16 Technical Specifications

16.1 Introduction

This chapter documents the staff review of the generic technical specifications (GTS) and the associated Bases proposed by the design certification (DC) applicant for the Advanced Power Reactor 1400 (APR1400) design. The review is for completeness and correctness in regard to NRC requirements and conformance with applicable guidance, and for consistency with related portions of the design control document (DCD). The APR1400 DCD provides the GTS in accordance with Title 10 of the *Code of Federal Regulations* (CFR), Section 50.36, "Technical Specifications," 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors," and 10 CFR 52.47(a)(11). The GTS are derived from the analyses and evaluations in the DCD.

16.2 Summary of Application

There are no DCD Tier 1 entries for this area of review. Korea Electric Power Corporation and Korea Hydro and Nuclear Power Co., Ltd. (KEPCO and KHNP, or the applicant) provided proposed GTS and Bases for the APR1400 design in DCD Tier 2, Chapter 16, "Technical Specifications," summarized here in part, as follows:

The proposed GTS and Bases were provided by the applicant for NRC review and approval in accordance with 10 CFR 50.36 and 10 CFR 50.36a. In its application, the applicant stated that the GTS and Bases were developed utilizing Revision 4.0 of NUREG-1432, "Standard Technical Specifications (STS) Combustion Engineering Plants." In support of DCD Tier 2, Chapter 16, the DC application references Technical Report APR1400-K-O-NR-14001-NP, Revision 3, "Deviation Report between NUREG-1432 Revision 4.0 and APR1400 Technical Specifications," August 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18234A428).

There are no Inspection, Test, Analysis, and Acceptance Criteria (ITAAC) for this area of review.

16.3 Regulatory Basis

The relevant requirements of the NRC's regulations for this area of review, and the associated acceptance criteria, are given in Chapter 16.0, "Technical Specifications," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), and are summarized below. Review interfaces with other SRP sections can be found in Chapter 16.0 of NUREG-0800.

Section 182a of the Atomic Energy Act of 1954 (AEA), as amended, requires that applicants for nuclear power plant operating licenses will state:

> such technical specifications, including information of the amount, kind, and source of special nuclear material required, the place of the use, the specific characteristics of the facility, and such other information as the Commission may, by rule or regulation, deem necessary in order to enable it to find that the utilization of special nuclear material will be in accord with the common defense and security and will provide adequate protection to the health and

safety of the public. Such technical specifications shall be a part of any license issued.

In 10 CFR 50.36, the NRC established its regulatory requirements related to the content of technical specifications (TS). In doing so, the NRC placed emphasis on those matters related to the prevention of accidents and the mitigation of accident consequences. As recorded in the Statements of Consideration, "Technical Specifications for Facility Licenses; Safety Analysis Reports" (33 *Federal Register* (*FR)* 18610, December 17, 1968), the NRC noted that applicants were expected to incorporate into their TS "...those items that are directly related to maintaining the integrity of the physical barriers designed to contain radioactivity." Accordingly, 10 CFR 50.36(c) requires that TS contain (1) safety limits and limiting safety system settings, (2) limiting conditions for operation (LCO), (3) surveillance requirements, (4) design features, and (5) administrative controls.

Paragraph (c)(2)(ii) of 10 CFR 50.36 requires that an LCO be established in TS for each item meeting one or more of the following four criteria (referred to as LCO selection criteria):

(A) *Criterion 1.* Installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary.

(B) *Criterion 2.* A process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

(C) *Criterion 3*. A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

(D) *Criterion 4.* A structure, system, or component which operating experience or a probabilistic risk assessment has shown to be significant to public health and safety.

In accordance with 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria" (GDC) 17, 21, 34, 35, 38, 41, and 44, those structures, systems, and components (SSCs) important to safety need to have sufficient independence, redundancy, and testability to perform their safety functions.

Section 50.36a of 10 CFR Part 50 requires that TS contain procedures for control of radioactive effluents.

Paragraph (a)(11) of 10 CFR 52.47, "Contents of Applications; Technical Information," requires that a DC applicant propose TS prepared in accordance with 10 CFR 50.36 and 50.36a.

For the reasons discussed in detail below, the acceptance criteria adequate to meet the above requirements are included in the STS documents. The STS for pressurized water reactor (PWR) designs currently in operation in the United States are contained in three NRC documents: NUREG-1430, "Standard Technical Specifications Babcock and Wilcox Plants"; NUREG-1431, "Standard Technical Specifications Westinghouse Plants"; and NUREG-1432, “Standard Technical Specifications Combustion Engineering Plants.” For each document, Volume 1 contains the TS, and Volume 2 contains the associated TS Bases. The STS include Bases for safety limits (SL), limiting safety system settings (LSSS), LCOs, and associated applicability, action and surveillance requirements. For the reasons discussed below, guidance documents applicable to the APR1400 proposed GTS and Bases include the model STS in NUREG-1432.

The STS reflect the detailed effort used to apply the criteria discussed in the Interim Policy Statement on Technical Specifications Improvements for Nuclear Power Reactors (52 *FR* 3788, February 6, 1987) to generic system functions, which were published in a “Split Report” and issued to the nuclear steam supply system (NSSS) vendor owners groups in May 1988. In addition, extensive discussions during the development of the STS were used to ensure that the application of the TS criteria and the joint industry and staff STS Writer's Guide would consistently reflect detailed system configurations and operating characteristics for all NSSS designs. As such, Bases documents include an abundance of information regarding the STS model requirements necessary to adequately protect public health and safety.

On July 22, 1993, the NRC issued its Final Policy Statement (58 *FR* 39132), expressing the view that satisfying the guidance in the policy statement also satisfies Section 182a of the AEA and 10 CFR 50.36. In the final policy statement, the NRC described the safety benefits of the STS and encouraged licensees, to the extent applicable, to use the STS for plant-specific TS amendments and for complete conversions to improved TS. Major revisions to the STS were published in 1995 (Revision 1), 2001 (Revision 2), 2004 (Revision 3), and 2012 (Revision 4).

The format and content of proposed GTS and Bases prepared for a DC application should use applicable provisions of the STS and STS Bases to the extent practicable, taking into account design-specific characteristics. As is appropriate, any deviation from conventions and precedents presented in STS, as well as any deviation based on design-specific characteristics, should be technically justified by the DC applicant and reviewed in detail by the NRC prior to design approval.

Generic changes to STS, known as Technical Specification Task Force (TSTF) travelers, which have been approved since issuance of STS Revision 4, are considered needed improvements or corrections to STS, and should be considered for inclusion, with suitable design-related modifications, in the proposed GTS and Bases. Disposition details of TSTF travelers are described in appropriate subsections of the technical evaluation section of this chapter.

16.4 Technical Evaluation

The staff evaluated the GTS to confirm that they will preserve the validity of the plant design, as described in the APR1400 DCD, by ensuring that the plant will be operated (1) within the required conditions bounded by the APR1400 DCD and (2) with operable equipment that is essential to prevent APR1400 postulated design-basis events or mitigate their consequences.

The staff also reviewed the GTS Bases to verify that their technical content, level of detail, and format are consistent with the STS Bases, and that they accurately provide the technical basis for each provision in GTS Chapter 2 and Chapter 3, consistent with the DCD.

The following table lists each request for additional information (RAI) question concerning general matters relevant to one or more of the following DCD Chapter 16 sections:

- Introduction (16.1);
- Use and application (Section 1.0);
- Safety limits (Sections 2.1 and 2.2, and Sections B 2.1 and B 2.2);
- LCO applicability and surveillance requirement (SR) applicability (Section 3.0 and Section B 3.0);
- LCO, applicability, action, and surveillance requirements (Sections 3.1 to 3.9, and Sections B 3.1 to B 3.9);
- Design features (Sections 4.1, 4.2, and 4.3); and
- Administrative controls (Sections 5.1 to 5.7).

Throughout Section 16.4 of this report, the staff's RAI questions are listed in tables describing the disposition of each question. In the SER with no open items, when a discussion is also provided for a question, and that discussion describes the question as being "resolved," the RAI question table listed the status of the question as "Closed Resolved (CR)"; "Resolved Confirmatory (RC)"; or "Closed Confirmed (CC)." A status of CR means the applicant has provided an acceptable response, but no DCD changes were needed. A status of RC means the applicant has provided an acceptable response, but confirmation of incorporation of the associated changes into the DCD is pending issuance of the next DCD revision. A status of CC means incorporation of the changes into the DCD is confirmed. In addition, a status of "Closed Unresolved (CU)" means the response was not adequate, and the question was superseded by a follow up question, which is listed for reference in the last column of the RAI question table. The last column may also list for reference any related questions for a question listed with a status of CR, RC, or CC. Also note that in addition to the initial response, many questions had one or more revised or supplemental responses to address deficiencies in an initial or a subsequent revised response, in lieu of initiating a follow up RAI question. Lastly, many RAI questions consist of two or more sub-questions. In such cases, the RAI question tables almost always list each sub-question separately. Based on review of DCD Revisions 2 and 3, the staff has confirmed incorporation of changes made in response to RAI-questions, which were listed with a status of RC in the RAI question tables of Chapter 16 of the SER with no open items. Therefore, the status of such questions in the RAI question tables has been changed to CC, since all of these questions are resolved and closed.

For each RAI question, the RAI question tables list the NRC Agencywide Documents Access and Management System (ADAMS) accession number reference to the NRC's RAI Letter (e.g., ML15227A009) and the applicant's response letter (e.g., ML15258A618). Since a question or sub-question may apply to more than one subsection of the GTS or Bases, and an RAI question table is provided for almost every subsection, an RAI question may appear in two or more tables. The RAI questions in the following table are listed together, since they have broad applicability to the design certification application (DCA), part 2, DCD Chapter 16, and DCA part 4, GTS and Bases.

