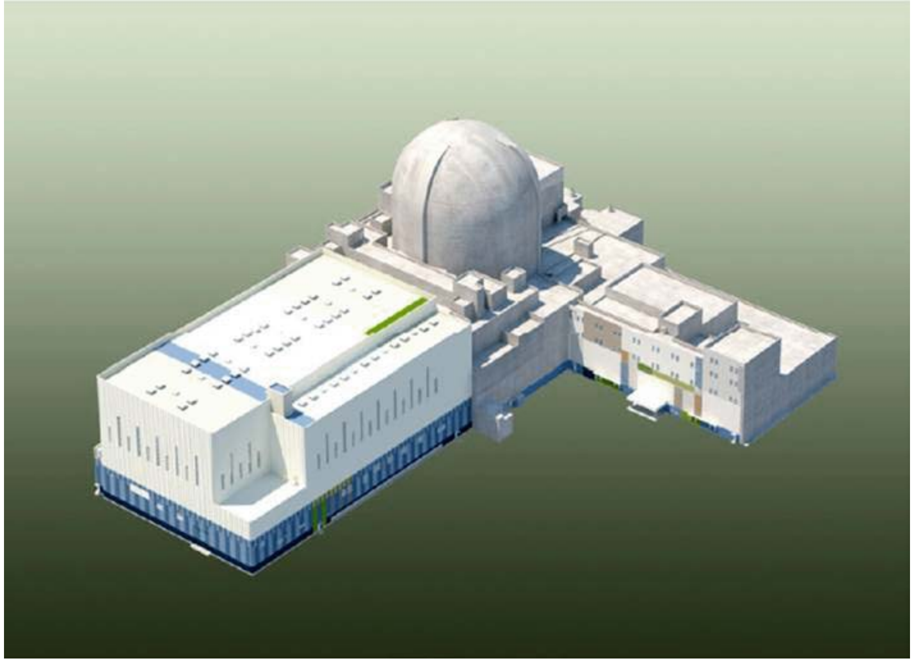
NON-PROPRIETARY

APR1400 Design Certification Review
I&C Topics



KEPCO/KHNP

May 2-3, 2016

Table of Contents

Q1 CPCS CPU Loading (1/2)

- **NRC Question**

  In RAI 43-7887, Question 7.1-25, 1) no analysis information was submitted to support the increase of the CPU loading threshold from 70% in the approved Common-Q TR and other technical sources to 75% for the APR1400 design, although one analysis done by ABB many years ago was mentioned in the response, but it was not attached. The RAI requested to 2) add a new ITAAC item for this new 75% design criterion, but, no info was included in the response for this request.

- **Response to NRC Question**

  1) Technical sources for AC160 75% CPU loads

  - **Proprietary ABB analysis and test report and other references can be accessible at WEC Rockville office.**

Q1 CPCS CPU Loading (2/2)

- **Response to NRC Question (Cont.)**
  - **2) ITAAC item for 75% CPU loading**
    - [ ]TS
      CPU load over 75% does not necessarily mean that the process module will fail.
    - **Overall channel response time is more meaningful for system's determinism. CPU load is one attribute of integrated response time characteristics.**
    - **Thus, KHNP thinks response time ITAAC for PPS and ESF-CCS intrinsically covers the CPU loading effects.**
      - **Table 2.5.1-5 Item 10, Table 2.5.4-4 Item 20**
    - **In addition, every process module continuously monitors CPU loading. When overload occurs in a CPU, an alarm is sent to the operator.**

Q2. IFPD Component Control (1/1)

- **NRC Question**

  In response to RAI 294-8302, Question 07.05-7, it states that the IFPDs are only used for non-safety components, which is not consistent with the Safety I&C System Topical Report. Is this a new change made to the APR1400 I&C architecture design? Are there any new changes to be made to the I&C architecture design?

- **Response to NRC Question**
  - **There is no change of the design features of Information Flat Panel Displays (IFPDs) in I&C architecture design.**
  - **IFPDs and ESF-CCS Soft Control Modules (ESCMs) on the operator console are used as the primary means of operation as follows:**
    - **The IFPDs are used for non-safety components controlled by the process-component control system (P-CCS) during normal, abnormal, and accident conditions.**
    - **The ESCMs are used for safety components controlled by the ESF-CCS during normal, abnormal, and accident conditions, except during a Common Cause Failure (CCF) of digital safety I&C systems.**
  - **APR1400 DCD Tier 2, Subsection 7.7.1.2 will be revised to include the information presented above.**

Q3. Setpoints between Chapter 7 and 15 (1/1)

- **NRC Question**

  Need clarification on why there are different setpoint values used in APR1400 FSAR Table 7.2-4 and Table 15.0-2.

- **Response to NRC Question**
  - **Table 15.0-2 states analytical limits**
    - **The analytical limit is a setpoint assumed in performing safety analysis.**
    - **The analytical limit does not consider safety I&C channel uncertainty.**
  - **Table 7.2-4 states trip setpoints**
    - **A trip setpoint considers safety I&C channel uncertainty, and is more conservative than the analytical limit.**
    - **When a measured process value exceeds its corresponding trip setpoint, a trip signal is initiated.**
    - **A trip setpoint is determined to ensure that a trip parameter does not exceed its analytical limit.**

Q4. Type A Variable Approach

- **(Separate Presentation)**

Q5. CEAC Inoperable PF (1/16)

- **NRC Question**
- ***For RAI 274-8277, Questions 7.1-37 and 7.1-38, the responses are not acceptable based on observations at the CPCS audit. The time delay for the pre-determined PF is not included in the safety analysis as stated in the response. The response definitions for pre-determined PF are not correct and are not consistent with the Functional Design for CPCS technical report. In addition, KHNP did not provide adequate/complete/clear responses for certain questions at the CPCS audit. KHNP should be ready to discuss these items, including the following:***

  a. ***Is there some type of methodology to determine the pre-determined PF value? If so, is it on the docket? Is this value of "8" listed in any of the APR1400 application materials (KHNP stated that they "think so" but have yet to confirm this)? What is the pre-determined PF value for Palo Verde and how is it being confirmed that it is still a valid value?***

Q5. CEAC Inoperable PF (2/16)

- **NRC Question (cont.)**
  - *b. Is confirming the validity of the pre-determined PF value throughout the fuel lifecycle/outage-to-outage completed as part of tech spec surveillance?*
  - *c. Does this pre-determined PF value ever change from new fuel insertion or from outage to outage?*
  - *d. KHNP stated that "anyone" can change the pre-determined PF at any time. What controls are in place to manage the change of this value? If so, where is this information located/identified in the APR1400 application? Where is the methodology located in the application to properly change this value?*
  - *e. KHNP stated pre-determined PF can not be too high. What is the basis for determining if a value is too high? Where is this discussed in the application?*

Q5. CEAC Inoperable PF (3/16)

- **Response to NRC Question**
  - **Each CPC channel judges the CEAC operability conditions based on the combination of the variable JINOP3 with the addressable constant CINOP.**

[ ] TS

  - **The value of JINOP3 and CINOP means:**

[ ] TS

Q5. CEAC Inoperable PF (4/16)

- **Response to NRC Question (Cont.)**
  - **For example,**

TS

[ ]

  - **For the various combinations of the JINOP3 and CINOP, each CPC channel applies the PFs to the DNBR and LPD calculations in the different manners based on the CEAC operability conditions as shown in next table.**
  - **The details are described in CPCS Functional Design Requirements (APR1400-F-C-NR-14003-P, Rev.0) Sections 4.2.4.3 and 4.2.4.4.**

Q5. CEAC Inoperable PF (5/16)

TS

Q5. CEAC Inoperable PF (6/16)

- **Response to NRC Question (Cont.)**
  - **The cases discussed in DCD Tier 2, Table 7.2-7, "Failure Mode and Effects Analysis (FMEA) for the Plant Protection System" comes from the failed status of CEACs, and thus those are related with JINOP3 not with CINOP.**

