KHNPDCDRAIsPEm Resource

From:	Ciocco, Jeff
Sent:	Monday, November 30, 2015 1:05 PM
To:	apr1400rai@khnp.co.kr; KHNPDCDRAIsPEm Resource; Harry (Hyun Seung) Chang; Andy Jiyong Oh; Erin Wisler
Cc:	Zhao, Jack; Jackson, Terry; Ward, William; Lee, Samuel
Subject:	APR1400 Design Certification Application RAI 323-8281 (07.03 - Engineered Safety Features Systems)
Attachments:	APR1400 DC RAI 323 ICE 8281.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, the following response times for the RAI questions. We may adjust the schedule accordingly.

07.03-6: 90 days
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Jeff Ciocco
New Nuclear Reactor Licensing
301.415.6391
jeff.ciocco@nrc.gov

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From: Ciocco, Jeff

Created By: Jeff.Ciocco@nrc.gov

Recipients:
"Zhao, Jack" <Jack.Zhao@nrc.gov>
Tracking Status: None
"Jackson, Terry" <Terry.Jackson@nrc.gov>
Tracking Status: None
"Ward, William" <William.Ward@nrc.gov>
Tracking Status: None
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"apr1400rai@khnp.co.kr" <apr1400rai@khnp.co.kr>
Tracking Status: None
"KHNPDCDRAIsPEm Resource" <KHNPDCDRAIsPEm.Resource@nrc.gov>
Tracking Status: None
"Harry (Hyun Seung) Chang" <hyunseung.chang@gmail.com>
Tracking Status: None
"Andy Jiyong Oh" <jiyong.oh5@gmail.com>
Tracking Status: None
"Erin Wisler " <erin.wisler@aecom.com>
Tracking Status: None

Post Office: HQPWMSMRS07.nrc.gov

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REQUEST FOR ADDITIONAL INFORMATION 323-8281

Issue Date: 11/30/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 07.03 - Engineered Safety Features Systems
Application Section:

QUESTIONS

07.03-6

Provide justification for using one-out-of-two logic for some engineered safety features (ESF) control systems proposed in the APR1400 design.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603–1991 and the correction sheet dated January 30, 1995.” IEEE Std. 603-1991, Clause 6.7, requires, in part, that capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During such operation, the sense and command features shall continue to meet the requirements of Clauses 5.1 and 6.3. EXCEPTION: One-out-of-two portions of the sense and command features are not required to meet Clauses 5.1 and 6.3 when one portion is rendered inoperable, provided that acceptable reliability of equipment operation is otherwise demonstrated.

There is an exception taken in APR1400 FSAR Tier 2, Section 7.3.1.3, for the balance of plant (BOP) ESF actuation system (ESFAS) function to use one-out-of-two logic, but the staff could not identify the justification for using this exception. Provide the necessary design information to justify this exception.

07.03-7

Describe how the voting logic for both reactor trip and engineered safety features systems in the APR1400 design will be automatically changed when one channel identifies a single failure and a second channel is in maintenance bypass. Also describe where the maintenance bypass mode will be set and reset for a channel.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603–1991 and the correction sheet dated January 30, 1995.” IEEE Std. 603-1991, Clause 6.7 requires, in part, that capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During such operation, the sense and command features shall continue to meet the requirements of Clauses 5.1 and 6.3.

APR1400 FSAR Tier 2, Sections 7.2 and 7.3, and Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” identify two-out-of-four coincidence logic for safety I&C systems would be changed to a two-out-of-three control logic if one channel is tripped. However, there is lack of design information describing how the coincidence voting logic will be modified to meet the above regulatory requirements for both reactor trip and engineered safety features systems in the APR1400 design when one channel is in a maintenance mode and at the same time another channel is tripped. Also it is not clear in the application where the bypass mode will be set and reset for a channel. Describe how the voting logic would be altered for all reactor trip and ESF functions for cases of single failure, maintenance bypass,

and both simultaneously. In addition, provide design information on where the maintenance bypass mode will be set and reset for a channel.

07.03-8

Provide design information and clarification on quality for safety-related display panels, such as ESF-CCS soft control modules (ESCM), qualified indication and alarm system-P (QIAS-P), and operator module (OM).

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” IEEE Std. 603-1991, Clause 5.3, requires components and modules to be of a quality that is consistent with minimum maintenance requirements and low failure rates.

Section 8 of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” states the Common-Q platform, which includes the flat panel display system, will be used for the safety I&C system of the APR1400 design. However, there is lack of information in the APR1400 application on whether the flat panel display system in the Common-Q will be used for the above mentioned ESCM, QIAS-P and OM or not. In addition, there are a few types of qualified flat display panels in the Common-Q platform, but, it is not clear in the APR1400 application which qualified display panels will be adopted for the above safety-related display panels in the APR1400 safety I&C system. Identify the flat-panel displays that will be used to implement the ESCM, QIAS-P, and OM and how Clause 5.3, "Quality," of IEEE Std. 603-1991 are met for these displays.