DCD Chapter 16 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-26	130-8065 ML15227A009 Response: ML15258A618	DCD Tier 2, Section 16.1, "Introduction to Technical Specifications" – • Removed unnecessary quotation of the four LCO selection criteria of 10 CFR 50.36(c)(2)(ii) and DCD Subsection 16.1.1; • Renumbered remaining subsections as follows: 16.1.2→16.1.1 (TS content); 16.1.2.1→16.1.1.1 (completion times and surveillance frequencies); 16.1.2.2→16.1.1.2 (plant design difference [with CE digital plant of STS]); 16.1.2.3→16.1.1.3 (LCO and Bases information); 16.1.2.4→16.1.1.4 (Combined License (COL) information); 16.1.3→16.1.2 (references)	CC	
16-43	154-8064 ML15295A495 Responses: ML16187A252 ML16334A543 ML17272A164	Updated Technical Report APR1400-K-O-NR-14001-NP, Revision 0 (deviation report) and docketed Revisions 1 and 2, which included discussion of adopted TSTF travelers.	CC	
16-44	154-8064 ML15295A495 Responses: ML16187A252 ML17180A444 ML17236A374 ML17290B218	Use of brackets and identification / enumeration of COL Action Items	CC	
16-45	154-8064 ML15295A495 Responses: ML16169A377 ML16211A328	Replaced "DCD Tier 2, Section" with "FSAR Section" in Bases and explained why in DCD Tier 2, Subsection 16.1.1.4.	CC	
16-49.1	162-8055 ML15235A003 Response:	DCD Subsection 16.1.1.4 – added a COL action item regarding all Metric-English	CC	

DCD Chapter 16 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML15301A207	physical unit pairs in GTS and Bases -- instead of bracketing all such physical unit pairs: "The choice of physical units is a COL ~~information~~ action item to be ~~resolved by~~ completed by the COL applicant." (Staff suggested edits indicated)		
16-49.2	162-8055 ML15235A003 Response: ML15301A207	DCD Subsection 16.1.1 – added the following explanation on not using brackets for Metric-English physical unit pairs: "The choice of units is a COL ~~information~~ action item to be ~~resolved by a~~ completed by the COL applicant; however, the TS and Bases do not enclose the parameter value pairs in square brackets. This is an exception to the use of brackets to denote COL information in the TS and Bases." (Staff suggested edits indicated)	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Deviation Report

In RAI 154-8064 (ML15295A495), Question 16-43, the staff requested that the applicant submit on the docket an update of Technical Report APR1400-K-O-NR-14001-NP, Revision 0, "Deviation Report between NUREG-1432 Revision 4.0 and APR1400 Technical Specifications," (deviation report) to facilitate evaluation of differences between the GTS and STS. In its initial response (ML16187A252) the applicant stated that it had submitted Revision 1 of the deviation report, dated December 2015 (ML15338A330). The staff observed that the deviation report only addresses departures from the STS Specifications, and does not describe related departures from the STS Bases.

The staff noted inconsistencies in Revision 1 of the deviation report with GTS Revision 0, and requested the applicant to resolve them in item-specific RAI questions, some of which are described below in this report. Pending resolution of all inconsistencies in the deviation report, this aspect of RAI 154-8064, Question 16-43 was tracked as an open item. In its revised response (ML17272A164) to Question 16-43 the applicant submitted Revision 2 of the deviation report. The staff determined that the updates corrected the noted inconsistencies in Revision 1 of the deviation report. Therefore this aspect of Question 16-43 was resolved. Verification that all corrections have been made was tracked as a confirmatory item to be completed following issuance of Revision 2, or possibly a later revision, of the deviation report. Based on the review of Revisions 2 and 3 of the deviation report (ML18102B336 and ML18234A428, respectively), the staff has confirmed incorporation of the updates described above; therefore, this aspect of RAI 154-8064, Question 16-43, is resolved and closed.

<u>Bracketed Information – Combined License (COL) Action Items</u>

In RAI 154-8064, Question 16-44 (ML15295A495), the staff requested that the applicant not include "conceptual design information," which the DCD proposed to denote by enclosing it in double brackets ([[ ]]) in DCD Chapter 16. The staff explained the reason for this request, as follows:

> DCD Tier 2, Section 16.1.2.4 states "Single brackets ([ ]) are used to identify the preliminary design information or plant-specific information. Double brackets ([[ ]]) indicate the conceptual design information for those portions of the plant for which the application does not seek certification." SRP Section 16.0 explains that COL action items, also referred to as site-specific information, are indicated in the generic technical specifications (TS) and Bases, DCD Tier 2, Chapter 16, usually by use of square brackets. Section 182a of the Atomic Energy Act requires TS to be included with any operating license for a utilization facility issued by the NRC. Consequently, the plant-specific TS issued with a COL must be complete and useable for facility operation. Therefore, a COL applicant must resolve all COL action items in the generic TS and Bases in order to complete the plant-specific TS for issuance with the COL in accordance with 10 CFR 52.97. Since it is possible for "conceptual design information" to not be finalized until after COL issuance, generic TS and Bases cannot contain placeholders for such information.

Included in RAI 154-8064, Question 16-44, was a request for the applicant to revise DCD Tier 2, Section 16.1.1.4 (as renumbered) to omit discussion of the possible use of double bracketed conceptual design information, and delete any placeholders for such information from the GTS and Bases, or replace it with placeholders for site-specific information in square brackets, which can be finalized by a COL applicant before COL issuance. (The staff observed that Chapter 16 only used double brackets in GTS Subsection 3.7.9, "Ultimate Heat Sink.")

The staff also requested that the applicant provide (1) a list of the Chapter 16 COL action items, providing a concise description of each; and (2) guidance to clarify expectations for properly completing or resolving each COL action item needing such guidance.

The applicant responded (ML16187A252) to RAI 154-8064, Question 16-44, by stating it will replace double brackets with single brackets in GTS Subsection 3.7.9, "Ultimate Heat Sink," and remove the definition of the double brackets from DCD Tier 2, (renumbered) Section 16.1.1.4, "Combined License Information." The staff finds these changes acceptable.

The applicant also provided a list of Chapter 16 COL action items in new Table 16-1, "List of COL Action Items." The staff noted that proposed DCD Table 16-1 did not appear to be complete, because (1) some of the listed items were missing brackets; and (2) some items depicted in square brackets in Chapter 16 of DCD Revision 0, were omitted (e.g., in Subsections 3.6.2, 3.6.7, 3.7.9, 3.7.11, 3.8.1, 3.9.3, 3.9.4, 3.9.5, 4.1, 5.1.2, 5.3.1, 5.4.1.f, 5.5.12, 5.6.1, 5.6.2). Finally, the COL action item list must also include bracketed information in the

Bases. Pending receipt and confirmation of a comprehensive and accurate response, RAI 154-8064, Question 16-44 was tracked as an open item.

In its third revised response (ML17290B218) to Question 16-44, the applicant provided a revised list of COL action items in DCD, Tier 2, Chapter 16, Table 16-1 (in Part 4 of the DC application). As described in the third revised response, this table included the following items, listed here by GTS Subsection; one COL action item designator is sometimes provided for each affected section, or more often, for each affected subsection, and may include one or more instances of bracketed information:

- Generic TS and Bases – Choice of metric or English units (See response to RAI 162-8055, Question 16-49 (ML15301A207) .... COL 16.1(1)
- 3.0, "LCO Applicability"
  - [LCO 3.0.9 text] .... COL 16-3.0(1)
- 3.6.7, "Containment Penetrations – Shutdown Operations" .... COL 16-3.6(1)
  - Minimum number of containment equipment hatch bolts, "[four bolts]" (LCO 3.6.7.a, and Applicability Note)
- 3.7.5, "Plant Systems ─ Auxiliary Feedwater (AFW) System" .... COL 16-3.7(1)
  - Required Action A.1 Completion Time, "[72 hours]"
  - Required Action C.1 Completion Time, "[24 hours]"
- 3.7.9, "Plant Systems ─ Ultimate Heat Sink (UHS)" .... COL 16-3.7(2)
- 3.7.11, "Plant Systems ─ Control Room HVAC System (CRHS)" .... COL 16-3.7(3)
  - Action requirements in case an automatic transfer to CRHS isolation mode design feature is needed to protect control room occupants from exposure to toxic gas
    - [Required Action C.2]
    - [Required Action column Note for Action E]
  - An action requirement to immediately suspend operations with a potential for releasing radioactivity from the Gaseous Radwaste System if needed to protect control room occupants (Required Action E.2)
- 3.8.1, "Electrical Power Systems ─ AC Sources – Operating"
  - Emergency diesel generator (EDG) fuel oil day tank [minimum required fuel oil volume] (SR 3.8.1.4) .... COL 16-3.8(1)
  - Permissible operational Modes to perform the .... COL 16-3.8(2)
    - Offsite power transfer test (SR 3.8.1.8) [surveillance column Note]
    - EDG single largest load rejection test (SR 3.8.1.9) [surveillance column Note 1]

- EDG full-load rejection test (SR 3.8.1.10) [surveillance column Note 1]
- EDG engineered safety features (ESF) actuation test (SR 3.8.1.12) [surveillance column Note 2]
- EDG bypassed trip signal test (SR 3.8.1.13) [surveillance column Note]
- EDG load sequencer test (SR 3.8.1.18) [surveillance column Note]

– Permissible EDG operating power factor to perform the................................ COL 16-3.8(3)

- EDG single largest load rejection test (SR 3.8.1.9) [surveillance column Note 2]
- EDG full-load rejection test (SR 3.8.1.10) [surveillance column Note 2]
- EDG endurance and load test (SR 3.8.1.14) [surveillance column Note 3]

- 3.8.3, "Electrical Power Systems – Diesel Fuel Oil, Lube Oil, and Starting Air" .. COL 16-3.8(4)
  - EDG starting air receiver [required minimum pressure] (Required Action E.1, SR 3.8.3.4)
  - EDG starting air receiver [temporarily acceptable pressure range] (Condition E)
- 3.9.3, "Containment Penetrations.. COL 16-3.9(1)
  - Minimum number of containment equipment hatch bolts, "[four bolts]" (LCO 3.9.3.a)
- 4.1, "Site Location" .... COL 16-4.1(1)
- 5.0, "Administrative Controls" .... COL 16-5(1)
  - [Reviewer's Note(s)]
    - 5.1, "Responsibility" [Reviewer's Notes 1 and 2]
    - 5.2.2, "Unit Staff" [Reviewer's Note for 5.2.2.a]
    - 5.3, "Unit Staff Qualifications" [Reviewer's Note]
    - 5.5.3, "Post-Accident Sampling" [Reviewer's Note]
    - 5.5.11, "Ventilation filter testing Program" [Reviewer's Note for 5.5.11.c regarding standard used for charcoal filter testing]
    - 5.5.17, "Battery Monitoring and Maintenance Program" [Reviewer's Note regarding providing information and verifications requested in Notice of Availability for TSTF-500, Revision 2]
    - 5.5.19, "Setpoint Control Program"

      [Reviewer's Note for 5.5.19.b regarding the listing of the NRC safety evaluation report by letter, date, and ADAMS accession number that approved the setpoint methodologies]

[Reviewer's Note for 5.5.19.d regarding the listing of instrument functions to which the program requirements of paragraph d will be applied]

  - 5.6.4, "PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)" [Reviewer's Note regarding content of methodology for calculation of pressure and temperature limits for NRC approval]

- 5.3, "Unit Staff Qualifications".. COL 16-5.3(1)
  - [Minimum qualification of each unit staff member] (5.3.1)
  - [Minimum qualification of each unit staff member not covered by Regulatory Guide 1.8] (5.3.1)
- 5.4, "Procedures".. COL 16-5.4(1)
  - [Modification of core protection calculator (CPC) addressable constants - procedure requirements for content, addressable constant operational margin, CPC software changes to algorithms and fuel cycle specific data, and technical reference for changes to CPC protection algorithm software] (5.4.1.f)
- 5.5.12, "Explosive Gas and Storage Tank Radioactivity Monitoring Program,".... COL 16-5.5(1)
  - [Methodology for determining gaseous radioactivity release quantities]
  - [Methodology for determining liquid radwaste radioactivity release quantities]
- 5.5.19, "Setpoint Control Program" .... COL 16-5.5(2)
  - 5.5.19.e [FSAR reference, or the name of any document incorporated into the FSAR by reference, in which the setpoint program {implementation} is specified]
- 5.6, "Reporting Requirements"
  - 5.6.1, "Annual Radiological Environmental Operating Report"
    - [Note regarding submitting a single report for multi-unit sites] .... COL 16-5.6(1)
    - [format of table in report] .... COL 16-5.6(2)
  - 5.6.2, "Radiological Effluent Release Report" [Note regarding submitting a single report for multi-unit sites].. COL 16-5.6(1)
- Bases for GTS Chapter 3 .... COL 16-3(1)
  - B 3.0, "LCO and SR Applicability," Bases for LCO 3.0.9, [all Bases text], [Reviewer's Note regarding commitments COL applicant must make to adopt LCO 3.0.9]
  - B 3.1.4, "Control Element Assembly (CEA) Alignment," Applicable Safety Analyses (ASA) section, "[ ]" inches a CEA is assumed withdrawn with its rod bank at the bank insertion limit