TS

Q5. CEAC Inoperable PF (7/16)

- **Response to NRC Question (Cont.)**
  - **It should be noted that there are two different expressions for two CEAC inoperable PFs in CPCS FDR;**
    - **Pre-selected PFs (PF_{MAXD} & PF_{MAXL})**
    - **Pre-determined PFs (PF_{PRD} & PF_{PRL})**
  - **Pre-selected PFs** [ ] TS
    - **These PFs are used to initiate plant trip for two CEAC fail condition.**
    - **These PFs are non-RDB constants that only can be changed by the CPCS software modification.**
  - **Pre-determined PFs** [ ] TS
    - **These PFs are used when CEAC is set to "two CEAC inoperable" mode by operator (by changing the addressable constant CINOP=3).**
    - **These PFs are RDB constants that are determined and verified every reload cycle.**

Q5. CEAC Inoperable PF (8/16)

- **Response to NRC Question (Cont.)**
  - **In KHNP response to RAI 274-8277 Questions 7.1-37 and 7.1-38, the terminology of "the pre-determined PF" has the same meaning as "the pre-selected PF" in CPCS FDR.**
  - **However, in CPCS FDR, there is also the terminology of "the pre-determined PF" which has different meaning as explained in previous Table.**

Q5. CEAC Inoperable PF (9/16)

- **Response to NRC Question (Cont.)**
  - **A time delay is considered before applying the maximum PF (PF_{MAXD} & PF_{MAXL}) when both CEACs are failed.**
  - **This time delay is not considered in the DCD Ch. 15 safety analysis.**
    - **There is no design basis event in DCD Ch. 15 that assumes the occurrence of CEA misoperation concurrent with the both CEAC failures.**
    - **In the safety analysis, the probability of CEA misoperation during the time delay is very low and the resulting consequence of fuel failure and radiological dose could be bounded by other postulated accidents in the DCD Ch. 15.**

Q5.a. CEAC Inoperable PF (10/16)

- **NRC Question**
  - *a. Is there some type of methodology to determine the pre-determined PF value? If so, is it on the docket? Is this value of "8" listed in any of the APR1400 application materials (KHNP stated that they "think so" but have yet to confirm this)? What is the pre-determined PF value for Palo Verde and how is it being confirmed that it is still a valid value?*
- **Response to NRC Question**
  - **The maximum PF for DNBR and LPD (PF_{MAXD} & PF_{MAXL}) are determined by the maximum value of static PF and Xenon PF transmitted from CEAC to CPC.**
  - **For PVNGS 1 cycle 1, these values were calculated as follows;**

TS

Q5.a. CEAC Inoperable PF (11/16)

- **Response to NRC Question (cont.)**
  - **The minimum power level used by the CPC is about 20%, thus, the effect of applying a PF of 8.0 is equivalent to a power level of 160%.**
  - **The value of 8.0 is large enough to initiate a plant trip as described in Section 2.6.4 of CEN-310-P-A, "CPC and Methodology Changes for the CPC Improvement Program", approved by NRC as follows:**
    - ***"… For all outward deviations, <u>a penalty of 8.0 will be used</u> if the deviation exceeds a preset maximum value. <u>This will cause an immediate CPC based plant trip</u> for any actual deviation not stopped by the CWP (CEA Withdrawal Prohibit). …"***

Q5.b&c. CEAC Inoperable PF (12/16)

- **NRC Question**
  - ***b. Is confirming the validity of the pre-determined PF value throughout the fuel lifecycle/outage-to-outage completed as part of tech spec surveillance?***
  - ***c. Does this pre-determined PF value ever change from new fuel insertion or from outage to outage?***

- **Response to NRC Question**
  - **The pre-selected PFs are set to 8.0 during the plant life as explained in Response A.**
  - **The pre-determined PFs are RDB constants that are determined and verified every reload cycle.**

Q5.d. CEAC Inoperable PF (13/16)

- **NRC Question**

  d. "KHNP stated that "anyone" can change the pre-determined PF at any time. What controls are in place to manage the change of this value? If so, where is this information located/identified in the APR1400 application? Where is the methodology located in the application to properly change this value?"

- **Response to NRC Question**
  - **Pre-selected PF are non-RDB constants**
    - **These can only be changed by a CPCS software change.**
    - **These cannot be changed by operators.**
  - **Pre-determined PF (same as the setpoint)**
    - **Pre-determined PF values are included in the Reload Data Block(RDB).**
    - **The RDB can be changed during the refueling period.**

Q5.d. CEAC Inoperable PF (14/16)

- **Response to NRC Question**
  - **Controls to manage the RDB**
    - **RDB values are saved in the non-volatile memory of the safety processor module (PM).**
    - **To change RDB values, the permission from the function enable key-switch must be in the enabled positon.**
    - **To change RDB values, the trip channel bypasses for the DNBR and LPD trips must be bypassed.**
    - **RDB values in the PM and MTP are secured with CRC values.**
    - **If RDB values are changed without permission, the CPCS will actuate to the fail-safe state.**
  - **Section C.5.1.3.6 of Safety I&C System TeR states;**
    - ***If CRC is changed, the processors in the CPCS will actuate as fail-safe state.***
    - ***In order to change addressable constant, keyswitch permission which is hardware Class 1E should be required to enable operator to change.***
    - ***All setpoints are saved on the non-volatile memory in the processor.***
    - ***All setpoints are monitored using CRC.***

Q5.d. CEAC Inoperable PF (15/16)

- **Response to NRC Question**
  - **Revision for terminology**
    - **There were some inconsistencies in the terms.**

	FDR	DCD Tier 2, TeR
Maximum DNBR and LPD penalty factors selected when both CEACs become inoperable due to CEACs failure or in-test	Pre-selected PF	Pre-assigned PF (DCD Tier 2) Pre-determined PF (TeR)

    - **For consistency, DCD Tier 2 and the Safety I&C System technical report will be revised as follows:**
      - **"Pre-assigned PF" and "Pre-determined PF" will be replaced with "Pre-selected PF"**
      - **The definition of "Pre-selected PF" will be provided.**
    - **Responses of RAI 274-8277-37 & 38 will be revised to apply the changes.**

Q5.e. CEAC Inoperable PF (16/16)

- **NRC Question**
  - *e.* ***KHNP stated pre-determined PF can not be too high. What is the basis for determining if a value is too high? Where is this discussed in the application?***

- **Response to NRC Question**
  - **KHNP corrects the sentence of "Pre-determined PF cannot be too high" as "Pre-determined PF need not be too high, but should be reasonably high to trip the plant ".**
  - **The pre-selected PFs are used to trip the plant when two CEACs are inoperable due to CEAC failure.**
  - **Therefore, it is necessary to set the pre-selected PF reasonably to initiate plant trip. As explained in Response A, it was concluded that a PF of 8.0 would result in a trip at any power level.**

Q6. PPS Functional Diversity (1/10)

- **NRC Question**
  1) *For RAI 43-7887, Question 7.1-15, the response states that "conformance to the requirements of IEEE Std. 603 and GDC 22 regarding functional diversity is described and provided in Sections 7.2.2.3 and 7.3.2.3 as well as in Section 4.1 of the Safety I&C System Technical Report." However, Sections 7.2.2.3 and 7.3.2.3 of the APR1400 Tier 2 FSAR only address independence and Section 4.1 of the Safety I&C System Technical Report does not discuss functional diversity.*
  2) *Section 4.2.2.1 of the Safety I&C System Technical Report does state that "Each BP processes the bistable logic in the reverse order to that of the other BP for software functional diversity." However, there was no definition provided for what is meant by "software functional diversity." Having reverse order in the different BPs does not constitute functional diversity in accordance with NUREG 6303. Further, the D3 Technical Report only discusses functional diversity between safety I&C systems and the DPS and not within the protection system design itself.*
  3) *Discuss how KHNP intends to demonstrate functional diversity within the PPS design.*

Q6. PPS Functional Diversity (2/10)

- **Response to NRC Question (1)**
  - **With regard to response to RAI 43-7887, Question 7.1-15, an additional RAI (8554) has been received and the response to this RAI will be prepared and submitted accordingly.**
  - **The response to RAI 43-7887, Question 7.1-15 states that *"functional diversity is described in Section 4.1 of the Safety I&C System technical report,"* but Section 4.2.2.1 of the Safety I&C System technical report, which contains the following description, is the appropriate section to discuss functional diversity, and will be updated as follows:**

    "Redundant PPS analog input parameters considering DBEs are assigned to each analog input module for functional diversity and minimizing (to minimize) the effects of a single failure of an analog input (AI) module, as shown in Figure 4-5."

