? Does the safety I&C system memory containing the self-testing features have its integrity verified by CRC checks?

4. Does the APR1400 have any failure modes that are identifiable but undetectable?

5. What specific failure modes are undetectable by the self-monitoring functions? Are these failures detectable through other forms of testing?

6. What I&C components in the Technical Specifications do not have automated self-testing/self-diagnostic capabilities and can only be verified through periodic testing?

Response

1. The plant protection system (PPS) does not credit the automated self-testing or self-monitoring features to reduce maintenance/surveillance frequencies. The self-testing and self-monitoring features for the PPS platform are used to maintain the integrity of the system and provide the operator with its status during power operation.

   However, the core protection calculator system (CPCS) credits the continuous self-monitoring features. Surveillance Requirement (SR) 3.3.1.10 of the APR1400 Technical Specifications is the same as SR 3.3.1.11 of NUREG 1432, “Standard Technical Specifications Combustion Engineering Plants,” Revision 4, Volume 2, “Bases” and states:

   > “The basis for the [18] month Frequency is that the CPCs perform a continuous self-monitoring function that eliminates the need for frequent CHANNEL FUNCTIONAL TESTS. This CHANNEL FUNCTIONAL TEST essentially validates the self-monitoring function and checks for a small set of failure modes that are undetectable by the self-monitoring function. Operating experience has shown that undetected CPC or CEAC failures do not occur in any given [18] month interval.”

   The CPCS calculates the departure from nucleate boiling ratio (DNBR) and the local power density (LPD) based on plant inputs. If there is a failure within the calculator, this failure will produce an effect on the values of DNBR and LPD. The values of the DNBR

and the LPD are monitored by the operator and compared with the values determined by the other channels. The operator checks the values of the DNBR and the LPD according to the Technical Specification SR 3.3.1.1, “Perform CHANNEL CHECK of each RPS instrument channel” every 12 hours. If there is a difference between the values of the DNBR and the LPD of each channel, it will be alarmed to the operator. The continuous self-monitoring function which is described in Technical Specifications SR 3.3.1.11 of NUREG 1432 Volume 2 includes monitoring the values of the DNBR and the LPD since these tasks are part of the channel functional test. Therefore, most failures will be detected by the continuous self-monitoring function. All combinations of the inputs to the CPCS are simulated by the system, in accordance with the safety analysis, and the results are verified by the acceptance criteria every 18 months.

Nevertheless, the major trip functions of the CPCS are tested by SR 3.3.1.7 every 31 days. The trip path for the DNBR and the LPD is tested by simple simulated inputs and the results are verified by the acceptance criteria every 31 days.

2. For the PPS, there is no self-testing or self-monitoring feature being credited for testing in lieu of the periodic surveillance testing.

   For the CPCS, there is no self-testing feature being credited for testing in lieu of the periodic surveillance testing; however, there are self-monitoring features being credited by Channel Check for the DNBR and the LPD, as described in the Technical Specification of SR 3.3.1.1. The self-monitoring features being used in the CPCS are the DNBR and the LPD trip algorithms themselves, which are classified as Safety Critical software. Please see the details for self-monitoring features in response to Item 1 of this question. These features will be designed, implemented, verified, and validated under the software life-cycle process described in the Software Program Manual technical report.

3. Response to “*<u>How does the applicant intend to periodically verify the self-testing feature functionality per the guidance in Branch Technical Position (BTP) 7-17?</u>*”
   ➔
   Subsection 4.1.1.3.6 of the Safety Evaluation, attached to Common Qualified Platform Topical Report, states, “On the basis of the review in Subsection 4.1.1.3, the NRC staff concludes that the self-testing features of the AC160 system adequately support the self-test issues identified in BTP 7-17.” The Software Program Manual technical report identifies the same software life cycle phases and addresses the same basic elements as the Common Q Software Program Manual.