- B 3.6.7, “Containment Penetrations – Shutdown Operations,” Background section, [four bolts] [Reviewer’s Note regarding determination of minimum number of equipment hatch bolts]
- B 3.7.5, “Auxiliary Feedwater (AFW) System,”
  - Actions section, [Reviewer’s Note regarding possibility of relaxing 72 hour Completion Time of Required Action A.1 and 24 hour Completion Time of Required Action C.1]
  - Actions section, [72] hour Completion Time of Required Action A.1 and [24] hour Completion Time of Required Action C.1
- B 3.7.9, “Ultimate Heat Sink,” [UHS site-specific design related Bases text] in Background, ASA, LCO, Actions, and Surveillance Requirements sections
- B 3.7.11, “CRHS,”
  - [text related to toxic gas] in Background, ASA, LCO, Actions, and Surveillance Requirements sections
  - [Reviewer’s Note regarding need for toxic gas isolation mode] in Background and Actions sections
  - [text related to Gaseous Radwaste System] in Applicability section
  - [text related to Modes 5 and 6] in Applicability and Actions sections
- B 3.7.12, “Auxiliary Building Controlled Area Emergency Exhaust System (ABCAEES),”
  - Actions section, [Reviewer’s Note regarding commitment to implement compensatory measures when in Condition B]
  - Actions section, [Reviewer’s Note regarding need for toxic gas isolation mode]
  - Actions section, for Required Action B.1, text regarding compensatory measures [meeting intent of GDC 19, 60, 64, and 10 CFR 50.34] to protect against “hazards such as radioactive contamination, [toxic gas,] smoke, temperature, and physical security”
- B 3.8.1, “AC Sources – Operating,” Surveillance Requirements section, [Reviewer’s Note regarding surveillance performance Mode restrictions] for SR 3.8.1.8 Note, SR 3.8.1.9 Note 1, SR 3.8.1.10 Note, SR 3.8.1.12 Note 2, SR 3.8.1.13 Note, and SR 3.8.1.18 Note
- B 3.9.3, “Containment Penetrations,” Background section, [Reviewer’s Note regarding determination of number of equipment hatch bolts]

The staff reviewed the revised Table 16-1 and finds it to be complete and accurate, and therefore, acceptable. Therefore, RAI 154-8064, Question 16-44, is resolved.

<u>Replacement of “DCD Tier 2” with “FSAR” in GTS and GTS Bases</u>

In RAI 154-8064 (ML15295A495), Question 16-45, the staff described its experience with previous DC and related COL application reviews, regarding the need for a COL applicant to change "DCD Tier 2" with "FSAR" in the References section of the Bases subsections for TS Chapters 2 and 3, either by proposing an exemption to the GTS Bases, or a COL holder by proposing an amendment to the plant-specific TS Bases. Neither of these administrative actions provide a safety benefit, but do need to be completed to ensure referential integrity between the plant-specific TS Bases and the licensing basis of the unit, most of which is described in the updated FSAR. Accordingly, the staff requested that the applicant use "FSAR" exclusively in the Bases, instead of "DCD Tier 2" in order to avoid the administrative burden of making this change during or after processing of a COL application. In its responses to RAI 154-8064, Question 16-45 (ML16169A377 and ML16211A328), the applicant proposed adding a paragraph to DCD Section 16.1.1.4 (as renumbered) to explain that "FSAR" as used in DCD Chapter 16 stands for "DCD Tier 2." In addition, the applicant will change all instances of "DCD Tier 2" in the GTS and Bases to "FSAR." The staff finds the response acceptable because it will facilitate the review of COL applications referencing the APR1400 certified design. Therefore, RAI 154-8064, Question 16-45 is resolved.

Correction of Editorial Deficiencies and Deviations from Improved TS Writer's Guide

Throughout the GTS and Bases, the staff identified many deviations from STS layout, format, and style conventions delineated in TSTF-GG-05-01, "Writer's Guide for Plant-Specific Improved Technical Specifications," Revision 1, August 2010 (writer's guide) (ML12046A089). In many of the RAI questions for DCD Tier 2, Chapter 16, the staff requested that the applicant correct such deviations individually. However, since many of such individual deviations were also found in other locations, the staff prepared RAI questions to document the different categories of deviations, and to request that the applicant resolve each category of deviation on a DCD Chapter 16 wide basis. Since completion of these corrections to the GTS and Bases will not be resolved until the final version of DCD Tier 2, Chapter 16 is submitted and verified by the staff, RAI 507-8587 (ML16214A057), RAI 509-8591 (ML16214A101), and RAI 508-8592 (ML16214A058) were tracked as open items; the corrections addressed by these RAIs are the following:

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-155	507-8587	Added left justified "APR1400 GTS" label in footer of each page of GTS and Bases.	CC
16-156	507-8587	Rendered Section 1.1 defined terms in all upper case letters in Subsection B 2.1.1 Applicability section, and Subsection B 3.1.1 SRs section for SR 3.3.1.8 and SR 3.3.1.10.	CC
16-157	507-8587	Inserted mathematical symbol in Bases text instead of words the symbol represents, in accordance with STS convention, in Subsection B 3.1.5, Actions section, and Subsection B 3.1.6, SRs section.	CC

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-158	507-8587	Verified that symbols, numbers, and units are kept together on the same line (e.g., ft, in, kg/cm^2); no space between number and percent symbol (e.g., 3% - except: 10^{-3} %); keep “10 CFR” together on same line; keep title number and name on same line (e.g., LCO 3.3.1, 3.3.1, “RPS Instrumentation - Operating”).	CC
16-159	507-8587	Verified implementation of appropriate degree of FSAR Section specificity in a Bases reference to an FSAR Section.	CC
16-160	507-8587	Verified implementation of “(Ref. 1)” format or “Reference 1” format in Bases in accordance with WG Section 3.1.1.j.	CC
16-161	507-8587	Defined acronym “RG” (Regulatory Guide) on first use within a TS or Bases Subsection.	CC
16-162	507-8587	Verified implementation of STS convention of not using hyphens to connect words and numbers that are used together as an adjective.	CC
16-163	507-8587	Used Capital Case for system names.*	CC
16-164	507-8587	Removed line breaks that split a line of text halfway between page margins.	CC
16-165	507-8587	Observe ordered list punctuation convention	CC
16-166	507-8587	Used Capital Case for system names when including the word “System” *	CC
16-167	507-8587	Vertically aligned Completion Time with first line of associated Required Action statement.	CC
16-168	507-8587	Vertically aligned Frequency with first line of associated Surveillance statement.	CC
16-169	507-8587	Ended each Surveillance Note text with a period.	CC
16-170	507-8587	Used correct number of blank lines before and after logical connectors.	CC
16-171	507-8587	Enumerated GTS Section 3.1 subsections consecutively, and corrected all references to Section 3.1 subsections in GTS and Bases.	CC
16-172	507-8587	References in the Bases “References” section should be in numeric order, and their enumeration should match the order of their first citation in the Bases Subsection text	CC
16-173	507-8587	Corrected Actions table header row to have one blank line before and after column heading text.	CC
16-174	507-8587	Corrected Surveillance Requirements table header row to have one blank line before and after column heading text.	CC

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-175	507-8587	Bases “Applicable Safety Analyses” section end reference to LCO selection criteria, should use format of “Criterion 3 of 10 CFR 50.36(c)(2)(ii).”	CC
16-176	507-8587	Follow STS convention on phrasing of surveillance column Notes	CC
16-177	507-8587	Same as Question 16-175.	CC
16-178	508-8592	3.1.1, B 3.1.2 – Defined acronyms or symbols on first use: RCS, k_{N-1}, and IRWST.	CC
16-179	508-8592	B 3.1.3 – Changed to clearer term, “negative MTC (moderator temperature coefficient),” in place of “non-positive MTC.”	CC
16-180	508-8592	B 3.1.4 Applicability – corrected typographical error.	CC
16-181	508-8592	B 3.1.5 Background – Defined acronym “MCR” (main control room) on first use; not in Bases for SR 3.1.5.1.	CC
16-182	508-8592	B 3.1.7 Surveillance Requirements, Bases for SR 3.1.7.1 – Defined acronym “MCR” on first use.	CC
16-183	508-8592	LCO selection criteria references in Applicable Safety Analyses section of Bases for 3.1.9, Special Test Exception (STE) - Shutdown Margin (SDM); 3.1.10, STE - Modes 1and 2; and 3.1.11, STE - Reactivity Coefficient Testing – Revised references to be consistent with removal of proposed definition for LCO selection criteria from Section 1.1.	CC
16-184	508-8592	B 3.1.10 Background – Corrected the citation to Reference 4, ANSI/ANS-19.6.1-2005.	CC
16-185	508-8592	Final sentence of Bases for Required Action B.1 of 3.1.10, STE - Modes 1 and 2, and 3.1.11, STE - Reactivity Coefficient Testing – Clarified sentence by adopting equivalent sentence from STS Bases.	CC
16-186	508-8592	Background section of Bases for 3.2.1, Linear Heat Rate (LHR), 3.2.2, Planar Radial Peaking Factors (F_{xy}), 3.2.3, Azimuthal Power Tilt (T_q), 3.2.4, Departure from Nucleate Boiling Ratio (DNBR), and 3.2.5, Axial Shape Index (ASI) – Clarified two sentences by adopting equivalent sentences from STS Bases.	CC
16-187	508-8592	Fourth paragraph of Background section of Bases for 3.2.2, F_{xy} – Clarified passage by adopting STS phrasing.	CC
16-188	508-8592	Fourth paragraph of ASA section of Bases for 3.2.2, F_{xy} – Justified deviation from equivalent sentence in STS Bases, which lists affected LCOs.	CR