Q6. PPS Functional Diversity (3/10)

- **Response to NRC Question (1) – (Cont.)**
  - **Each bistable processor (BP) rack within each plant protection system (PPS) division contains two separate analog input (AI) modules to achieve functional diversity as shown in Figure 4-5, "PPS Division A Trip Path Diagram" of the Safety I&C System technical report. Two or more initiating signals are identified for each design basis event in Chapter 15 of DCD Tier 2. Functional diversity is provided, as these initiating signals are separately assigned into two different AI modules.**
  - **The functional diversity is implemented to maximize the safety function by the PPS in the event of a failure of one of the two AI modules in one BP rack. If the PPS is assumed to have two trip parameters to mitigate a certain design basis event (DBE), one trip parameter input is assigned to AI1 and the other trip parameter input is assigned to AI2.**
  - **It should be noted that not every DBE is covered by two or more trip parameters. Functional diversity is considered for distributing the trip parameters in two different AI modules per DBE so that the BP in that particular BP rack can successfully perform its intended safety function.**

Q6. PPS Functional Diversity (4/10)

TS

Q6. PPS Functional Diversity (5/10)

- **Response to NRC Question (1) – (Cont.)**
  - **NUREG/CR-6303, Section 2.6.4, “Functional Diversity” states in part that two systems that are functionally diverse may have overlapping safety effects.**
  - **One BP receives one set of trip parameter inputs through AI1 and it generates the trip outputs. The same BP receives the other set of trip parameter inputs through AI2 and it generates the trip outputs, which corresponds to the overlapping safety effects from a safety perspective.**

Q6. PPS Functional Diversity (6/10)

- **Response to NRC Question (1) – (Cont.)**
  - **In summary, response to RAI 8554 will be prepared to include the correct section where '*functional diversity*' is described:**

    [Response to RAI 7887 Q07.01-15] – previously submitted

    The conformance to the requirements of IEEE Std. 603 and GDC 22 regarding independence and functional diversity is described and provided in Sections 7.2.2.3 and 7.3.2.3 as well as in Section 4.1 of Safety I&C System technical report.

    [Response to RAI 8554] – to be submitted

    The conformance to the requirements of IEEE Std. 603 regarding independence is described and provided in Sections 7.2.2.3 and 7.3.2.3. The conformance to the requirements of GDC 22 regarding independence and functional diversity is described and provided in Sections 3.2 and 4.2.2.1 of the Safety I&C System technical report.

Q6. PPS Functional Diversity (7/10)

- **Response to NRC Question (1) – (Cont.)**
  - **The submitted mark-up included in RAI 43-7887, Question 7.1-15 will be updated as follows:**

    [Mark-up] – previously submitted in RAI 43-7887, Q 7.1-15

7.1.2.24 Conformance with GDC 22

~~The I&C systems that are applicable to GDC 22, as shown in Table 7.1-1, are designed in accordance with GDC 22.~~ The protection systems comply with the independence requirements of IEEE Std. 603 except for the CEA position inputs described in Subsection 7.1.2.3.

7.1.2.25 Conformance with GDC 23

The I&C systems that are applicable to GDC 23, as shown in Table 7.1-1, are designed in accordance with GDC 23. Failure modes and effects analysis (FMEA) for protection systems is described in Subsections 7.2.3.1 and 7.3.3.1.

7.1.2.26 Conformance with GDC 24

The applicable I&C systems listed in Table 7.1−1 are designed to meet the requirement of GDC 22 as described in Subsections 7.2.2.3 and 7.3.2.3 as well as in Section 4.1 of the Safety I&C System Technical Report.

wrong

Q6. PPS Functional Diversity (8/10)

- **Response to NRC Question (1) – (Cont.)**

  [Mark-up] – to be submitted in response to RAI 8554

7.1.2.24 Conformance with GDC 22

~~The I&C systems that are applicable to GDC 22, as shown in Table 7.1-1, are designed in accordance with GDC 22.~~ The protection systems comply with the independence requirements of IEEE Std. 603 except for the CEA position inputs described in Subsection 7.1.2.3.

7.1.2.25 Conformance with GDC 23

The I&C systems that are applicable to GDC 23, as shown in Table 7.1-1, are designed in accordance with GDC 23. Failure modes and effects analysis (FMEA) for protection systems is described in Subsections 7.2.3.1 and 7.3.3.1.

7.1.2.26 Conformance with GDC 24

The I&C systems that are applicable to GDC 24, as shown in Table 7.1-1, are designed in accordance with GDC 24. Electrical isolation, physical separation, and communication

~~The applicable I&C systems listed in Table 7.1-1 are designed~~ to meet the requirement of GDC 22 as described in Item 'k' of Section 3.2, "GDC 22, Protection System Independence" of the Safety I&C System technical report.

correct

7.1-15 Rev. 0

Q6. PPS Functional Diversity (9/10)

- **Response to NRC Question (2)**
  - **Having "reverse order in the different BPs" does not constitute functional diversity in accordance with NUREG/CR-6303.**
  - **NUREG/CR-6303 shows that a "different order of execution" is one of the factors that increases the degree of software diversity.**
  - **Response to RAI 50-7911 Question 07.02-2 has been submitted to clarify that the reverse order of operation between two bistable processors (BPs) within a PPS division "increases the degree of software diversity" with the associated mark-up for Sections 4.2.2.1 and 6.1.2 of the Safety I&C System technical report.**
  - **In summary, the term "software functional diversity" is no longer used in the application document and the "reverse order of operation" between two BPs within a PPS division contributes to increasing the degree of software diversity.**

Q6. PPS Functional Diversity (10/10)

- **Response to NRC Question (3)**
  - **The response to RAI 8554 and associated mark-up will be prepared and submitted.**

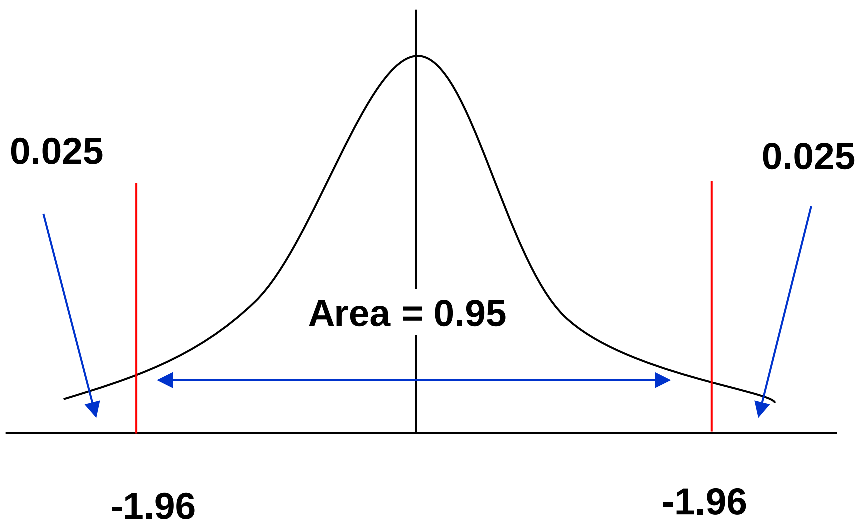
Q7. CPC Tolerance Limit Factor (1/4)

- **NRC Question**

It is not clear to the staff why these coefficients are consistent with the 95/95 tolerance limit discussion in Regulatory Guide 1.105, Rev. 3, which the staff interprets the limit to correspond to an error distribution approximately equal to two sigma value, 1.96, and not 1.645 as stated in the Technical Report APR1400-F-C-NR-14001. Provide justification and supporting analysis for this deviation from the guidance within RG 1.105.