07.03-9

Clarify whether the ITAAC associated with equipment quality or qualification in APR1400 FSAR Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, include the Class 1E equipment in the scope of the Common-Q platform which will be used for the APR1400 system. Also, clarify whether type tests, analyses, or a combination of type test and analyses will be performed again for those types of Class 1E Common-Q equipment for plant-specific conditions or the qualification of the approved Common-Q platform will be credited during the closure stage of ITAAC.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” IEEE Std. 603-1991, Clause 5.4, requires safety system equipment be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis.

ITAAC associated with equipment quality or qualification in APR1400 FSAR Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-4, state, in part, that type tests, analyses, or a combination of type test and analyses will be performed for Class 1E equipment. Clarify whether the above ITAAC items include all Class 1E equipment in the scope of the Common-Q platform; whether type tests, analyses, or a combination of type test and analyses will be re-performed for all those types of Class 1E Common-Q equipment; and whether the qualification in the approved Common-Q platform will be credited for the APR1400 safety I&C system during the stage of ITAAC closure. Update the APR1400 FSAR Tier 1 and 2 accordingly.

07.03-10

Clarify how both minimum inventory (MI) system-level and component-level manual switches are implemented in the ESF-CCS system for the APR1400 design.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that the information provided for the design basis items, taken alone and in combination, should have one and only one interpretation.

As shown in Figure 7.3-1 in APR1400 FSAR Tier 2, Section 7.3, both system-level and component-level MI manual switches are connected to the same control panel multiplexer (CPM) in the same way without any differentiation. Figure 4-13 in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, Safety I&C System shows MI switches connected to the CPM. Clarify whether both system-level and component-level MI manual switches are implemented in the same way for the ESF systems. Provide a consistent illustration of the same functions among various diagrams.

07.03-11

Provide design information on how the safety-related containment spray actuation signal (CSAS) is used in the four-channel safety I&C system to actuate the two trains of the containment spray system (CSS) and two shutdown cooling pumps.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that information provided for each design basis item should be sufficient to enable the detailed design of the I&C system to be carried out, and all functional requirements for the I&C system and the operational environment for the I&C system should be described.

The logic diagram in Figure 7.3-5, "ESFAS Functional Logic (CSAS)," of APR1400 FSAR Tier 2 shows four divisions for the CSAS safety function. However, there are only two containment spray pumps used for the two containment spray trains, respectively. It is not clear in Section 7.3, "Engineered Safety Features Systems," of APR1400 FSAR Tier 2 how the two containment spray pumps are controlled. In addition, there is no design information in Section 7.3 of APR1400 FSAR Tier 2 on how the two shutdown cooling pumps will be controlled. Describe the control and interface of the containment spray and shutdown cooling pumps in relation to the safety-related I&C systems.

07.03-12

Provide design information on how the control functions are implemented for auxiliary safety systems to support safe shutdown functions, including essential service water system (ESWS), component cooling water system (CCWS), essential chilled water system (ECWS), Class 1E power system, and the heating, ventilation, and air conditioning (HVAC) system.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 5.12, "Auxiliary Features," of IEEE Std. 603-1991 requires auxiliary supporting features meet all requirements of IEEE Std. 603-1991, and Clause 8.1, "Electrical Power Sources," requires those portions of the Class 1E power system that are required to provide the power to the many facets of the safety system are governed by the criteria of IEEE Std. 603-1991.

The staff was not able to identify in Chapter 7 of APR1400 FSAR Tier 2 on how the control functions are implemented for auxiliary systems that support safe shutdown functions, such as ESWS, CCWS, ECWS, Class 1E power system, and HVAC system. Provide adequate design information accordingly in the application on how the control functions for those auxiliary systems are implemented to support the safe shutdown systems. In addition, describe the impact of the loss of HVAC for the safety-related I&C equipment and any mitigating measures to address such loss. This would include the amount of time for I&C equipment to fail due to rising temperatures.

07.03-13

Provide design information on how the signals from the non-safety-related diagnostic section of the component interface module (CIM) will not interfere with the safety functions of the ESF-CCS loop controllers.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 5.6.3, "[Independence] Between Safety Systems and Effects of Design Basis Event," of IEEE Std. 603-1991 requires the safety system design be such that credible failures in and consequential actions by other systems shall not prevent the safety systems from meeting the requirements of this standard.