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-189	508-8592	Reference to FSAR Chapter 15 at end of second paragraph of ASA section of Bases for STS 3.2.4, DNBR, is omitted from equivalent passage in GTS B 3.2.4 – Justified this deviation.	CR
16-190	508-8592	B 3.2.4 Actions, Bases for Required Action A.1 – corrected a grammatical error.	CC
16-191	508-8592	B 3.4.7, B 3.4.8 – Corrected typographical errors in page headers.	CC
16-192	508-8592	• B 3.7.11 Background – In third paragraph used correct term of “adsorber” and explained sentence concerning operation of the air cleaning unit (ACU) with heaters on. • B 3.7.11 Background – In fourth and sixth paragraphs, corrected logical and grammatical errors. • B 3.7.11 Applicable Safety Analyses – Enclosed sentence about toxic gas hazards in brackets to indicate it is COL information. • B 3.7.11 LCO – Corrected typographical error in last paragraph. • B 3.7.11 Actions – Corrected typographical error in Bases for Required Action A.1.	CC
16-193	508-8592	• In Bases for 3.9.6 and in Bases Table of Contents - Used correct title of “Refueling Water Level”; • In Subsection B 3.9.6 replaced “refueling cavity” with “refueling pool”; replaced “irradiated fuel” with “irradiated fuel assemblies”; corrected document cited for Reference 3. • In Subsection B 3.9.6 SRs section, for SR 3.9.6.1 - Clarified second paragraph by adopting STS phrasing.	CC
16-194	509-8591	2.0 – Corrected typographical errors.	CC
16-195	509-8591	3.1.4 Required Action A.2 – Corrected font size.	CC
16-196	509-8591	SR 3.1.4.4 – Removed unnecessary definition of acronym “RSPT” for reed switch position transmitter.	CC
16-197	509-8591	3.1.6 Conditions B and C, and 3.1.7 Condition A – Inserted “accumulated times” in place of CE-STS word “intervals” in the phrase “...CEA groups inserted between the long term steady state insertion limit and the transient insertion limit for *accumulated times* > 5 EFPD...or > 14 EFPD ...”	CC
16-198	509-8591	3.1.7 – Inserted a blank line below Subsection title to correct vertical placement of LCO statement, which must be two blank lines below title.	CC

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-199	509-8591	3.1.8 Applicability – Removed unnecessary condition “during maintenance” (see response to Question 16-139).	CC
16-200	509-8591	3.3 – Function table column headings: Changed letters for prepositions to upper case.	CC
16-201	509-8591	3.3.5 Required Action F.1 – Corrected label of E.1 to F.1 (see response to Question 16-111).	CC
16-202	509-8591	3.3.6 Required Actions C.1, D.1, E.1 – Corrected labels (see response to Question 16-114, Rev. 1).	CC
16-203	509-8591	3.3.6 Required Actions B.1 and B.2 – Corrected placement of Completion Time.	CC
16-204	509-8591	SR 3.3.6.2 Note – Corrected typographical errors (see response to Question 16-114).	CC
16-205	509-8591	SR 3.3.9.2 – Inserted blank line below surveillance statement.	CC
16-206	509-8591	3.3.13 Required Action A.1 NOTE – Corrected format so the NOTE spans the column’s action statement text field, not the column width from border to border.	CC
16-207	509-8591	LCOs 3.4.10.b and 3.4.16.b – Inserted missing period.	CC
16-208	509-8591	3.4.14 Condition D – Underlined logical connector “AND” (see response to Question 16-143).	CC
16-209	509-8591	3.4.14 Required Action C.2 – deleted extra space from “C. 2” (see response to Question 16-143).	CC
16-210	509-8591	3.5.2 Condition A, follow up to response to RAI 106-8069, Question 16-18 – Revised Required Action A.1 to account for second Condition statement regarding “Two diagonally oriented safety injection trains inoperable.” (Used two separate Condition rows.)	CC
16-211	509-8591	3.6.3 Required Actions A.1, A.2, and D.2 – Corrected formatting.	CC
16-212	509-8591	3.7.2 Conditions A, B, C, and D – Corrected Condition column formatting.	CC
16-213	509-8591	SR 3.7.10.2 – Corrected formatting.	CC
16-214	509-8591	3.8.1 and 3.8.2 – Removed non-standard use of preposition “on” for “in.”	CC
16-215	509-8591	3.8.1 Surveillance Requirements table – Corrected formatting of row border lines.	CC
16-216	509-8591	SR 3.8.1.9 – Corrected list formatting	CC

Question No.	NRC Letter No.– RAI No.	Affected Generic TS	Status
16-217	509-8591	SR 3.9.5.3 – Justified maintaining existing format (see response to Question 16-143).	CR
16-218	509-8591	Sections 5.1, 5.2, 5.3, 5.5, and 5.6 – STS Reviewer's Notes omitted from generic TS	CC
16-219	509-8591	B 5.5, Subsection 5.5.4 continuation page title, removed underline from " (continued)."	CC
16-220	509-8591	Subsection 5.5.4 reference to Chapter 3 – Changed to "FSAR Chapter 3."	CC
16-221	509-8591	Subsection 5.5.19, paragraph b -- Added list of NRC approved setpoint methodology technical reports. (This was a follow up to response to RAI 180-8059, Question 16-55, Sub-question 3.)	CC
16-222	509-8591	5.6.4.a – Corrected a typographical error.	CC

Status Codes:
RC Resolved Confirmatory CR Closed Resolved with no DCD changes CC Closed Confirmed

The applicant responded to these RAIs as follows:

- RAI 507-8587, Questions 16-155 through 16-177 (ML16305A436);
- RAI 508-8592, Questions 16-178 through 16-193 (ML16243A519); and
- RAI 509-8591, Question 16-194 (ML16236A261);
  Question 16-195 through 16-199 (ML16242A439);
  Question 16-200 through 16-204 (ML16252A511);
  Question 16-205 (ML16242A439);
  Question 16-206 (ML16242A439, ML16334A540);
  Question 16-207 (ML16222A945)
  Question 16-208 through 16-209 (ML16250A197)
  Question 16-210 (ML16251A532, ML17208B034)
  Question 16-211 (ML16238A430);
  Question 16-212 (ML16236A261);
  Question 16-213 (ML16231A445);
  Question 16-214 through 16-216 (ML16229A344);
  Question 16-217 (ML16257A565);
  Question 16-218 (ML16334A546);
  Question 16-219 (ML16354A203);
  Question 16-220 (ML16334A546);
  Question 16-221 through 16-222 (ML16312A524).

In these responses, the applicant agreed to upgrade the style, format, and quality of the Specifications and Bases to be more consistent with the CE STS, Revision 4. Most of these editorial improvements were verified by the staff to have been incorporated in DCD Revision 1. Based on its review of the responses and DCD Revision 1, the staff considers Questions 16-155 through 16-222 of the listed RAIs to be resolved.

Verification that all corrections have been made was tracked as a confirmatory item to be completed following issuance of Revision 2, or possibly a later revision, of the DCD. Based on the review of DCD Revisions 2 and 3, the staff has confirmed incorporation of the changes described above; therefore, Questions 16-155 through 16-222 are resolved and closed.

16.4.1 Selection of Limiting Conditions for Operation

According to 10 CFR 50.36(c)(2)(i), LCOs are “the lowest functional capability or performance levels of equipment required for safe operation of the facility.” Acceptable GTS must include LCOs as required by the four criteria of 10 CFR 50.36(c)(2)(ii).

The following table lists the RAI questions concerning the selection of LCOs included in GTS Sections 3.1 to 3.9.

GTS Chapter 3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-42	154-8064 ML15295A495 Responses: ML16169A377 ML17296A119	Provided results of evaluation to apply LCO selection criteria to APR1400 design and safety analyses	CC	
16-43	154-8064 ML15295A495 Responses: ML16187A252 ML16334A543 ML17272A164	Updated and docketed deviation report and included discussion of adopted TSTF travelers	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

<u>Application of LCO Selection Criteria</u>

DCD Tier 2, Section 16.1.1, “Limiting Conditions for Operations (LCOs) Selection Criteria,” states that “The APR1400 Technical Specifications LCOs have included the structures, systems, components, and parameters which are identified by the LCO criteria of 10 CFR 50.36(c)(2)(ii)...” However, the DCD contained no description of the process employed by the applicant to select the LCOs in GTS Sections 3.1 through 3.9. Absent such a docketed description to support the applicant’s DCD statement, the staff asked in RAI 154-8064, Question 16-42, that KHNP describe (1) the process employed to ensure identification of TS limiting conditions for operation (LCOs) for all structures, systems, and components (SSCs) as required by 10 CFR 50.36(c)(2)(ii) Criteria 1, 2, 3, and 4; and (2) the process employed to ensure the accuracy of the GTS Bases and its consistency with the DCD.

The applicant’s response (ML16169A377) to RAI 154-8064, Question 16-42 follows:

(1) LCOs selection

To select the LCOs for APR1400 TS, the design characteristics of APR1400 that are different to conventional CE plant design are reviewed by each system engineers. Based on the review results, applicability of existing NUREG-1432 LCOs to APR1400 is examined. Results show that most of the LCOs in NUREG-1432 are applicable to APR1400 in respect to the LCO selection criteria of 10CFR50.36(c)(2)(ii). However, full scope comparison on each individual SSCs applicability to 10CFR50.36(c)(2)(ii) LCOs selection criteria were not performed.

(2) Background, Applicable Safety Analyses, LCO, Applicability Section, and Consistency to DCD

NUREG-1432 Bases sections are examined for applicability of Background, Applicable section, LCOs by each system engineer. Also, safety analysts reviewed to maintain consistency against Applicable Safety Analyses. This process is commonly applicable for whole DCD. No specific process that is used only for DCD 16 Technical Specification exist.

The staff acknowledges that KHNP applied no DCD Chapter 16 specific process for verifying the completeness of the GTS LCO selection and ensuring the fidelity of the GTS Bases to the DCD. Without KHNP having performed a dedicated comprehensive review, the staff has insufficient confidence that the GTS comply with 10 CFR 50.36 and that the Bases are accurate and consistent with the DCD descriptions of the APR1400 design and safety analyses. Pending KHNP completing measures to remedy this lack of confidence, RAI 154-8064, Question 16-42 was tracked as an open item.

The staff identified items for which an LCO is not provided that appear to satisfy one or more of the LCO selection criteria:

- Based on DCD Tier 2, Section 15.4, “Reactivity and Power Distribution Anomalies,” it appears that the core protection calculator (CPC) variable overpower reactor trip (VOPT) Function, which is a CPC auxiliary trip listed in DCD Tier 2, Table 7.2-4, “Reactor Protection System Design Inputs,” like the separate reactor protection system (RPS) VOPT Function, should also be explicitly required by LCO 3.3.1 in Table 3.3.1-1, “Reactor Protection System Instrumentation - Operating.” Additional discussion of the CPC VOPT Function is provided in the GTS 3.3.1 evaluation in Section 16.4.8 of this SER.

- Based on the following statement in DCD Tier 2, Section 15.6.3.1.2, for a steam generator tube rupture (SGTR) without a loss of offsite power, it appears that the CPC hot leg saturation temperature reactor trip Function, which is a CPC auxiliary trip listed in DCD Tier 2, Table 7.2-4, should also be explicitly required by LCO 3.3.1 in Table 3.3.1-1:

  > The SGTR event increases the SG level and results in the high steam generator level (HSGL) trip *or the generation of a CPC hot leg saturation temperature trip* or low DNBR trip due to the decrease in the pressurizer pressure.

  The following statement in DCD Tier 2, Section 15.6.3.2.2, “Sequence of Events and Systems Operation,” for a SGTR with a concurrent loss of offsite power and turbine trip for the minimum DNBR case, also suggests that the CPC hot leg saturation temperature reactor trip Function be specified in Table 3.3.1-1:

For this case, the initial conditions are chosen to initiate the tube rupture from a power-operating limit. During the SGTR accident, the pressurizer pressure continuously decreases while the core power, core flow rate, and core average temperature remain constant until a reactor trip is realized. The DNBR also continuously decreases, eroding the thermal margin to DNB. *A CPC trip is consequently generated on hot leg saturation temperature trip signal.* The turbine trips due to the reactor trip, and a loss of offsite power is assumed concurrent with the turbine trip.