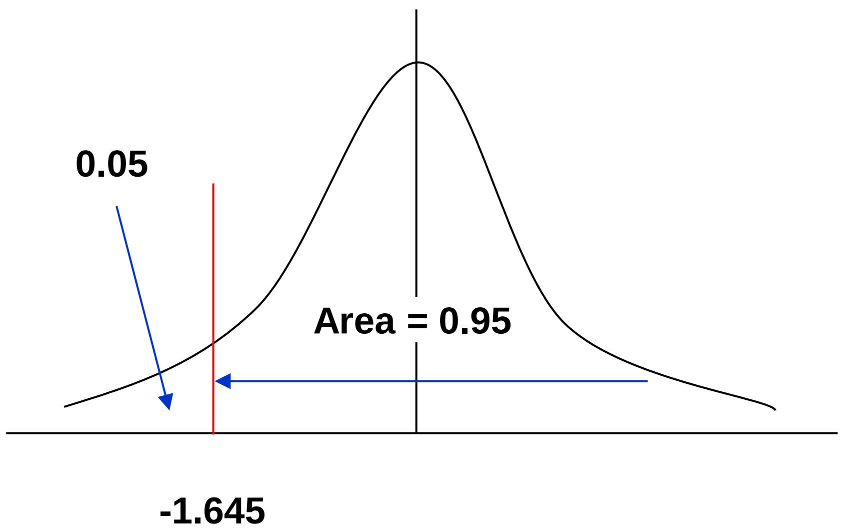
Q7. CPC Tolerance Limit Factor (2/4)

- **Response to NRC Question**



<Two-sided confidence interval>

$$\int_{-k\sigma}^{+k\sigma} g(x)dx = 0.95$$



<One-sided confidence interval>

$$\int_{-k\sigma}^{\infty} g(x)dx = 0.95$$

Q7. CPC Tolerance Limit Factor (3/4)

- **Response to NRC Question (Cont.)**

The Fq modeling error (X_F^i) between the CPC synthesized Fq and the actual Fq is defined as follows:

TS

Where ("SYN" Fq)^i and ("ACTUAL" Fq)^i are the CPC Fq and the reactor core simulator Fq for the i-th case. The Fq error is analyzed for each case at each time-in-life. Approximately 1200 cases are analyzed at each time-in-life (BOC, MOC, and EOC).

Q7. CPC Tolerance Limit Factor (4/4)

- **Response to NRC Question (Cont.)**
  - **A one-sided tolerance limit is applied to the probability density function (PDF) for Fq modeling errors.**
  - **In the PDF for Fq modeling errors, the right side of the mean shows the CPC Fq is greater than the reactor core simulator Fq to the left of the mean.**
  - **The left side, having a smaller CPC Fq is of concern with respect to safety. The right side, where the CPC Fq is greater than the reactor core simulator Fq, is more conservative.**
  - **Thus, a one-sided tolerance limit is used in the TeR (APR1400-F-C-NR-14001), and a one-sided tolerance limit factor value of 1.645, instead of the two side tolerance limit factor value of 1.96, is applied.**
  - **This method was approved by NRC;**
    - **"Statistical Combination of Uncertainties Part2," CEN-283(S)-P, October 1984.**

Q8.a. RAI 7883 Hardwired Signals (1/3)

- **NRC Question**

  Staff requested applicant to list all safety system to safety system interfaces and their connection types and all safety system to non-safety system interfaces and their connection types. The response appears acceptable but staff would like additional clarification. Are there hardwired signals from non-safety control system to safety systems? For example, staff would like confirmation that there are no hardwire signals from PCS or the PCCS to the PPS or ESF-CCF.

- **Response to NRC Question**
  - **Hardwired connection from P-CCS to ESF-CCS**

[ ] TS

Q8.a. RAI 7883 Hardwired Signals (2/3)

- **Response to NRC Question**
  - **Hardwired connection from P-CCS to ESF-CCS**

TS

Q8.a. RAI 7883 Hardwired Signals (3/3)

- **Response to NRC Question (Cont'd)**
  - **Hardwired connection from P-CCS to ESF-CCS**

TS

Q8.b. RAI 7883 Interface between IFPD & ESCM (1/1)

- **NRC Question**

  The staff requests the applicant to address the staff positions in ISG-04, Section 3, for this interface. Also, it is not clear if it is possible to bypass or lockout any safety functions from the non-safety IFPD via the ESCM. Identify and describe the various types of commands that ESCM could send to the Engineered Safety Features - Component Control System (ESF-CCS) Loop Controller (LC).

- **Response to NRC Question**
  - **Section C.5.3 of Safety I&C System TeR will be wholly revised to address compliance of the interface between the ESCM and the IFPD to the guidance in DI&C ISG-04, Section 3. The revised description in the TeR associated with this response has been submitted by the response of RAI 45-7883, 07.09-3.**
  - **The ESCM does not provide any manual bypass function or lockout function for safety components or safety systems.**
  - **The signal types sent from the ESCM to the ESF-CCS loop controller (LC) are as follows:**
    - **Discrete control signal, which is momentary (not continuous) – Manual open/close, start/stop, auto/manual mode, ESFAS override (active command on release of button)**
    - **Continuous pulse for modulation control (continuous pulse to hold command)**

Q8.c. RAI 7883 ITP Interdivisional Communication (1/3)

- **NRC Question (RAI 7883 Q.07.09-4)**

  Discuss how the Interface and Test Processor (ITP) interdivisional communications to display Containment Isolation Valve (CIV) positions support or enhance the performance of the safety.

- **Response to NRC Question**
  - **In order for divisions A and B of the QIAS-P to provide information on the positions of all CIVs in trains A, B, C and D, each QIAS-P division should receive the CIV position signals from other divisions through ITPs via inter-divisional communications.**
  - **The inter-divisional communication of the ITPs satisfies the requirements of independence in accordance with IEEE 603, IEEE 7-4.3.2 and DI&C-ISG-04(Positions 1 & 3).**
  - **This configuration is aimed to provide information on all the CIV positions to the control room operators to assess the proper operation of CIVs to confirm the isolation of all containment penetrations, and, as a result, to support the performance of the safety function.**

Q8.c. RAI 7883 ITP Interdivisional Communication (2/3)

- **NRC additional question to the response to RAI #7883 Q.07.09-4**

  The response did not describe how the ITP interdivisional communications support or enhance the performance of the safety function. At the August 2015 APR1400 public meeting, the staff had commented that a coordinated I&C and human factors analysis is a way to address ISG-04 staff guidance. It does not appear the applicant understood the staff's feedback since the RAI response lacked a human factors analysis.

- **Revised Response to NRC Question**

The following description will be added to the previous response.

- **A design description and ITAAC will be added in Section 2.5.3.1 and Table 2.5.3-3 of DCD Tier 1**
  - **To perform the human factors analysis to verify how the integrated CIV position displays support or enhance the performance of the safety functions compared with the partial CIV position display.**
- **Markups on DCD Tier 1 are as shown in the next page.**

Q8.c. RAI 7883 ITP Interdivisional Communication (3/3)

- **Markups on DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3**
  - **Section 2.5.3.1**

5. The QIAS-P software is implemented according to the software lifecycle process.

6. Integrated CIV positions are displayed on each division of the QIAS−P via the intra− and inter−divisional communications through the ITPs to support or enhance the performance of the safety functions compared with the partial CIV positions display.