Figure 4.2-1, "Overview Diagram of the CIM," of Technical Report APR1400-E-J-NR-14001-P, Rev. 0, “Component Interface Module,” identifies that signals from the diagnostic section of the CIM are inputs to the safety-related ESF-CCS loop controller. These diagnostic functions are non-safety related. Describe the measures taken to prevent those non-safety diagnostic signals from interfering with the safety functions of the ESF-CCS loop controllers.

07.03-14

Describe how safety-related modulating control functions are implemented for the ESF components.

10 CFR 50.55a(h)(3) states “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 5.2, "Completion of Protective Action," of IEEE 603-1991 requires safety systems be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion.

Figure 7.3-1, "Simplified Functional Diagram of the ESF-CCS," in APR1400 FSAR Tier 2, Section 7.3, and Figure 4-13, "ESF-CCS Functional Configuration," in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” illustrate the CIM being used to actuate all ESF components without

differentiation between on-off and modulating ESF components. Figure 5.3-1, "Priority Logic Configuration in the CIM for the APR1400," of Technical Report APR1400-E-J-NR-14001-P, Rev. 0, “Component Interface Module,” shows discrete inputs only to the priority logic section of the CIM for the ESF components. In the APR1400 application there is lack of design information on how safety-related control functions are implemented in the ESF-CCS system for ESF modulating components. Provide a clear description on how modulating control functions for certain ESF components are accomplished and update the technical report and FSAR figures and descriptions accordingly.

07.03-15

Provide logic tables for L-R memory and S-R memory and legends for symbols used in diagrams for the safety I&C diagrams in the APR1400 design.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that information provided for each design basis item should be sufficient to enable the detailed design of the I&C system to be carried out, and all functional requirements for the I&C system and the operational environment for the I&C system should be described.

The L-R (latch-reset) memory and S-R (set-reset) memory are used extensively in the safety I&C systems of the APR1400, but the logic associated with setting and resetting the memories is not clear. Provide truth tables, signal diagrams, or other logic-based means to demonstrate the operation of the L-R memory and S-R memory in Figure 7.1-2, "Symbol & Legend Diagram ,"of APR1400 FSAR Tier 2 for all possible signal combinations. In addition, some symbols used in safety I&C diagrams in the APR1400 application are not included in Figure 7.1-2. Include a legend in Figure 7.1-2 for all symbols used in safety I&C diagrams in the APR1400 application.

07.03-16

Provide necessary design information to clarify the inputs of component control logic for the ESF systems in Figure 4-15, "Simplified Component Control Logic," in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System.” Also provide design information on how each specific component control logic given in Section 7.3.1.4, "Component Control Logic," of APR1400 FSAR Tier 2 are used with logic shown in the above Figure 4-15.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that information provided for each design basis item should be sufficient to enable the detailed design of the I&C system to be carried out, and all functional requirements for the I&C system and the operational environment for the I&C system should be described.

Figure 4-15 in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System”, shows the simplified component control logic for ESF components. However, there is lack of definition or descriptive information in the APR1400 application for some logic inputs showing in the above diagram, such as process control (auto start), auxiliary stop, etc. Provide definition and functional description of logic inputs shown in Figure 4-15 which are not included in the application. Section 7.3.1.4 and its related component logic diagrams (CLD) in Figures 7.3-12 to 7.3.20 of APR1400 FSAR Tier 2 show the actuation logic for each type of ESF components. But, there is lack of design information on what relationship exists

between those CLD figures and Figure 4-15 in the above Technical Report. Describe how each specific type of component logic diagram given in Section 7.3.1.4 of APR1400 FSAR Tier 2 is to be applied together with Figure 4.15 in the Safety I&C Technical Report.

07.03-17

Provide consistent and clear design information for various manual control switches used for the ESF functions. Also provide description of credited safety functions of those manual switches and location of local and remote manual commands.

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that the information provided for the design basis items, taken alone and in combination, should have one and only one interpretation. 10 CFR 50.55a(h), “Protection and Safety Systems,” 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.

Figure 7.3-1, "Simplified Functional Diagram of the ESF-CCS," in APR1400 FSAR Tier 2, Section 7.3, illustrates minimum inventory (MI) system-level and component level manual switches. Figure 4-28, "ESF Control Block Diagram," in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” shows the MI switches only. Figure 4-13, "ESF-CCS Functional Configuration," in the same technical report shows the MI switches, ESF switches, and local manual ESF switches. Figure 7.1-1, "APR1400 I&C System Overview Architecture," in APR1400 FSAR Tier 2, Section 7.1, identifies both MI switches and ESF switches. Clarify the differences in using MI switches in the above different diagrams and provide consistent and clear indication in those figures. APR1400 FSAR Tier 2, Section 7.3, states that the MI switches are designed to provide manual controls for credited safety functions. Provide design information on what these credited safety functions are. Figure 7.3-3, "ESF-CCS Simplified Logic Diagram for 2-out-of-4 Actuation," in APR1400 FSAR Tier 2, Section 7.3 shows the local manual command and remote manual command. However, it is not clear where those manual commands originate. Provide design information on the location of the above local and remote manual remote commands.