The applicant subsequently proposed to evaluate the APR1400 design and the accident and transient safety analyses as described in the DCD to validate the proposed LCOs in the GTS, and provide the results of this evaluation in a revised response to RAI 154-8064, Question 16-42. In its revised response (ML17296A119), the applicant provided four tables, one for each of the LCO selection criteria. Each table listed the SSCs and operational limitations on process parameters satisfying the associated criterion. The staff noted the applicant had identified additional LCOs and changes to some LCOs concerning which criterion the associated SSC or process parameter satisfies. These LCOs are summarized in the following list:

- LCO 3.1.8, “Charging Flow”

  As initially proposed, the LCO on charging flow was only concerned with protecting the assumed 150 gpm maximum charging flow rate during a boron dilution event under mid-loop conditions in MODE 5. In mid-loop operation, reactor vessel level is maintained within the top half of the RCS hot leg (an elevation less than 119 ft 1 in but greater than 117 ft 4 in). However, with the addition of LCO 3.1.12, a boron dilution event during mid-loop operation is precluded from occurring, and the 150 gpm limit on charging flow rate no longer satisfies Criterion 2. However, with one or more RCS loops in operation, a boron dilution event can occur, and the accident analysis assumes a maximum charging flow rate of 180 gpm. *To protect this initial condition and satisfy Criterion 2, the applicant revised LCO 3.1.8 to require limiting charging flow to ≤ 180 gpm when one or more reactor coolant pumps (RCPs) are running in MODES 1, 2, 3, 4 and 5.*

- LCO 3.1.12, “Unborated Water Source Isolation Valve – MODES 4 and 5”

  The inadvertent dilution of reactor coolant boron concentration accident analysis does not consider this event occurring when all RCS loops are idle; that is, when no reactor coolant pump (RCP) is running, because adequate mixing of the dilution source with reactor coolant before reaching the reactor core cannot be ensured with no forced circulation. Neither is adequate mixing assured with a shutdown cooling (SC) train in operation. This issue was the subject of RAI 17-7917, Question 15.4.6-1 (ML15146A260, ML15238B709, and ML17244A657). To preclude a boron dilution event when all RCPs are idle with the unit in MODE 4 or 5, the applicant added Subsection 3.1.12 to require that the unborated water source isolation valve be in the closed position, similar to Subsection 3.9.7, “Unborated Water Source Isolation Valve – MODE 6.”

- LCO 3.3.1, “Reactor Protection System (RPS) Instrumentation - Operating,” LCO 3.3.3, “Control Element Assembly Calculators (CEACs),” and

LCO 3.3.4, “RPS logic and Trip Initiation”

The Core Protection Calculator auxiliary reactor trip Functions were added to the scope of LCO 3.3.1, LCO 3.3.3, and LCO 3.3.4 because DCD Tier 2 Chapter 15 credits them for initiating High Local Power Density (LPD) and Low Departure from Nucleate Boiling Ratio (DNBR) reactor trips in the sequence of events of some analyzed accidents. Specifically, the applicant’s response added Footnote (d) to the titles of these RPS Functions in Table 3.3.1-1. The footnote states, “The OPERABILITY of the Local Power Density - High and DNBR - Low Functions includes the CPC auxiliary trips.” The response also added suitable discussion about the CPC auxiliary trip Functions in the Applicable Safety Analyses section, the LCO section, and the Surveillance Requirements section (for SR 3.3.1.10) of Subsection B 3.3.1.

- LCO 3.6.7, “Containment Penetrations - Shutdown Operations”

  The applicant changed the Applicable Safety Analyses section of Subsection B 3.6.7 to state that “Containment penetration status during shutdown operations satisfies Criterion 4 of 10 CFR 50.36(c)(2)(ii)” instead of Criterion 3.

- LCO 3.7.14, “Spent Fuel Pool Water Level (SFPWL)”

  The applicant changed the Applicable Safety Analyses section of Subsection B 3.7.14 to state that “The spent fuel pool water level satisfies Criteria 2 and 3 of 10 CFR 50.36(c)(2)(ii)” instead of just Criterion 3.

- LCO 3.9.6, “Refueling Water Level”

  The applicant changed the Applicable Safety Analyses section of Subsection B 3.9.6 to state that “Refueling water level satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii)” instead of Criterion 4.

The staff finds that the applicant’s evaluation resulted in a set of LCOs that meet the requirements of 10 CFR 50.36(c)(2)(ii). Therefore, RAI 154-8064, Question 16-42, is resolved.

<u>Disposition of NRC-approved TSTF Travelers</u>

In RAI 154-8064, Question 16-43 (ML15295A495), the staff requested that the applicant discuss adopted TSTFs approved since issuance of STS Revision 4, and approved TSTFs previously incorporated in STS that are not included in the GTS and Bases. In its first revised response (ML16334A543) to RAI 154-8064, Question 16-43, the applicant provided a summary list of the disposition of TSTF traveler reports, which are applicable to and included in the STS for CE digital plants. Pending completion of the staff’s evaluation of the summary list, this aspect of RAI 154-8064, Question 16-43, was tracked as an open item.

In its first revised response (ML16334A543) to RAI 154-8064, Question 16-43, the applicant also stated

> To clarify the technical difference between APR1400 and NUREG-1432, KHNP updated and submitted the Technical Report APR1400-K-O-NR-14001-NP, “Deviation Report between NUREG-1432, [Standard TS (STS) Combustion Engineering (CE) Plants,] Rev. 4.0 and APR1400 Technical Specifications,

> Rev. 01. Further updates to reflect the RAI responses are scheduled to be done after DCD revisions are submitted.

Pending verification that the deviation report accurately identifies approved TSTF travelers that are not included in GTS and includes an acceptable justification for their omission, this aspect of RAI 154-8064, Question 16-43, was tracked as an open item.

In its second revised response (ML17272A164) to Question 16-43, the applicant proposed to revise the deviation report to explicitly address TSTF travelers in new Section II.6, which states:

> The APR1400 TS adopts the approved technical specifications task force travelers that are included in NUREG-1432 Rev.4. TSTFs that are not included in the APR1400 TS are indicated in Table II-4 with technical rationale. APR1400 TS status of applicable TSTF travelers that have been approved since NUREG-1432 Rev.4 are indicated in Table II-5.

The staff reviewed the travelers listed in deviation report Tables II-4 and II-5, and for each of the travelers listed in these tables, verified that the rationale for not including, or including, the traveler's APR1400 design appropriate CE STS changes, is reasonable. In many instances, not including a traveler results in more conservative requirements in the GTS. For each traveler listed in Table II-5 that is incorporated into the GTS and Bases, the staff verified that the adaptation of applicable CE STS changes is technically appropriate for the APR1400 design as described in the DCD. The staff also verified that any conditions, such as a licensee commitment to an NRC accepted industry guidance document, for adopting a traveler, are adequately addressed by the GTS and Bases. The following TSTF travelers, according to deviation report Tables II-4 and II-5, are not proposed for inclusion in the GTS and Bases.

TSTF Traveler	Rationale for Omission from APR1400 Generic TS
TSTF-30, Revision 3, Extend the Completion Time for inoperable [containment] isolation valve to a closed system to 72 hours (Based on STS Revision 1)	Applicant retains the 4 hour Completion Time of Required Action 3.6.3.C.1 of Revision 1 of STS Subsection 3.6.3, "Containment Isolation Valves," because the applicant has not chosen to incorporate risk-informed relaxations.
TSTF-51, Revision 2, Revise containment requirements during handling irradiated fuel and core alterations (Based on STS Revision 1)	Applicant does not include the change to the Applicability of STS Revision 1, to require meeting the LCO only during movement of "recently" irradiated fuel assemblies, because the applicant has not chosen to incorporate risk-informed relaxations. This traveler changed the following (CE digital) STS Subsections: — 3.3.8, B 3.3.8; 3.3.9, B 3.3.9; 3.3.10, B 3.3.10; — B 3.6.3; — 3.7.11, B 3.7.11; 3.7.12, B 3.7.12; 3.7.14, B 3.7.14 — 3.8.2, B 3.8.2; 3.8.5, B 3.8.5; 3.8.8, B 3.8.8; 3.8.10, and B 3.8.10; — 3.9.3, B 3.9.3; 3.9.6, B 3.9.6.
TSTF-68, Revision 2, Containment Personnel	Applicant does not include the allowance of LCO 3.9.3.b of Revision 4 of STS Subsection 3.9.3 to have both airlock doors open in Mode 6 during Core Alterations or

TSTF Traveler	Rationale for Omission from APR1400 Generic TS
Airlock Doors Open During Fuel Movement (Based on STS Revision 1)	in Mode 6 during movement of irradiated fuel assemblies within containment, because the applicant has not chosen to incorporate risk-informed relaxations.
TSTF-207, Revision 5 Completion Time for Restoration of Various Excessive Leakage Rates (Based on STS Revision 1)	This traveler changed STS Subsection 3.6.3, Conditions A, B, and bracketed Condition D, and the Completion Time for Required Action D.1, and added brackets to Action E. None of these changes are incorporated into GTS Subsection 3.6.3 because APR1400 has no secondary containment, which obviates including STS 3.6.3 Action D, and has no containment penetrations with more than two CIVs, thus obviating related changes to Conditions A and B. Instead, GTS 3.6.3 adopts Revision 1 of STS 3.6.3, excluding Action D, and relabeling Actions E and F as Actions D and E, and removing the brackets from Action D, as relabeled.
TSTF-373, Revision 2 Increase Containment Isolation Valve (CIV) Completion Time in Accordance with CE-NPSD-1168 (Based on STS Revision 1)	Applicant does not include the risk-informed relaxation of the 4 hour Completion Time of Revision 2 of STS 3.6.3 Required Action A.1 (relabeled as bracketed Required Action B.1) (Isolate the affected penetration flow path ...) to 7 days, because the applicant has not chosen to incorporate risk-informed relaxations.
TSTF-422, Revision 2 Change in Technical Specifications End States (CE NPSD-1186) (Based on STS Revision 1)	Applicant does not include the risk-informed changes to selected required actions, which specify exiting the LCO's Applicability, to allow remaining in the LCO's Applicability (called a modified end-state), because the applicant has not chosen to incorporate risk-informed relaxations, and because APR1400 design-specific analysis for modification of end states was not performed.
TSTF-425, Revision 3 Relocate Surveillance Frequencies to Licensee Control – Risk-Informed TSTF Initiative 5b (ADAMS Accession Nos. ML090850627, ML090850630, ML090850638, and ML090850640; also ML101390330 (Based on STS Revision 1)	The applicant has not chosen to incorporate risk informed relaxations.
TSTF-426, Revision 5 Revise or Add Actions to Preclude Entry into LCO 3.0.3	The applicant has not chosen to incorporate risk-informed relaxations.