  - **Table 2.5.3-3**

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
6. Integrated CIV positions are displayed on each division of the QIAS-P via the intra- and inter-divisional communi-cations through the ITPs to support or enhance the performance of the safety functions compared with the partial CIV positions display.	6. An human factors(HF) analysis of the as-built equipment will be performed to verify how the integrated CIV positions display supports or enhances the performance of the safety functions compared with the partial CIV positions display.	6. The HF analysis result verifies that the integrated CIV positions display supports or enhances the performance of the safety functions compared with the partial CIV positions display.

Q8.d. Independence between Redundant Divisions (1/2)

- **NRC Question**

  Question 7.9-6: Staff requested applicant to provide summary of how communication independence requirements are met between redundant portions of the safety system.

  Staff would like KHNP to supplement the response to include the response in DCD, Section 7.2.2.3.

  KHNP should discuss the planned supplemental information.

- **Response to NRC Question**
  - **A supplemental response to RAI 45-7883, Question 07.09-6 will be prepared.**
  - **The response to RAI 45-7883, Question 07.09-6 states that Subsection 4.6.2.1 of the Safety I&C System technical report describes the interdivisional serial data links used for data communication between safety portions of the plant protection system (PPS) in particular.**

Q8.d. Independence between Redundant Divisions (2/2)

- **Response to NRC Question**
  - **Subsection 4.6.2.1 of the Safety I&C System technical report provides the following information:**
    - **Both bistable processor (BP) and local coincidence logic (LCL) processor include a communication processor.**
    - **The data flow between redundant PPS divisions is buffered at the outgoing side of the communication processor of the BP and at the incoming side of the communication processor of the LCL processor to ensure independence of the redundant safety divisions.**
    - **One way communication over fiber optic cable is used to ensure communication independence and electrical isolation between redundant portions of the safety system.**
  - **The above information will be added to Section 7.2.2.3, "Independence" of DCD Tier 2.**

Q9. RAI 8279-8 Clarification of SW Loading (1/1)

- **NRC Question**

  "clarify the MTP and its relation with maintenance and software loading."

- **Response to NRC Question**
  - **The purpose of the MTP is to provide the capability to perform maintenance, initiate tests, and display system status.**
  - **MTP is not used for software loading.**
  - **Software loading to the safety programmable logic controller (PLC) is done by serial connection between the PLC and the portable engineering station.**
  - **The following paragraph will be added to Section 4.2.3.4 of the Safety I&C System TeR.**

TS

[ ]

Q9. RAI 8279-9 Shutdown Cooling Pump (1/2)

- **NRC Question**

  Describe the interconnections between Division A/B and C/D for shutdown cooling pump start on CS pump trouble and demonstrate the functional dependency will not challenge the independence between the divisions.

- **Response to NRC Question**
  - **The containment spray function is primarily achieved by the two redundant and independent Containment Spray Pumps (CSPs) of division C and D (one CSP in division C and one in division D). Each CSP has 100% capability of the containment spray function.**
  - **The Shutdown Cooling Pumps (SCPs) are designed to backup the CSPs function when CSPs are not available. The inoperable signal of the CSP in division C is used for actuation of the SCP in division A when a Safety Injection Actuation Signal (SIAS) or a Containment Spray Actuation Signal (CSAS) is present.**
  - **A spurious inoperable signal from the CSP in division C cannot result in spurious actuation of the SCP in division B, because actuation of the SCP in division B is dependent on inoperable signal of the CSP in division D when a SIAS or CSAS is present.**

Q9. RAI 8279-9 Shutdown Cooling Pump (2/2)

- **Response to NRC Question**
  - **The interconnection between the CSP and the SCP of division A and C are electrically separated from the interconnection between the CSP and the SCP of division B and D.**
  - **Therefore, the functional dependency between CSPs and SCPs does not challenge the independence between divisions.**

Q9. RAI 8279-10 DCS Gateway (1/1)

- **NRC Question**

  Besides the MTP, it is not clear to the staff if there are any other safety systems that send data to the DCS gateway. Clarify whether there are additional safety systems that send data to the DCS gateway and update the FSAR as appropriate.

- **Response to NRC Question**
  - **As shown in DCD Tier 2, Figure 7.9-1, besides the Maintenance and Test Panel (MTP), there are no other safety systems that directly send data to the Distributed Control System (DCS) gateway server.**
  - **The interface between the safety systems and the Information Processing System (IPS) is achieved by unidirectional Ethernet communication from the MTP to the DCS gateway.**
  - **The other interface to send data from the safety systems to non-safety systems is the ITP interface to QIAS-N. The interface is a diverse interface for safety status signals, which allows QIAS-N to serve as an Human System Interface (HSI) backup for complete IPS failure.**

Q9. RAI 8279-11 Interface between MTP and IPS (1/1)

- **NRC Question**

  Describe the uni-directional interface between MTP and IPS and clarify what is meant by "no receiving connection," since a typical Ethernet connector has 4 pairs of wires. It is not clear to staff if a standard Ethernet cable is used or a modified cable/connectors with TX pairs/pins on the non-safety end removed and RX pairs/pins on the safety end removed.

- **Response to NRC Question**

TS

Q9. RAI 8279-12 Ethernet between IFPD and ESCM (1/2)

- **NRC Question**

  Since the ESCM is connected to 4 IFPDs, the applicant is requested to identify the "certain number of cycles" and the how much erroneous data the Ethernet Communication Module can handle.

  The staff also request the applicant to demonstrate how the effects of data storms are addressed for this connectivity in order to provide reliable data transmissions to support important to safety functions as required by GDC 13.

- **Response to NRC Question**

TS

Q9. RAI 8279-12 Ethernet between IFPD and ESCM (2/2)

- **Response to NRC Question**

TS

Q9. RAI 8279-13 IFPD Interdivisional Com. (1/2)

- **NRC Question**

  It is not clear to the staff how the IFPD interdivisional communication as described in the technical report meets DI&C ISG-04, Section 1, Position 3. Specifically, how do the described IFPD interdivisional communications support or enhance the performance of the safety functions? The staff requests the applicant to address this portion of DI&C ISG-04 and update the FSAR accordingly.

- **Response to NRC Question**

TS

Q9. RAI 8279-13 IFPD Interdivisional Com. (2/2)

- **Response to NRC Question (Cont.)**

TS

Q9. RAI 8279-14 Response Time for IFPD to ESCM (1/1)

- **NRC Question**

  Discuss the testing and analysis that will be performed to demonstrate how these response times will be verified for IFPD to ESCM interdivisional communication; particularly for those manual actions that are credited to implement a safety function.

- **Response to NRC Question**

TS

Q9. RAI 8279-15 ISG-04 (1/3)

- **NRC Question**

  Address DI&C-ISG-04, "Highly Integrated Control Room - Communication," Rev. 1, Positions 12, 13, 14, 15 and 17 for the IFPD to ESCM interface.

- **Response to NRC Question**
  - **Position 12 - The response to RAI 45-7883, Question No.07.09-7 addressed compliance to DI&C-ISG-04, Position 12 for the IFPD to ESCM interface.**
  - **In regards to Position 13, 14, 15 and 17, the IFPD to ESCM Ethernet communication is not relied on for credited accident mitigation or safe shutdown functions, because**
    - **The ESCMs can be used in a stand alone manner,**
    - **There are ESCMs on the safety console that have no IFPD interface, and**
    - **There are also minimum inventory control switches on the safety console for control of the components in the main flow paths of the preferred emergency success paths.**

Q9. RAI 8279-15 ISG-04 (2/3)

- **Response to NRC Question**
  - **Position 13 - Regardless of the non-vital nature of this interface, errors in the IFPD to ESCM Ethernet communication interface are detected as described for compliance to Position 12, above.**
    - **While communication errors do not affect the operation of the ESCM FP, these compliance descriptions describe the errors that would require the ESCM to be used in a stand alone manner (i.e., with manual screen navigation to the desired control or function template).**
  - **Point 14 - The communication from IFPD to the ESCM is "point-to-point". The point-to-point means that the message is passed directly from the sending node (IFPD) to the receiving node (ESCM), without the involvement of equipment outside the division of the sending or receiving node.**
    - **For example, if there is a failure of the ESCM EPs for Divisions B, C and D, there would be no adverse impact to the communication between any of the four IFPDs at the operator console and the ESCM for Division A.**