   Response to “*<u>Would the self-testing features be verified in conjunction with other forms of periodic testing?</u>*”
   ➔
   The provisions for periodic manual surveillance testing include a set of overlap tests which cover the trip path from sensor input to the reactor trip switchgear system (RTSS) or engineered safety features (ESF) actuation device. The overlap tests replace the actual input or calculated signals with test signals which follow the same signal path as the input or calculated signals. Failures detected by the AC160 diagnostics (e.g. hardware module failures, software corruption, communication interface connections) will result in a failure of the associated surveillance test. Therefore, the manual surveillance testing provides an

additional verification of the error conditions which are detected by the AC160 module self-diagnostics (which are described in Section 5.4.1 of the Common Qualified Platform Topical Report).

Response to "*Does the safety I&C system memory containing the self-testing features have its integrity verified by CRC checks?*"

➔

The AC160 module self-diagnostics (provided by previously developed software (PDS)) are qualified for use via commercial-grade dedication. Refer to Sections 2.1, 2.2 and 2.4 of the Common Qualified Platform Topical Report. The application software (which includes the application automatic self-checking features and the provisions for periodic manual surveillance testing) is developed using the software life cycle process defined in the Software Program Manual technical report. The integrity of the memory containing all of the diagnostics, self-checking features, and provisions for periodic manual surveillance testing is verified by CRC checks.

4. Failures which are not detected by the AC160 diagnostics are failures of components which are not part of the Common Qualified Platform described in the Common Qualified Platform Topical Report. This typically includes mechanical failures of input/output components (e.g. sensors, contacts, interposing relays, circuit breakers, etc.), failures of man-machine interface components (e.g. displays, keyboards), and failures associated with the power distribution system. Failures of some of the input and output components can be detected during surveillance testing or are identified by application self-check features (e.g. comparison of input values.)

   For the failures not detected by automatic self-test functions (i.e. self-contained diagnostics or self-check features) or periodic surveillance testing, other indications are identified in DCD Tier 2 Tables 7.2-7 and 7.3-8 (e.g. occurrence of unexpected pretrip/trip conditions, indication of invalid plant status data, presence of spurious alarms, inoperable displays, etc.) which can be observed by maintenance and operations personnel. In addition, failures associated with the power distribution system can be identified during periodic maintenance of the power supply systems and by observation of power supply status.

5. As provided in Response 4 of this RAI, failures which are not detected by the AC160 self-monitoring functions or diagnostics are failures of components which are not part of the Common Qualified Platform as described in the Common Qualified Platform Technical Report. The failure detection provided by the automatic self-test functions (i.e., AC160 module self-diagnostics and application automatic self-check features) is further supplemented by the provisions provided for periodic surveillance testing.

   DCD Tier 2 Table 7.2-7, "Failure Modes and Effects Analysis for the PPS" and Table 7.3-8, "Failure Modes and Effects Analysis for the ESF-CCS" provide the results of the system-level analysis. The "Method of Detection" field identifies failures that are detectable by execution of periodic sur\veillance tests.

6. For the PPS, CPCS, and RTSS, the operability of the reactor trip initiation circuit and the reactor trip circuit breaker is only tested via the manual periodic surveillance testing. Also,

the functional integrity of the PPS and the CPCS is tested only via manual periodic surveillance testing.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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

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Question No. 07-19

Address potential discrepancies in equipment qualification information for safety I&C systems in the APR1400 FSAR.

10 CFR 50.55a(h)(3) requires compliance with IEEE Std. 603-1991. IEEE Std. 603-1991, Clause 5.4, states, in part, that safety system equipment shall be qualified to substantiate that it be capable of continuously meeting performance requirements as specified in the design basis. SRP Section 7.1-C states, in part, that lightning protection should be addressed as part of the electromagnetic compatibility (EMC) review and conforms to the guidance of Regulatory Guide (RG) 1.204, "Guidelines for Lightning Protection of Nuclear Power Plants.