TSTF Traveler	Rationale for Omission from APR1400 Generic TS
– Risk-Informed TSTF Initiatives 6b & 6c (Based on STS Revision 1) (Not in STS Revision 4)	
TSTF-505, Revision 1 Provide Risk-Informed Extended Completion Times – Risk-Informed TSTF Initiative 4b (Based on STS Revision 1) (Not in STS Revision 4)	The applicant has not chosen to incorporate risk informed relaxations.
TSTF-529, Revision 4 Clarify Use and Application Rules (Based on STS Revision 4)	The applicant has not chosen to incorporate risk informed relaxations.
TSTF-545, Revision 3 TS Inservice Testing Program Removal & Clarify SR Usage Rule Application to Section 5.5 Testing (Based on STS Revision 4)	The applicant has not incorporated this traveler because the included changes have no possibility of promoting safer operation.

The applicable TSTF travelers, approved since NUREG-1432 Revision 4 that are incorporated into the GTS and Bases, according to deviation report Table II-5, are the following:

TSTF Traveler	Rationale for Inclusion in APR1400 Generic TS
TSTF-490, Revision 0 Deletion of E Bar Definition and Revision to RCS Specific Activity Tech Spec (Based on STS Revision 3) (Not in STS Revision 4)	Changes are applicable to GTS Subsection 3.4.15, RCS Specific Activity, and Section 1.1, Definitions
TSTF-510, Revision 2 Revision to Steam Generator Program Inspection Frequencies and Tube Sample Selection (Based on STS Revision 3) (Not in STS Revision 4)	Changes are applicable to GTS Subsections 3.4.17 and B 3.4.17, Steam Generator (SG) Tube Integrity, 5.5.9, Steam Generator Program, and 5.6.7, Steam Generator Tube Inspection Report. (Note that GTS omit bracketed material that accounts for operating reactor plant-specific TS, which contain NRC approved provisions for alternate tube plugging criteria, or tube repair methods and associated repair criteria.)
TSTF-522, Revision 0 Revise Ventilation System	Changes are applicable to GTS Subsections 3.7.11 and B 3.7.11, Control Room HVAC System (CRHS); 3.7.12 and B 3.7.12, Auxiliary Building Controlled Area Emergency Exhaust System (ABCAEES); and 3.7.13

TSTF Traveler	Rationale for Inclusion in APR1400 Generic TS
Surveillance Requirements to Operate for 10 hours per Month (Based on STS Revision 3) (Not in STS Revision 4)	and B 3.7.13, Fuel Handling Area Emergency Exhaust System (FHAEES). Changed surveillance requirement to operate each emergency filtration system train, with heaters operating, from "≥ 10 continuous hours" to "≥ 15 continuous minutes" on a 31 day Frequency.
TSTF-523, Revision 2 Generic Letter 2008-01, Managing Gas Accumulation (Based on STS Revision 3) (Not in STS Revision 4)	Changes are applicable to GTS Subsections 3.4.6 and B 3.4.6, RCS Loops – MODE 4; 3.4.7 and B 3.4.7, RCS Loops – MODE 5 (Loops Filled); 3.4.8 and B 3.4.8, RCS Loops – MODE 5 (Loops Not Filled); 3.5.2 and B 3.5.2, Safety Injection System (SIS) – Operating; 3.6.6 and B 3.6.6, Containment Spray System; 3.9.4 and B 3.9.4, Shutdown Cooling System (SCS) and Coolant Circulation – High Water Level; and 3.9.5 and B 3.9.5, Shutdown Cooling System (SCS) and Coolant Circulation – Low Water Level.

Based on the above information describing TSTF traveler dispositions, which is reflected in the deviation report, and which the staff concludes is complete and accurate, the staff finds that the applicant has properly addressed the TSTF traveler related provisions affecting the CE STS for incorporation in the GTS and Bases. Therefore, this aspect of RAI 154-8064, Question 16-43 is resolved.

16.4.2 TS Chapter 1.0 Use and Application ─ Section 1.1 Definitions

The GTS definitions section provides the definitions of the defined terms, which are presented in all upper case letters in the GTS and Bases.

The applicant proposed retaining the definitions of CORE ALTERATION and DOSE EQUIVALENT I-131 as they are presented in STS NUREG-1432, Revision 3, with TSTF-490, Revision 0, incorporated. Since the definitions are consistent with the STS in format, content and punctuation, the staff finds the proposals acceptable.

The following table lists the RAI questions concerning Section 1.1.

Section 1.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.5	125-7975 ML15216A651 Response: ML16032A596	1.1, 3.4.8, 3.6.7, 3.9.3, 3.9.5 – use "127 ft 1/4 inch" instead of the defined term REDUCED RCS INVENTORY; remove this defined term	CU	16-149.2A
16-26	130-8065 ML15227A009 Response: ML15258A618	1.1 - Removed unnecessary proposed definition of LCO SELECTION CRITERIA	CC	

Section 1.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-27	130-8065 ML15227A009 Response: ML15294A532	1.1 - Conformed definition of LEAKAGE to STS Section 1.1 definition	CC	
16-28	130-8065 ML15227A009 Response: ML15294A532	1.1 - Removed unnecessary proposed definition of MAXIMUM ALLOWABLE CONTAINMENT LEAKAGE RATE (L_a)	CC	
16-29	130-8065 ML15227A009 Response: ML15294A532	1.1 - Justified using T_{cold} in GTS Section 1.1 definition of MODE and in Table 1.1-1	CR	
16-30	130-8065 ML15227A009 Responses: ML15258A618 ML17236A351	1.1 - Justify using “division” in definition of OPERABLE - OPERABILITY	CC	
16-31.3 16-31.13	133-7978 ML15227A011 Response: ML16036A378	3.9.3 and 3.9.6 - retained revised provisions for Core Alterations, which were removed from STS by TSTF-471-A	CR	
16-127	439-8524 ML16074A284 Response: ML16125A546	1.1 - Revised the proposed definition of ENGINEERED SAFETY FEATURE (ESF) RESPONSE TIME to match STS definition	CC	
16-139.5	478-8568 ML16131A614 Responses: ML16189A174 ML17138A937 ML17240A398 ML17296A128 ML17319A417	1.1 and 3.4.8 – remove “MID-LOOP” as a defined term	CC	
16-149.2A	481-8546 ML16133A271 Response: ML16312A528	1.1 - Removed the proposed definition of REDUCED RCS INVENTORY	CC	

Status Codes:

CU Closed Unresolved (has follow up question)
CR Closed Resolved with no DCD changes
RC Resolved Confirmatory
CC Closed Confirmed

Although GTS Section 1.1 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Section 1.1 and the deviation report.

The staff noted that the defined term CORE ALTERATIONS, which had been removed from STS by TSTF-471-A, Revision 1 (ML062860320), is included in the GTS in the following places:

- Section 1.1, “Definitions”;
- Subsection 3.3.8, “Containment Purge Isolation Actuation Signal (CPIAS)”
  (Applicability; Condition C, Required Action C.2.1, SR 3.3.8.3 Note);
- Subsection B 3.3.8, “CPIAS”
  (LCO, Applicability, Actions, and Surveillance Requirements sections of Bases);
- Subsection 3.3.9, “Control Room Emergency Ventilation Actuation Signal (CREVAS)”
  (Applicability, Condition C, Required Action C.2.3);
- Subsection B 3.3.9, “CREVAS”
  (Applicability and Actions sections of Bases);
- Subsection 3.9.3, “Containment Penetrations”
  (Applicability, Required Action A.1, SR 3.9.3.1 Frequency);
- Subsection B 3.9.3, “Containment Penetrations”
  (Background, Applicable Safety Analyses, Applicability, Actions, and Surveillance Requirements sections of Bases);
- Subsection 3.9.6, “Refueling Water Level”
  (Applicability, Required Action A.1);
- Subsection B 3.9.6, “Refueling Water Level”
  (Background, Applicable Safety Analyses, Applicability, and Actions sections of Bases);
- Subsection 3.9.7, “Unborated Water Source Isolation Valve – MODE 6”
  (Required Action A.1); and
- Subsection B 3.9.7, “Unborated Water Source Isolation Valve – MODE 6”
  (Actions section of Bases).

In addition, the applicant had revised the definition, which had been included in STS before incorporation of TSTF-471-A, as indicated:

> “CORE ALTERATION shall be the movement or manipulation of any fuel, sources, ~~or~~ reactivity control components ~~[~~or other components (excluding control element assemblies (CEAs) withdrawn into the upper guide structure)~~],~~ affecting reactivity within the reactor vessel with the vessel head removed and fuel in the vessel. Suspension of CORE ALTERATIONS shall not preclude completion of movement of a component to a safe position.”

Since the indicated changes to the previous STS definition only clarify the intended meaning, the GTS definition is acceptable. Including the definition is more restrictive on the APR1400 CPIAS, CREVAS, containment penetrations, and minimum refueling water level than the requirements on the equivalent systems and parameter in STS 3.3.8B for the Containment Purge Isolation System, STS 3.3.9B for the Control Room Isolation System, STS 3.9.3 for containment penetrations, and STS 3.9.6 for minimum refueling water level. Therefore, the staff finds the proposed definition and use of the term CORE ALTERATION acceptable.

The staff noted in RAI 130-8065, Question 16-27 (ML15227A009), that the format, content, and punctuation of the GTS Section 1.1 definition of LEAKAGE proposed by the applicant did not conform to the STS Section 1.1 definition. In keeping with NRC policy to maintain standardization of TS requirements, the applicant was requested to change the proposed definition so it is identical to the STS definition. In its response (ML15294A532) to RAI 130-8065, Question 16-27, the applicant changed the definition of LEAKAGE so that it is identical to the STS definition in format, content, and punctuation. The staff finds the response acceptable. Therefore, RAI 130-8065, Question 16-27 is resolved.

The staff noted in RAI 130-8065, Question 16-28 (ML15227A009), that the applicant proposed a definition in GTS Section 1.1, "Definitions," for MAXIMUM ALLOWABLE CONTAINMENT LEAKAGE RATE (L_a). This defined term is not included in the STS, and is not needed. L_a is defined in Specification 5.5.16., "Containment Leakage Rate Testing Program," item c, and is also fully described in the Applicable Safety Analyses section of the Bases for Specifications 3.6.1, "Containment," and 3.6.2, "Containment Air Locks." In addition, these Bases also fully describe "calculated peak containment pressure (P_a)" which is used in the definition of L_a. The staff also observed that the proposed GTS and Bases did not use this term as a defined term at all. In keeping with NRC policy to maintain standardization of TS requirements, in its response (ML15294A532) to RAI 130-8065, Question 16-28, the applicant deleted the term "MAXIMUM ALLOWABLE CONTAINMENT LEAKAGE RATE (L_a)" from the definitions listed in GTS Section 1.1. The staff finds the response acceptable. Therefore, RAI 130-8065, Question 16-28 is resolved.

In the SER with open items, Section 16.4.6, in the evaluation of Subsections 3.1.8 and 3.4.8, the staff identified an open item about whether there is a need for the defined term "MID-LOOP" in the GTS and Bases. As discussed in Section 16.4.6 in the updated evaluation of Subsection 3.1.8, verifying the removal of "MID-LOOP" from Section 1.1 and the replacement of "MID-LOOP" with "mid-loop" in Subsections 3.4.8 and B 3.4.8, in Revision 2 of the DC application was tracked as a confirmatory item under RAI 478-8568, Question 16-139, Sub-question 5. Based on the review of DCD Revision 2, the staff has confirmed incorporation of the changes described above; therefore, RAI 478-8568, Question 16-139, Sub-question 5, is resolved and closed.