Q9. RAI 8279-15 ISG-04 (3/3)

- **Response to NRC Question**
  - **Position 15 - The IFPD transmits information data to the ESCM based on event-driven transmission. So, the transmission of data between the IFPD and ESCM takes place when the operator selects the component on the IFPD. In response, the ESCM EP receives and stores the data set in the predefined address of the buffer memory.**
    - **However, the ESCM FP reads the data set in the buffer memory at regular intervals, whether data in the set has changed or not. In addition, all data from the ESCM FP is transmitted to the ESF-CCS controllers every execution cycle periodically regardless of any data change from the EP.**
  - **Point 17 - IFPD to ESCM interface are tested to the same seismic and EMI criteria as the plant safety systems, to ensure there are no spurious component or function template selection commands that would interfere with stand alone operation of the ESCMs.**

Q9. RAI 8279-16 Communication Failure (1/1)

- **NRC Question**

  Identify and discuss if there by any data communication failures that are APR1400 architecture specific or related to the APR1400 application (including the APR1400 software).

- **Response to NRC Question**
  - **As stated in Section C.5.1.1, C.5.1.2, C.5.1.3, and C.5.1.4 of Safety I&C System TeR;**

TS

Q9. RAI 8279-17 Message Transfer (1/1)

- **NRC Question**

  "…the applicant to discuss if there are operational limits for message transfer and how message transfer would not impact any safety functions."

- **Response to NRC Question**
  - **Subsection 4.6.1.3 of Safety I&C System TeR states that there are two modes of SDN data transmission.**
  - **One mode is the process data transfer mode.**
    - **Deterministic**
  - **The other is the message transfer mode.**
    - **Non-deterministic**
    - **Used in downloading SW and supporting event driven message.**
  - **Message transfer mode of the SDN will not be used in the APR1400 safety systems.**
  - **Message transfer feature will be blocked in the implementation phase of the safety software.**
  - **Modification in subsection 4.6.1.3 of Safety I&C System TeR**
    - **Before :** ***Message transfer is received for on-demand data that is initiated from the FPDs.***
    - **After :** ***Message transfer is not used in the safety systems.***

Q9. RAI 8279-18 Interdivisional Communications (1/3)

- **NRC Question**

  "Discuss how the CPP and CEAC/CPP interdivisional communications support or enhance the performance of the safety functions."

- **Response to NRC Question**
  - **The DNBR and LPD reactor trip functions are credited for anticipated operational occurrences(AOO) and postulated accidents (PA) in the APR1400 safety analysis.**
  - **CEA positions effect on the DNBR and LPD calculation**
    - **DNBR and LPD are calculated from temperature, flow, neutron flux, and pressure inputs.**
    - **Axial power distribution is calculated from ex-core neutron flux detectors.**
    - **Radial flux distribution is a function of CEA positions.**
    - **Each CPCS channel corrects the output of its ex-core detectors for changes in power distribution due to CEA insertion.**

Q9. RAI 8279-18 Interdivisional Communications (2/3)

- **Response to NRC Question (Cont.)**
  - **Compensation for CEA positions**
    - **Account for any deviations between the positions of the four CEAs within each subgroup.**
    - **Detect CEA position deviation within each subgroup.**
    - **Generate PFs to compensate the DNBR and the LPD calculation.**
  - **Reactor head area space limitations in APR1400**
    - **Physical space limitation**
      - **Installation space for four channel RSPTs on each CEA is not available.**
    - **Two RSPTs for each CEA (RSPT1, 2) are implemented.**
  - **Enhancement of the safety functions with CEA positions**
    - **CPCS design takes advantage of the fuel protection benefits provided by real time measurements that facilitate accurate DNBR and LPD calculations.**
    - **Deviations are an important component of the DNBR and LPD calculations because differences in CEA positions within the same subgroup can skew the normally symmetrical power distribution within the core.**

Q9. RAI 8279-18 Interdivisional Communications (3/3)

- **Response to NRC Question (Cont.)**
  - **Enhancement of the safety functions with CEA positions**
    - **Without direct CEA position monitoring, uncertainties and assumptions must be added into the ex-core detector measurements to relate the indirect measurements to the calculated real conditions in fuel assemblies.**
    - **Achieving more accurate DNBR and LPD calculations with direct CEA position monitoring is an enhancement of the safety functions.**
  - **Single Failure Criteria**
    - **Two RSPTs on a CEA are assigned to separate safety channels.**
    - **Within each CPCS channel, there are two separate PF calculations.**
    - **One based on CEA positions only from RSPT1, the other based on CEA positions only from RSPT2.**
    - **The PFs from two CEACs are transmitted to the CPC within the same channel.**
    - **Each CPC uses the more conservative PF of the two PFs in its final DNBR and LPD calculations.**
    - **If single failure occurs in one of two RSPTs or CEACs, the CPCS can performed the its safety functions.**

Q9. RAI 8279-19 Undetectable Failures (1/2)

- **NRC Question**

  "…requests applicant to discuss failures that have been identified through analysis but cannot be detected through equipment or diagnostics, and how those undetectable failures are addressed."

- **Response to NRC Question**
  - **Detectable failures**
    - **Failure modes for reed switch position transmitters (RSPT) which are detectable by the CPCS are described in Section C.5.1.3.7 (2) of the Safety I&C System TeR.**
    - **Common Q Platform has been dedicated and qualified for nuclear power plants and accepted by the NRC.**
    - **Various types of diagnostics and self-testing to continuously monitor the integrity of the system as it performs its safety functions.**
    - **Using these diagnostics and self-testing, failures can be detected by the application software of safety systems.**

Q9. RAI 8279-19 Undetectable Failures (2/2)

- **Response to NRC Question (Cont.)**
  - **Undetectable failures**
    - **There are failures undetected by the diagnostics and self-testing of platform or application software.**
    - **Considering the undetectable single failure in a CEAC side including RSPT 1 or 2 inputs**
      - **The redundant CEAC calculates the correct PFs and send them to the CPC to generate the DNBR and LPD trips.**
      - **PPS still remains in 2-out-of-3 coincidence logic (DCD 2 Table 7.2-7, item 2-14 b)).**
    - **Undetectable failures by self-diagnostic features but identifiable by analysis can be revealed by alarm, anomalous indication or channel comparison.**
    - **Failures which cannot be detected by self-diagnostic features can be found by the surveillance testing of SR of the TS.**
    - **Safety systems in the APR1400 include redundant components and channels to mitigate the effects of a failure, and to improve system availability.**
    - **Diverse protection system is also provided in the case of common cause failure of all safety systems.**

Q9. RAI 8280-41 Periodic Test Error Band (1/4)

- **NRC Question (RAI 8280, Q 7.1-41)**

  Describe clearly the periodic test error band and its relation with calculating the draft trip setpoint (DTSP) as well as the effect on the DTSP, AV, and TSP of having a PPS Cabinet Periodic Test Error Band with a value of zero, regarding TeR APR1400-Z-J-NR-14005.

- **Response to NRC Question**

  The following will be incorporated into Section 2.1 of the TeR.