Section 3.4.22 of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, "Safety I&C System" states the safety system I&C design complies with the guidance of RG 1.204. APR1400 FSAR Tier 2, Table 7.1-1, describes the applicability of regulations and guidance the safety and non-safety I&C systems of the APR1400 design. RG 1.204 is listed on this table, but the applicant does not state that this document applies to any I&C systems (it refers to Chapter 8 of the DCD). APR1400 FSAR Tier 1, Table 2.5.1-5, for example, has an ITAAC Item for EMC compliance, but does not incorporate lightning protection, nor does any other item on this table.

APR1400 FSAR Tier 2, Table 7.1-1, does not include 10 CFR 50.49 as part of the applicable requirements for the safety I&C systems and is not actually listed on this table. Appendix Section C.5 of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, states that, with regard to DI&C-ISG-04 compliance to applicable aspects of the safety I&C design to 10 CFR 50.49, refer to Reference 12 of this technical report. Reference 12 is WCAP-16097-P-A, "Common Qualified Platform Topical Report," Rev. 3. This document has not been incorporated by reference into the APR1400 DCD in Section 1.6.

1. Verify that design attributes with regard to lightning protection for the safety I&C systems are accounted for with the APR1400 FSAR Tier 1 ITAAC. If such information is already in Tier 1, point out where this information is captured.

2. Explain the discrepancy between APR1400 FSAR Tier 2, Table 7.1-1, and Section 3.4.22 of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, "Safety I&C System," regarding conformance with the guidance of RG 1.204.

3. Provide an explanation for why 10 CFR 50.49 is not included as an applicable requirement on APR1400 FSAR Tier 2, Table 7.1-1.

4. Does APR1400 FSAR Tier 1, Table 2.5.1-5, Item 19, provide testing and verification of the safety I&C cabinets HVAC systems such as cooling fans, etc.?

Response

1. Section B, "Discussion", of NRC RG 1.204 identifies IEEE Std. 1050-1996 as describing design and installation practices regarding grounding methods for generating station I&C equipment. Accordingly, DCD Tier 2 Section 7.1.2.56 will be updated to state that the I&C systems comply with IEEE Std. 1050-1996, as endorsed by NRC RG 1.204. Also, IEEE Std. 1050-1996 will be added in DCD Tier 2 Section 7.1.5.

   As the Safety I&C System technical report, Section 3.4.22, "Guidelines for Lightning Protection of Nuclear Power Plants," states that the safety I&C system equipment is designed to comply with the guidance of RG 1.204, the "I&C System" columns in DCD Tier 2 Table 7.1-1 item 56 will be checked for requirement applicability.

   Item 2 in DCD Tier 1 Section 2.5.1.1 and Table 2.5.1-5 will include the lightning strikes condition to indicate that the Class 1E equipment identified in Table 2.5.1-1 are to be able to withstand lightning strikes, electrical surge, electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD).

2. The "I&C System" columns in DCD Tier 2 Table 7.1-1 item 56 will be checked for requirement applicability to be consistent with Section 3.4.22 of the Safety I&C System technical report. Both Table 7.1-1 Item 56 of DCD Tier 2 and Section 3.4.22 of the Safety I&C System technical report indicates the details are described in DCD Tier 2 Chapter 8.

3. Table 7.1-1 of DCD Tier 2 is exclusively based on Item 1, "10 CFR Parts 50 and 52" in Table 7-1 of NUREG-0800 Standard Review Plan, Rev. 5. This table does not include 10 CFR 50.49. Also, Section 3.1 of the Safety I&C System technical report describes that the criterion of 10 CFR 50.49 is not applicable since the safety I&C system is installed in a mild environment.

4. The PPS cabinets listed in Table 2.5.1-1 of DCD Tier 1 include all the components inside the cabinets. Therefore, the components, such as safety I&C cabinets cooling fans, are included for the testing and verification described in Item 19 of Table 2.5.1-5 in DCD Tier 1.