In GTS Table 1.1-1, "Modes," and in the definition of the term MODE, RCS cold leg temperature is used instead of RCS average temperature, which is used by the STS and the Combustion Engineering System 80+ certified design GTS. In keeping with NRC policy to maintain standardization of TS requirements, the staff requested in RAI 130-8065, Question 16-29 (ML15227A009), that the applicant provide a technical justification for this difference. The applicant responded (ML15294A532) to RAI 130-8065, Question 16-29, that the APR1400 GTS Section 1.1 Mode definition is based on RCS cold leg temperature because RCS cold leg temperatures are utilized in the various safety analyses. In addition, operator actions during shutdown modes typically use RCS cold leg temperature for maintaining the RCS within pressure and temperature (P/T) limits. Therefore, the applicant intends to continue using RCS cold leg temperature for defining Modes. For the reasons stated in the applicant's response, the staff finds that defining Modes with RCS cold leg temperature is acceptable. Therefore, RAI 130-8065, Question 16-29 is resolved and closed.

The content of the definition of OPERABLE - OPERABILITY proposed by the applicant did not fully conform to the STS definition, in that the GTS definition includes the concept of a "division." In RAI 130-8065, Question 16-30 (ML15227A009), the staff requested that the applicant justify the addition of "division" to the STS definition, since such justification was neither provided in the DCD nor included in the deviation report. The applicant stated in its response (ML15258A618) to RAI 130-8065, Question 16-30, that it would justify the deviation from the STS definition of OPERABLE - OPERABILITY regarding the GTS use of "division" in categorizing some of the APR1400 redundant systems. RAI 130-8065, Question 16-30, was tracked as an open item. In its revised response (ML17236A351) to Question 16-30, the applicant revised the deviation report with an adequate justification for the deviation. Therefore, RAI 130-8065, Question 16-30 is resolved.

The applicant proposed to quote the four LCO selection criteria of 10 CFR 50.36(c)(2)(ii), paragraphs (A), (B), (C), and (D) in a new defined term, LCO SELECTION CRITERIA, in GTS Section 1.1. Regulatory requirements are not normally duplicated in the TS; it is unnecessary and avoids potential problems or additional work were the regulation to change. The GTS only use this proposed term in the Applicable Safety Analyses section of the Bases for each LCO subsection in GTS Chapter 3, "Limiting Condition for Operation (LCO) Applicability," where it is customary to end the discussion with a statement regarding which of the criteria the LCO satisfies. For example, instead of the usual phrase "Criterion 3 of 10 CFR 50.36(c)(2)(ii)" the GTS Bases proposed to use "LCO SELECTION CRITERION 3." Since the phrase LCO selection criterion (as a defined term) is never used within the GTS Chapter 3 Specifications, it has no practical benefit for the usability of the GTS, and its use in the Bases is not consistent with the STS. The applicant was requested in RAI 130-8065, Question 16-26 (ML15227A009), to justify adding the phrase "LCO selection criteria" as a definition in GTS Section 1.1, or remove it from DCD Tier 2, Chapter 16. (The staff noted that only a subset of the Applicable Safety Analyses section discussions in the proposed Bases for GTS Sections 3.1 through 3.9 used the proposed defined term, LCO SELECTION CRITERION 1, 2, 3, or 4; many remained consistent with the STS convention of citing the regulation.) As stated in its response (ML15258A618) to RAI 130-8065, Question 16-26, to avoid potential problems or additional work were the regulation to change and for better consistency with the STS, the applicant decided to remove the defined term for the LCO selection criteria and its definition from Section 1.1, and to remove the defined term from the GTS Bases, using a citation to 10 CFR 50.36(c)(2)(ii) instead. The staff finds the response acceptable. Therefore, RAI 130-8065, Question 16-26 is resolved.

In its response (ML16312A528) to RAI 481-8546, Question 16-149, Sub-question 2A, the applicant agreed to remove the defined term of REDUCED RCS INVENTORY and its definition. Therefore, RAI 481-8546, Question 16-149, Sub-question 2A is resolved.

Note that in its response (ML16312A528) to RAI 481-8546, Question 16-149, Sub-question 2B, the applicant also replaced the defined term of REDUCED RCS INVENTORY, everywhere it is used in the GTS and Bases, with a suitable phrase containing the elevation of the corresponding RCS water level, "< 127 ft 1/4 in," except for the title of Subsection 3.6.7, which the applicant changed to "Containment Penetrations – ~~REDUCED RCS INVENTORY~~ Shutdown Operations," in response to Question 16-149, Sub-question 2G. Specifications and Bases revised by the applicant's responses to Sub-questions 2A, 2B, and 2G, as indicated in the response letter enclosure’s Attachments 1, 2, and 5, are Section 1.1; and Subsections B 3.6.1 Applicability section; B 3.6.2 Applicability section; 3.6.7; B 3.6.7 Background, Applicability, and Actions sections; 3.9.5; and B 3.9.5 LCO and Actions sections. See evaluation of other affected subsections for disposition of Sub-questions 2B and 2G.

Based on the above evaluation, the staff concludes that Section 1.1 is acceptable.

16.4.3 TS Chapter 1.0 Use and Application ─ Section 1.2 Logical Connectors; Section 1.3 Completion Times; Section 1.4 Frequency

GTS Section 1.2, “Logical Connectors,” which defines the use of “OR” and “AND” in GTS Sections 2.0, 3.0, and 3.1 through 3.9, is identical to the STS. Therefore, the staff concludes it is acceptable.

GTS Section 1.3, “Completion Times,” defines the rules for applying required action completion times in GTS Sections 2.2, 3.0, and 3.1 through 3.9 (i.e., the time within which a particular LCO requires completion of an identified action, given the operability status of the equipment governed by the LCO). Since this section is identical to STS Section 1.3, the staff concludes it is acceptable.

GTS Section 1.4, “Frequency,” defines the rules for applying frequencies (test intervals) specified for performing SRs.

The following table lists the RAI questions concerning Sections 1.2, 1.3, and 1.4.

Sections 1.2, 1.3, 1.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-51	162-8055 ML15235A003 Response: ML15301A207	Example 1.2-2 logical connector indentation corrected	CC	
16-51	162-8055 ML15235A003 Response: ML15301A207	Example 1.3-7 logical connector placement corrected	CC	
16-130.2	439-8524 ML16074A284 Response: ML16187A196	Corrected DR to address adoption of STS Rev. 2.2 version of LCO 3.0.4, and non-adoption of TSTF-359 version of LCO 3.0.4	CC	
16-130.2A	439-8524 ML16074A284 Response: ML16187A196	Justified differences between GTS and STS Rev. 2.2 regarding Notes excepting LCO 3.0.4	CR	
16-130.2B3	439-8524 ML16074A284 Response: ML16187A196	Example 1.4-5 – changed surveillance column Note to say “performed” instead of “met” to match the	CC	

Sections 1.2, 1.3, 1.4 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		discussion regarding the exception to LCO 3.0.4		

Status Codes:
CR Closed Resolved with no DCD changes needed RC Resolved Confirmatory CC Closed Confirmed

The surveillance column Note in Example 1.4-5 should say “performed” instead of “met” to match the discussion regarding the exception to LCO 3.0.4. In RAI 439-8524, Question 16-130 (ML16074A284), in Sub-question 2B3, the staff requested the applicant to correct this error in conformance to STS Example 1.4-5. In Sub-question 2 the applicant was also requested to correct the corresponding entry in the deviation report. In its response (ML16187A196) to RAI 439-8524, Question 16-130, the applicant made the requested changes. Therefore, RAI 439-8524, Question 16-130, Sub-questions 2 and 2B3 are resolved.

The staff finds that GTS Section 1.4, “Frequency,” is consistent with the STS rules for applying frequencies (test intervals) specified for performing SRs. Therefore, Section 1.4 is acceptable.

Examples involving a Note for an exception to LCO 3.0.4, and such Notes in the GTS, may vary from the STS to account for the differences between the APR1400 design and the Combustion Engineering (CE) digital plant design (e.g., such as at the Palo Verde Nuclear Generating Station) upon which the CE STS requirements are based.

In RAI 439-8524, Question 16-130 (ML16074A284), in Sub-question 2A, the staff requested that the applicant justify differences between GTS and STS Revision 2.2 regarding Notes excepting LCO 3.0.4. In its response (ML16187A196), the applicant provided the requested justification. Therefore, RAI 439-8524, Question 16-130, Sub-question 2A is resolved.

Conclusion for GTS Chapter 1.0

The applicant adhered to the use and application provisions as provided in the CE STS (digital), with some differences to reflect APR1400 unique design features. Therefore, based on its review and the above evaluation, the staff concludes that Chapter 1.0 is acceptable.

16.4.4 TS Chapter 2.0 Safety Limits ─ Section 2.1 Safety Limits; Section 2.2 Safety Limit Violations

The GTS reactor core safety limits (SLs) on the minimum value of the departure from nucleate boiling ratio (DNBR) and the peak value of the fuel centerline temperature, are consistent with the DCD and the STS, and therefore, are acceptable.

The GTS RCS SL on the peak value of RCS pressure is consistent with the DCD and the STS, and, therefore, is acceptable.

The GTS requirements for SL violations are identical to the STS requirements and, therefore, are acceptable.

Apart from formatting and content errors, which are discussed below, GTS Subsection B 2.1.1, “Reactor Core SLs,” is consistent with STS Subsection B.2.1.1, “Reactor Core SLs (Digital),” and the DCD.

Apart from formatting and content errors, which are discussed below, GTS Subsection B 2.1.2, “RCS Pressure SL,” is consistent with STS Subsection B.2.1.2, “RCS Pressure SL (Digital),” and the DCD.

The following table lists the RAI questions concerning Chapter 2.0.

Chapter 2.0 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-58	188-8056 ML15253A592 Responses: ML15280A326 ML17179A410	B 2.1.2 – RCS Pressure SL Violations section of Bases – added missing sentence from STS B 2.1.2; and removed unnecessary deviations from STS phrasing	CC	
16-194	509-8591 ML16214A101 Response: ML16236A261	2.0 – corrected typographical errors	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsection 2.1.2

In RAI 188-8056, Question 16-58 (ML15253A92), the staff requested that the applicant revise the “Safety Limit Violations” section of the Bases for SL 2.1.2, “RCS Pressure SL,” to conform to the content and phrasing of STS Subsection B 2.1.2, “RCS Pressure SL (Digital).” In particular, under the heading “2.2.2.2”: The first paragraph should match the STS by beginning with the phrase “If the RCS pressure SL is exceeded in MODE 3, 4, or 5, RCS pressure must...”; and the second paragraph should match the STS by inserting a missing sentence, which is included in the STS Bases, after the first sentence: “As such, pressure must be reduced to less than the SL within 5 minutes.” Also, in the next sentence, “mode” should be “MODES.” In its response (ML15280A326) to RAI 188-8056, Question 16-58, the applicant agreed to the suggested changes and provided a markup of the affected page of Subsection B 2.1.2.