  - **The total instrument channel uncertainty between the analytical limit (AL) and the DTSP includes all uncertainty factors existing on the PPS channel, which consists of the sensor, the APC-S, and the PPS cabinet uncertainties.**
  - **The total instrument channel uncertainty is generally determined by the algebraic summation of;**
    - **The termination and splicing effect, the reference leg error, the dynamic flow error, and the square-root-sum-of-squares (SRSS) combination of the reference accuracy, the drift, the temperature effect, the power supply effect, the radiation effect, the seismic effect, the measurement test error, and the static pressure effect.**

Q9. RAI 8280-41 Periodic Test Error Band (2/4)

- **Response to NRC Question (Cont.)**
  - **The detailed method to combine all uncertainty factors to calculate the total instrument channel uncertainty is described in Section 2.3.3 and Section III, "Measurement Channel Uncertainties" of each appendix.**
  - **Only the PPS cabinet periodic test error, which is based on a monthly testing interval, is used to determine the AV since the surveillance test for the PPS cabinet is required during normal plant operation.**
  - **However, the transmitter and the APC-S errors are each individually verified every refueling period to be within their respective calibration error bands and periodic test error bands.**
  - **When the PPS cabinet periodic test error band has a value of zero, the DTSP is equal to the AV.**
  - **When the PPS cabinet periodic test error band has a value of zero, the AV is the most conservative due to the difference in value between the AL and the DTSP not being reduced by the value of the PPS cabinet periodic test error band to establish the AV.**

Q9. RAI 8280-41 Periodic Test Error Band (3/4)

- **Response to NRC Question (Cont.)**
  - **If the PPS cabinet periodic test error band is greater than zero, the AV will be less conservative than the DTSP by the value of the PPS cabinet periodic test error band.**
  - **The final TSP is offset in a conservative direction from the calculated AV by approximately 0.5% of the channel span, which operational experience has shown to be sufficiently greater than the PPS cabinet periodic test error.**
  - **This approach can reduce the possibility of a licensee event report being required when a periodic test result exceeds the AV.**
  - **For the sensors and the APC-S, the calibration error band and periodic test error band serve as error limits during a periodic test.**
    - **If the instrument reading is within the calibration error band, no recalibration is necessary.**
    - **If the instrument reading is outside the calibration error band, but within the periodic test error band, the channel segment is functioning as intended although recalibration is required.**
    - **If the reading is outside of the periodic test error band, the source of the anomaly is to be investigated and operability is also to be evaluated since the instrumentation is not behaving as expected.**

Q9. RAI 8280-41 Periodic Test Error Band (4/4)

- **Response to NRC Question (Cont.)**
  - **For the PPS cabinet, if the instrument reading is within the calibration error band, no recalibration is necessary.**
    - **If the instrument reading is outside the calibration error band, but within the periodic test error band, the channel segment is functioning as intended although recalibration is required.**
    - **If the reading is outside of the periodic test error band but is conservative with respect to the AV, the source of the anomaly and the possibility of exceeding the AV are to be investigated since the instrumentation is not behaving as expected.**
    - **Only a violation of the AV is a reportable incident.**
  - **When the periodic test error band or the AV is exceeded, an appropriate action contains;**
    - **Adjustment of testing frequency, setpoint revision in the conservative direction, reevaluation of the trip setpoint or acceptance criterion, evaluation of equipment installation and environment, evaluation of calibration, repair or replacement of the device, or procedure change to implement supplemental action.**

Q9 RAI 8280-42 CPC flow information (1/1)

- **NRC Question**

Discuss KHNP's intended approaches (if available) to RAI 8279 and RAI 8280 for those questions that have no response has been submitted.

[RAI 301-8280 Q07.01-42]

why flow information is derived and not measured directly. Staff request applicant to provide rationale as to why it is acceptable to measure flow indirectly per Clause 6.4 of IEEE Std 603-1991.

- **Response to NRC Question**

  - **In the CPCS, flow information is derived from RCP speed and density of the coolant in the hot leg, because no method that directly measures the flow information is available in modern engineering.**
  - **An ultrasonic flow meter is the one recent non-destructive means for flow measurement, and it requires various inputs (velocity of a fluid, temperature, density, etc.) to calculate the flow information accurately.**

Q9. RAI 8280-44 Common Q Platform (1/2)

- **NRC Question**

  The staff requests identification of an ITAAC that verifies the Common Q platform is installed in accordance with the approved Common Q topical report, and as necessary, provide corresponding updates to the APR1400 FSAR.

  The staff also requests details regarding any modifications to the Common Q platform design, processes, hardware, and software, since the Common Q topical report was approved by the staff.

- **Response to NRC Question**
  - **Installation of the Common Q platform**
    - **The Common Q platform is installed in accordance with the dedicated process that is referred to in the approved Common Q Topical Report.**
    - **To verify the installation of Common Q platform has been performed in accordance with the approved Common Q Topical Report, DCD Tier 1 and 2 will be updated as shown on the next slide.**
  - **Modifications to the Common Q platform Topical Report**
    - **The Common Q Topical Report was approved by the NRC in 2013.**
    - **After approval, WEC provided WCAP-17926-P, WCAP-17922-P documents regarding Common Q modifications.**

Q9. RAI 8280-44 Common Q Platform (2/2)

- **Response to NRC Question (Cont.)**
  - **The following Items are added in DCD Tier 1 sections 2.5.1, 2.5.3 and 2.5.4**

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
24. The PPS and CPCS are installed in accordance with the dedicated process of commercial grade hardware and software.	24. An inspection will be performed for installation of the hardware and software.	24. A report exists and concludes that the systems are installed in accordance with the dedicated process of commercial grade hardware and software.

  - **The sentence of DCD Tier 2 section 7.1 is modified as follows ;**

"The PLC platform described in Section 8 of the Safety I&C System Technical Report (Reference 2) is loaded with the APR1400-specific application software to implement various safety functions."

Q9. RAI 8280-48 Calibration Error Band (1/2)

- **NRC Question (RAI 8280, Q 7.1-48)**

  Describe clearly the calibration error band and periodic error band, regarding TeR APR1400-Z-J-NR-14005.

- **Response to NRC Question**

  The following will be incorporated into Section 2.1 of the TeR.

  - **The calibration error band is the as-left limit of a parameter. The calibration error band represents the transmitter, the APC-S, or the PPS cabinet calibration error band.**
  - **The transmitter, the APC-S, and the PPS cabinet errors after calibration are each individually verified to be within their respective calibration error bands.**
  - **The calibration error band is determined by the SRSS combination of the reference accuracy, the power supply effect, and the measurement test error.**

Q9. RAI 8280-48 Calibration Error Band (2/2)

- **Response to NRC Question (Cont.)**
  - **The periodic test error band is the as-found limit of a parameter. The periodic test error band represents the transmitter, the APC-S, or the PPS cabinet periodic test error band.**
  - **The transmitter, the APC-S, and the PPS cabinet errors before calibration are each individually verified to be within their respective periodic test error bands.**
  - **The periodic test error band is determined by the SRSS combination of the reference accuracy, the drift, the temperature effect, the power supply effect, the radiation effect, and the measurement test error.**
  - **The uncertainty factors to determine the band are selected from those used to determine the total instrument channel uncertainty.**

Q9. RAI 8280-49 Appropriate Actions (1/1)

- **NRC Question (RAI 8280, Q 7.1-49)**

  Describe what appropriate actions are to be taken in case the measured TSP value is outside the predefined limits, that is, the double-sided (as-found) acceptance criteria band as described in RIS.

- **Response to NRC Question**

  The followings will be incorporated into Section 2.1 of the TeR.

  - **If the reading is outside of the periodic test error band, the source of the anomaly is to be investigated and the operability is also to be evaluated since the instrumentation is not behaving as expected.**
  - **If the reading is outside of the periodic test error band but is conservative with respect to the AV, the source of the anomaly and the possibility of exceeding the AV are to be investigated since the instrumentation is not behaving as expected.**
  - **Only a violation of the AV is a reportable incident.**
  - **When the periodic test error band or the AV is exceeded, an appropriate action contains;**
    - **adjustment of testing frequency, setpoint revision in the conservative direction, reevaluation of the trip setpoint or acceptance criterion, evaluation of equipment installation and environment, evaluation of calibration, repair or replacement of the device, or procedure change to implement supplemental action.**

Q9. RAI 8280-50 Allowable Value Determination (1/1)

- **NRC Question (RAI 8280, Q 7.1-50)**

  Add a description of the basis or rationale for the stated offset value to the APR1400 FSAR Tier 2 or to the TeR.