Impact on DCD

DCD Tier 1, Section 2.5.1.1 and Table 2.5.1-5, and Tier 2, Table 7.1-1, and Sections 7.1.2.56 and 7.1.5 will be revised, as indicated in the attachment 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

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

2.5 Instrumentation and Control

2.5.1 Reactor Trip System and Engineered Safety Features Initiation

2.5.1.1 Design Description

The reactor trip system (RTS) consists of four channels of sensors, auxiliary process cabinet-safety (APC-S) cabinets, ex-core neutron flux monitoring system (ENFMS) cabinets, and four divisions of core protection calculator system (CPCS) cabinets, the reactor protection system (RPS) portion of plant protection system (PPS) cabinets, and reactor trip switchgear system (RTSS) cabinets.

The engineered safety features (ESF) system consists of four sensors, APC-S cabinets, and four divisions of the engineered safety features actuation system (ESFAS) portion of the PPS cabinets and engineered safety feature-component control system (ESF-CCS) cabinets. The ESF initiation is performed in sensors, APC-S cabinets and the ESFAS portion of the PPS cabinets.

The Subsection 2.5.1 describes the RTS and ESF initiation. The ESF-CCS is described in Subsection 2.5.4.

The RTS and ESF initiation equipment is located in the auxiliary building and reactor containment building.

The operator module (OM), the maintenance and test panel (MTP), and the interface and test processor (ITP) which are part of the safety I&C system, provide monitoring and testing for the safety-related plant components and instrumentation.

The RTS and ESF initiation is designed as follows:

1. The seismic Category I equipment, identified in Table 2.5.1-1 withstand seismic design basis loads without loss of safety function.

   lightning strikes,

2. The Class 1E equipment identified in Table 2.5.1-1 withstand the electrical surge, electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.

Table 2.5.1-5 (1 of 10)

Reactor Trip System and Engineered Safety Features Initiation ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The seismic Category I equipment, identified in Table 2.5.1-1 withstand seismic design basis loads without loss of safety function.	1.a Inspections will be performed to verify that the as-built seismic Category I equipment identified in Table 2.5.1-1 is located in a seismic Category I structure.	1.a The as-built seismic Category I equipment identified in Table 2.5.1-1 is located in a seismic Category I structure.
	1.b Type tests, analyses, or a combination of type tests and analyses of seismic Category I equipment identified in Table 2.5.1-1 will be performed.	1.b A report exists and concludes that the seismic Category I equipment identified in Table 2.5.1-1 can withstand seismic design basis loads without loss of safety function.
	1.c Inspections and analyses will be performed to verify the as-built seismic Category I equipment identified in Table 2.5.1-1, including anchorages, is seismically bounded by the tested or analyzed conditions.	1.c A report exists and concludes that the as-built seismic Category I equipment identified in Table 2.5.1-1, including anchorages, is seismically bounded by the tested or analyzed conditions.
2. The Class 1E equipment identified in Table 2.5.1-1 withstand the electrical surge, electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.	2.a Type tests, analyses, or a combination of type tests and analyses will be performed.	2.a A report exists and concludes that the Class 1E equipment identified in Table 2.5.1-1 can withstand the electrical surge, EMI, RFI, and ESD conditions that would exist before, during, and following a design basis accident without loss of its safety function, for the time required to perform the safety function.
	2.b Inspection and analysis will be performed on the as-built Class 1E equipment identified in Table 2.5.1-1.	2.b The as-built Class 1E equipment and the associated wiring, cables, and terminations identified in Table 2.5.1-1 are bounded by type tests or a combination of type tests and analyses.

lightning strikes,

guidance specified in NRC RG 1.180. The equipment qualification plan is described in Section 6 of the Safety I&C System Technical Report.

7.1.2.55 Conformance with NRC RG 1.189

The I&C systems that are applicable to NRC RG 1.189 (Reference 55), as shown in Table 7.1-1, are designed in accordance with NRC RG 1.189. The details of the conformance with NRC RG 1.189 are provided in Chapter 9.

7.1.2.56 Conformance with NRC RG 1.204

comply with IEEE Std. 1050 (Reference 79), as endorsed by NRC RG 1.204.

The I&C systems that are applicable to NRC RG 1.204 (Reference 56), as shown in Table 7.1-1, ~~are designed in accordance with NRC RG 1.204~~. The details of the conformance with NRC RG 1.204 are provided in Chapter 8.