07.03-18

Provide justification on why certain ESF commands are not latched for safety systems in the APR1400.

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 5.2, "Completion of Protective Action," in IEEE Std. 603-1991 requires safety systems to be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion.

Section 4.4.2, "Design Features," of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” mentioned that the valve logic for auxiliary feedwater actuation signals (AFAS) is not latched. Similarly, in Section 7.3.1.3, "Actuation Logic," in APR1400 FSAR Tier 2 an exception was taken

for the ESF actuation signals for the cycling portion of the AFAS. But, there is lack of justification. Provide justification and description for these ESF commands without latching functions.

07.03-19

Describe the mechanisms that will alert operators when the information flat panel display (IFPD) is malfunctioning and if the safety I&C systems, such as PPS, ESF-CCS, QIAS-P, and core protection calculator system (CPCS) are working correctly.

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 5.8.2, System Status Indication," in IEEE Std. 603-1991 requires display information to provide accurate, complete, and timely information pertinent to safety system status.

The staff was not able to identify the mechanisms that will alert operators when the IFPD, which communicates with the safety-related ESF-CCS soft control module (ESCM), is malfunctioning. In addition, the staff was not able to identify how operators are informed of the status of the safety I&C systems, such as PPS, ESF-CCS, QIAS-P, and core protection calculator system (CPCS). Provide necessary design information in the application accordingly for the staff to make reasonable findings associated with the above regulatory requirements.

07.03-20

Provide and clarify necessary design information associated with ESF-1 and ESF-2 safety command signals for the ESF components in Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System.”

10 CFR 52.47(a)(2) requires, in part, that the description of the structures, systems, and components shall be sufficient to permit understanding of the system designs and their relationship to the safety evaluations. The guidance of SRP Appendix 7.1-C, “Guidance for Evaluation of Conformance to IEEE Std. 603”, Section 4, “Safety System Designation”, states that the information provided for the design basis items, taken alone and in combination, should have one and only one interpretation.

In Section 4.4.2 of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” the ESFAS signals are generally categorized as ESF-1 and ESF-2. However, there is lack of design information in the APR1400 application regarding the identification of those ESF components associated with ESF-1 and ESF-2 safety command signals. Provide a list of components associated with ESF-1 and ESF-2 safety command signals and location in the ESF-CCS where these safety command signals are generated.

07.03-21

Describe the preferred safe states of ESF components to be controlled by both the diverse protection system (DPS) and ESF-CCS.

10 CFR 50.55a(h), “Protection and Safety Systems,” 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 safety systems be designed to accomplish their safety functions under the full range of applicable conditions enumerated in the design basis.

Section 4.4.3.4, "Component Interface Module," of Technical Report APR1400-Z-J-NR-14001-P, Rev. 0, “Safety I&C System,” and Section 5.2, "Priority Logic," of Technical Report APR1400-E-J-NR-14001-P, Rev. 0, “Component Interface Module,” identify state-based priority as applicable to the ESF-CCS and DPS signals that are input to the component interface module. However, the staff was not able to identify the preferred safe states for each ESF component that is controlled by both DPS and ESF-CCS. Provide the preferred safe state of individual ESF components controlled by both the DPS and ESF-CCS.

07.03-22

Describe how the APR1400 design meets the regulatory guidance in Branch Technical Position (BTP) 7-2, "Guidance on Requirements on Motor-Operated Valves in the Emergency Core Cooling System Accumulator Lines."

10 CFR 50.55a(h)(3) states that “Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.” Clause 6.6, "Operating Bypasses," of IEEE Std. 603-1991 requires that, "Whenever the applicable permissive conditions are not met, a safety system shall automatically prevent the activation of an operating bypass or initiate the appropriate safety function(s). If plant conditions change so that an activated operating bypass is no longer permissible, the safety system shall automatically accomplish one of the following actions: (1) Remove the appropriate active operating bypass(es); (2) Restore plant conditions so that permissive conditions once again exist; or (3) Initiate the appropriate safety function(s)."

Section 7.1.2.59, "Conformance with BTP 7-2," of APR1400 FSAR Tier 2 states the I&C systems are designed in accordance with BTP 7-2, but the staff found that there is no further design information provided in the application to substantiate the claimed conformance with regulatory guidance in BTP 7-2. Provide necessary design information or clarification on how the design of APR1400 safety I&C systems conform to the regulatory guidance in BTP 7-2.