- **Response to NRC Question**

  The following will be incorporated into Section 2.5.4 of the TeR.

  – **To prevent a licensee event report, the TSP is offset in a conservative direction from the calculated AV by a drift allowance of about 0.5% of the channel span, which is sufficiently greater than the PPS cabinet periodic test error.**

  – **Since the PPS cabinet periodic test error is used in determining the AV from the DTSP, the drift allowance does not consider the sensor and the APC-S periodic test errors, which are individually verified to be within their respective periodic test error bands.**

  – **Historically, the 0.5% of channel span value is larger than the value of the PPS cabinet periodic test error.**

  – **Because the PPS cabinet periodic test error is the difference of the DTSP and the AV, the approach results in a TSP which is reasonable.**

  – **This approach does not negatively affect safety since the TSP is moved in the conservative direction by reducing the plant operating margin.**

Q9. RAI 8280-51 Offset Value Basis (1/2)

- **NRC Question (RAI 8280, Q 7.1-51)**

  What is the rationale for not including the transmitter and APC-S individual periodic test errors in the AV determination/calculation?

  Explain why the proposed offset (0.5 percent of span) provides an adequate margin to ensure that automatic protective action will correct an abnormal situation before a safety limit is exceed.

- **Response to NRC Question**

The following will be incorporated into Section 2.1 of the TeR.

- **The transmitter and the APC-S periodic test error bands are not used in determining the AV since the surveillance test for the PPS cabinet is performed every month but the test frequency of the transmitter and the APC-S is every refueling period.**
- **However, the transmitter and the APC-S errors are each individually verified every refueling period to be within their respective calibration error bands and periodic test error bands.**

Q9. RAI 8280-51 Offset Value Basis (2/2)

- **Response to NRC Question (Cont.)**

The changes which will be incorporated into Section 2.5.4 of the TeR in response to RAI 301-8280, Question 7.1-50 provide information which is pertinent to the applicant's response to this question.

Please see Slide 77 of this presentation.

Q9. RAI 8280-52 Setpoint Reset (1/1)

- **NRC Question (RAI 8280, Q 7.1-52)**

  It is not clear if one Setpoint Reset switch on the Safety Console applies to both low pressurizer pressure and low SG pressure trips or if there are two switches, one for each manual reduction.

  Clarify the capability of the Setpoint Reset.

- **Response to NRC Question**
  - **There are two Setpoint Reset switches on the Safety Console. One switch applies to low pressurizer pressure trip and the other switch applies to low SG pressure trip.**
  - **The Safety I&C System technical report (APR1400-Z-J-NR-14001-P, Rev.0) will be revised to include that there are two setpoint reset switches, one for low pressurizer pressure and the other for low steam generator pressure, on the MCR Safety Console and Remote Shutdown Console.**

Q10. RAI 8280-46.a. Geometry of Hot Leg Sensors (1/8)

- **NRC Question**

  For RAI 8280, Question 7.1-46: The staff requested applicant to clarify the hot leg temperature and division description in Table 7.5-1, Accident Monitoring Instrumentation Variables," and describe the geometry of the installed hot leg sensors. Staff requests additional clarification on this response.

  Table 7.3-4, "ESFAS Sensors," do not have any information regarding the number and location of the RCS hot leg temperature sensors, as stated in Section A.4 of Technical Report APR1400-Z-J-NR-14001-P.

- **Response to NRC Question**
  - **RCS hot leg temperature sensors are used only for the RPS functions of DNBR and LPD.**
  - **ESFAS functions do not use the RCS hot leg temperature sensors.**
  - **Therefore, no information regarding those sensors is stated in Table 7.3-4.**

Q10. RAI 8280-46.b. Geometry of Hot Leg Sensors (2/8)

- **NRC Question**

  Table 7.2-3, "Reactor Protection System Sensors," states there are 8 RTD sensors for hot leg temperature. Staff is inferring that there are 4 sensors for each steam generator based on the attached non-FSAR instrument loop diagram. It would be helpful if applicant explicitly states in the FSAR that there are 4 sensors per steam generator. Also, location of the sensors are not provided.

- **Response to NRC Question**
  - **Regarding cold leg temperature and hot leg temperature stated in the column "Monitored Variable" of Table 7.2-3, the numbers described in the column "Number of Sensors" will be changed from "8" to "4/steam generator" as indicated on the following slide.**
  - **In addition, the locations of temperature sensors will be changed from "Cold leg piping" and "Hot leg piping" to "Cold leg piping connected to steam generators" and "Hot leg piping connected to steam generators" respectively, as indicated in the attachment.**

Q10. RAI 8280-46.b. Geometry of Hot Leg Sensors (3/8)

- **Attachment**

APR1400 DCD TIER 2

Table 7.2-3

Reactor Protection System Sensors

4/steam generator

Cold leg piping connected to steam generators

Hot leg piping connected to steam generators

Monitored Variable	Type	Number of Sensors	Location	Receiving System
Neutron flux power	Fission chamber	12	Shield of primary side	ENFMS (for generating VOPT and high Log Power)
Cold leg temperature	Precision RTD	~~8~~	~~Cold leg piping~~	CPCS (for generating high LPD and low DNBR)
Hot leg temperature	Precision RTD	~~8~~	~~Hot leg piping~~	CPCS (for generating high LPD and low DNBR)

Q10. RAI 8280-46.c. Geometry of Hot Leg Sensors (4/8)

- **NRC Question**

  The attached schematics "Instrument Loop Diagram for RCS Loop 1 Temperatures" and "Instrument Loop Diagram for RCS Loop 2 Temperatures" do not show the location of the sensors per the RAI response.

- **Response to NRC Question**
  - **The hot leg temperature sensors on the pipes are located as indicated on the next slide.**

Q10. RAI 8280-46.c. Geometry of Hot Leg Sensors (5/8)

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[ ]

Q10. RAI 8280-46.d. Geometry of Hot Leg Sensors (6/8)

- **NRC additional question to RAI #8280 Q.07.01-46**

  The response stated that "the 'Channel Number' column specifies that there are 4 RTD sensors." The use of "Channel Number" to specify number of sensors is not obvious to the staff. Additional clarification is needed in the FSAR.

- **Revised Response to NRC Question**

  Table 7.5-1 will be revised as follows:

  - **The title "Channel Number" in the fourth column will be changed to "Number of Sensors" in order to provide clarity.**
  - **The ambiguity of hot leg temperature and cold leg temperature will be changed to "C, D (PPS OM)" in order to correct wrong description.**

Q10. RAI 8280-46.d. Geometry of Hot Leg Sensors (7/8)

- Markups on DCD Tier 2, Table 7.5-1

Table 7.5-1 (1 of 5)

Accident Monitoring Instrumentation Variables

Number of Sensors

Variable	Range	Monitored Function or System	~~Channel Number~~	Type	Ambiguity (Division)
Pressurizer Pressure (Wide Range)	0 to 210.9 kg/cm^2A (0 to 3,000 psia)	Pressurizer	2	B	C,D (PPS OM)
Pressurizer Level	0 to 100 % (0 to 562.15 in)	Pressurizer	2	B	C,D (PPS OM)
Reactor Coolant Hot Leg Temperature (Wide Range)	0 to 400°C (32 to 752 °F)	RCS	4	B	~~2 Hot Leg signals per division (QIAS-P)~~
Reactor Coolant Cold Leg Temperature (Wide Range)	0 to 400°C (32 to 752 °F)	RCS	4	B	~~2 Cold Leg signals per division (QIAS-P)~~
Steam Generator Pressure	0 to 105 kg/cm^2A (0 to 1,494 psia)	Steam Generator	2/SG	B	C,D (PPS OM)

C, D (PPS OM)

NON-PROPRIETARY

Q10. RAI 8280-46.d. Geometry of Hot Leg Sensors (8/8)

- Instrument Loop Diagrams for RCS Loop 1 Temperatures