7.1.2.57 Conformance with NRC RG 1.206

The APR1400 DCD including referenced technical reports is prepared in accordance with the guidance of NRC RG 1.206 (Reference 57) together with NUREG-0800 in order for NRC to evaluate and confirm the safety evaluation.

7.1.2.58 Conformance with BTP 7-1

The I&C systems that are applicable to BTP 7-1 (Reference 58), as shown in Table 7.1-1, are designed in accordance with BTP 7-1.

7.1.2.59 Conformance with BTP 7-2

The I&C systems that are applicable to BTP 7-2 (Reference 59), as shown in Table 7.1-1, are designed in accordance with BTP 7-2.

69. NUREG-0800, Standard Review Plan, BTP 7-13, "Guidance on Cross-Calibration of Protection System Resistance Temperature Detectors," Rev. 5, U.S. Nuclear Regulatory Commission, March 2007.

70. NUREG-0800, Standard Review Plan, BTP 7-14, "Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems," Rev. 5, U.S. Nuclear Regulatory Commission, March 2007.

71. NUREG-0800, Standard Review Plan, BTP 7-17, "Guidance on Self-Test and Surveillance Test Provisions," Rev. 5, U.S. Nuclear Regulatory Commission, March 2007.

72. NUREG-0800, Standard Review Plan, BTP 7-18, "Guidance on the Use of Programmable Logic Controllers in Digital Computer-Based Instrumentation and Control Systems," Rev. 5, U.S. Nuclear Regulatory Commission, March 2007.

73. NUREG-0800, Standard Review Plan, BTP 7-19, "Guidance for Evaluation of Diversity and Defense-In-Depth in Digital Computer-Based Instrumentation and Control Systems," Rev. 6, U.S. Nuclear Regulatory Commission, July 2012.

74. NUREG-0800, Standard Review Plan, BTP 7-21, "Guidance on Digital Computer Real-Time Performance," Rev. 5, U.S. Nuclear Regulatory Commission, March 2007.

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

76. DI&C-ISG-04, Rev. 1, "Highly Integrated Control Rooms – Communications Issues (HICRc)," U.S. Nuclear Regulatory Commission, 2009.

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

78. NUREG-0737, Supplement No. 1, "Clarification of TMI Action Plan Requirements: Requirements for Emergency Response Capability," U.S. Nuclear Regulatory Commission, 1983.

79. IEEE Std. 1050-1996, "IEEE Guide for Instrumentation Control Equipment Grounding in Generating Stations," Institute of Electrical and Electronic Engineers, 1996.

Table 7.1-1 (4 of 6)

Applicable Criteria		Title	I&C System							Section in APR1400 DCD
			RTS	ESF System	QIAS-P	QIAS-N	PCS	P-CCS	DAS	
47	NRC RG 1.168	Verification, Validation, Reviews and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
48	NRC RG 1.169	Configuration Management Plans for Digital Computer Software Used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
49	NRC RG 1.170	Software Test Documentation for Digital Computer Software Used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
50	NRC RG 1.171	Software Unit Testing for Digital Computer Software Used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
51	NRC RG 1.172	Software Requirements Specifications for Digital Computer Software Used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
52	NRC RG 1.173	Developing Software Life Cycle Processes for Digital Computer Software used in Safety Systems of Nuclear Power Plants	×	×	×					7.2, 7.3, 7.5, 7.9
53	NRC RG 1.180	Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems	×	×	×					7.2, 7.3, 7.4, 7.5, 7.6, 7.9
54	NRC RG 1.189	Fire Protection for Nuclear Power Plants								Refer to Chapter 9 (Subsection 9.5.1)
55	NRC RG 1.200	An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities								See BTP 7-12 for applicability
56	NRC RG 1.204	Guidelines for Lightning Protection of Nuclear Power Plants	X	X	X	X	X	X	X	Refer to Chapter 8 (Subsection 8.3.1.1.8)

"Add"