However, the staff noted additional unnecessary deviations from STS phrasing under the heading “2.2.2.1”: The first paragraph should match the STS by beginning with the phrase, “If the RCS Pressure SL is violated...”; and the second paragraph should match the STS by beginning with the phrase, “With RCS pressure greater than the value specified in SL 2.1.2 in MODE 1 or 2, the pressure...”

The staff also noted that the “Safety Limit Violations” section of the Bases for SL 2.1.2 unnecessarily included a discussion of the Reactor Core SL violations in the discussion of the RCS Pressure SL violations. The Reactor Core SL violations are already addressed in Subsection B 2.1.1.

Pending receipt of a revised response to Question 16-58 that removes this unnecessary misplaced discussion, and conforms the phrasing of the “Safety Limit Violations” section of the Bases for SL 2.1.2 to that of STS Subsection B 2.1.2, RAI 188-8056, Question 16-58 was tracked as an open item. In its supplemental response (ML17179A410), the applicant revised Subsection B 2.1.2, "RCS Pressure SL," as requested. Therefore, RAI 188-8056, Question 16-58 is resolved.

Conclusion for GTS Chapter 2.0 and Chapter B 2.0

The applicant adhered to the SL provisions as provided in the Combustion Engineering STS (digital), but the GTS provisions reflect APR1400 appropriate values for the reactor core SLs and the RCS pressure SL. Based on its review, the above evaluation, and the resolution of the open item, the staff concludes that Chapter 2.0 and Chapter B 2.0, which are consistent with STS Chapters 2.0 and B 2.0, satisfy paragraph (1)(A) of 10 CFR 50.36(c), and paragraphs (1) and (2) of 10 CFR 50.36(a), and are therefore acceptable.

16.4.5 TS Chapter 3.0 Limiting Conditions for Operation (LCOs) and Surveillance Requirements (SRs) ─ Section 3.0 LCO Applicability; Section 3.0 SR Applicability

The GTS Section 3.0, and Bases, Section B 3.0, "LCO Applicability and SR Applicability," include the general provisions regarding determination of equipment operability and performance of SRs used in GTS Sections 3.1 through 3.9. In general, GTS Section 3.0 is modeled after STS Section 3.0.

The following table lists the RAI questions concerning Section 3.0.

Section 3.0 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-33	138-8067 ML15227A010 Responses: ML16014A764 ML16355A484	Justified adoption of LCO 3.0.8 and TSTF-372 with a suitable risk evaluation regarding snubbers	CC	
16-34	138-8067 ML15227A010 Responses: ML15357A434 ML17199F605	Justify adoption of LCO 3.0.9 and TSTF-427 with a suitable risk evaluation regarding barriers – designated LCO 3.0.9 as COL 16-3.0(1) and its Bases as COL 16-3(1)	CC	
16-34	138-8067 ML15227A010 Responses: ML15357A434 ML17199F605	Revised LCO 3.0.9 by restoring the STS LCO 3.0.9 phrase "and risk is assessed and managed"; and by adding the STS Reviewer's Note about commitments that a licensee must make as part of adopting TSTF-427 – designated LCO 3.0.9 as COL 16-3.0(1) and its Bases as COL 16-3(1)	CU	130.1

Section 3.0 Question.Sub-Question No.	NRC Letter No.– RAI No.; ADAMS Accession Nos.	Affected Generic TS or DCD Tier 2 Description	Status	Follow up Question.Sub-Question No.
16-35	138-8067 ML15227A010 Response: ML15357A434	B 3.0 LCO – revised introductory sentence to the LCO Applicability section of the Bases to refer to "LCO 3.0.1 through LCO 3.0.9" – designated LCO 3.0.9 Bases as COL 16-3(1)	CC	
16-36	138-8067 ML15227A010 Response: ML15294A548	B 3.0 LCO – corrected LCO 3.0.3 Bases to reference LCO 3.7.14	CC	
16-37	138-8067 ML15227A010 Response: ML15294A548	B 3.0 LCO – resolved LCO 3.0.4 Bases difference with STS Bases by changing "a normal shutdown" to "any shutdown."	CC	
16-38	138-8067 ML15227A010 Response: ML15294A548	B 3.0 LCO – resolved LCO 3.0.5 Bases differences with STS Bases by changing • "SRs to demonstrate" to "required testing to demonstrate either"; • "Allowed SRs" to "required testing to demonstrate OPERABILITY"; and • "an SR" or "SRs" to "required testing"	CC	
16-39	138-8067 ML15227A010 Response: ML15294A548	B 3.0 LCO – corrected LCO 3.0.6 Bases reference to "Specification 5.5.15, 'Safety Function Determination Program (SFDP)'"	CC	
16-40	138-8067 ML15227A010 Response: ML15294A548	B 3.0 LCO – resolved LCO 3.0.6 Bases differences with STS LCO 3.0.6 Bases by conforming to STS phrasing, and including from STS fourth paragraph "Upon entry into LCO 3.0.6, an evaluation shall be made to determine if a loss of safety function exists." Also replaced paragraphs regarding Figure B 3.0-1 and cross train	CC	

Section 3.0 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		checks with the paragraphs in Bases for STS LCO 3.0.6.		
16-41	138-8067 ML15227A010 Response: ML15294A548	B 3.0 SR – resolved SR 3.0.1 Bases difference with STS Bases by inserting two STS sentences: "Surveillances may be performed by means of any series of sequential, overlapping, or total steps provided the entire Surveillance is performed within the specified Frequency. Additionally, the definitions related to instrument testing (e.g., Channel Calibration) specify that these tests are performed by means of any series of sequential, overlapping, or total steps."	CC	
16-130.1a	439-8524 ML16074A284 Response: ML16187A196	Corrected deviation report to include LCO 3.0.9; bracketed LCO 3.0.9 to indicate it is designated as COL 16-3.0(1)	CC	See 16-44
16-130.1b	439-8524 ML16074A284 Response: ML16187A196	B 3.0 LCO – Added Reviewer's Notes to Bases for LCO 3.0.9 – designated LCO 3.0.9 Bases as COL 16 3(1)	CC	

Status Codes:
CU Closed Unresolved (has follow up question)
CR Closed Resolved with no DCD changes
RC Resolved Confirmatory
CC Closed Confirmed

STS LCO 3.0.8 provides action requirements that must be met when one or more snubbers are unable to perform their intended support function. LCO 3.0.8 was developed as a risk-informed technical specification improvement and was designated TSTF-372. TSTF-372 included in its justification a generic risk evaluation applicable to operating plants. However, the applicant included no such risk evaluation in the DCD. In its initial response (ML16014A764) to RAI 138-8067, Question 16-33, the applicant agreed to justify the adoption of TSTF-372 and LCO 3.0.8 in GTS Section 3.0, "LCO Applicability." In its revised response (ML16355A484) the applicant provided an acceptable technical justification based upon the TSTF-372 model and the APR1400 design with an applicable generic risk evaluation. Therefore, RAI 138-8067, Question 16-33 is resolved.

STS LCO 3.0.9 provides action requirements that must be met when one or more barriers are unable to perform their intended support function. LCO 3.0.9 was developed as a risk-informed technical specification improvement and was designated TSTF-427. TSTF-427 included in its justification a generic risk evaluation applicable to operating plants. However, the applicant included no such risk evaluation in the DCD. In its response (ML16014A764) to RAI 138-8067, Question 16-34, the applicant agreed to justify the adoption of TSTF-427 and LCO 3.0.9 in GTS Section 3.0, “LCO Applicability”; the technical basis for the justification will account for the APR1400 design with an applicable generic risk evaluation. Pending receipt and acceptance of this evaluation by the staff, this aspect of RAI 138-8067, Question 16-34, was tracked as an open item. In its revised response (ML17199F605) to Question 16-34, the applicant provided a risk assessment supporting adoption of LCO 3.0.9 on degraded barriers. The staff finds that the risk assessment is consistent with the assessment provided in TSTF-427 and is therefore adequate to support adoption of LCO 3.0.9. Therefore, this aspect of Question 16-34 is resolved. Since the applicant plans to submit a revised PRA associated with DCD, Tier 2, Chapter 19, and the basis of the applicant’s LCO 3.0.9 risk assessment includes an adequate PRA, acceptance of the revised PRA by the DCD Chapter 19 review staff was tracked as a confirmatory item. The staff’s evaluation of the revised PRA is provided in Chapter 19 of this SER. Based on that evaluation, this confirmatory item is closed.

Since STS LCO 3.0.9 is risk-informed, the applicant was also requested in Question 16-34 to include risk-informed related material from STS LCO 3.0.9, which GTS LCO 3.0.9 had inappropriately omitted. One omitted item was the requirement to ensure “risk is assessed and managed”; this phrase was restored as indicated in the Question 16-34 response letter’s attachment. In addition, the response restored the Reviewer’s Notes in the Bases for STS 3.0.9 to the Bases for GTS 3.0.9, which prescribed commitments that a licensee must make as part of adopting TSTF-427. Note that the response (ML16187A196) to RAI 439-8524, Question 16-130, Sub-question 1, also indicated the inclusion of these Reviewer’s Notes. Restoration of these two items is acceptable. Therefore, this aspect of RAI 138-8067, Question 16-34, is resolved.

The Reviewer’s Notes in the LCO 3.0.9 Bases contain bracketed information regarding the name of the licensee making the stated commitments (to the guidance of NUMARC 93-01, Revision 3, Section 11, which provides guidance and details on the assessment and management of risk during maintenance; and NEI 04–08, “Allowance for Non Technical Specification Barrier Degradation on Supported System OPERABILITY (TSTF–427) Industry Implementation Guidance,” March 2006.)

In its response (ML16187A196) to RAI 439-8524, Question 16-130, Sub-question 1, the applicant included the incorporation of LCO 3.0.9 in the deviation report, and (as discussed above) the addition of the Reviewer’s Notes of the Bases for STS LCO 3.0.9 to the Bases for GTS LCO 3.0.9; although not shown in the response letter’s attachments, which include markups of affected GTS pages, the applicant stated it would bracket LCO 3.0.9 to indicate that it is an optional requirement which requires justification (as described in TSTF-427) to be adopted by a COL applicant. In its third revised response (ML17290B218) to RAI 154-8064, Question 16-44, , in DCD, Tier 2, Chapter 16, Table 16-1, the applicant designated the bracketed LCO 3.0.9 as COL 16-3.0(1). However, the associated bracketed Bases for LCO 3.0.9 is considered as part of COL 16-3(1). Therefore, RAI 439-8524, Question 16-130, Sub-question 1, is resolved.

Verification of the placement of brackets around LCO 3.0.9 was tracked in the beginning portion of Section 16.4 of this report, as a part of the evaluation of COL information and the applicant’s response (ML16187A252) to RAI 154-8064, Question 16-44, which was also tracked as an open item. As stated above, the staff evaluated the applicant’s proposed COL action items and concluded that all appropriate site-specific bracketed information in the generic TS and Bases has been identified. Therefore, RAI 154-8064, Question 16-44, is resolved.

<u>Conclusion for GTS Section 3.0 and Section B 3.0</u>

Based on the Section 3.0 and Section B 3.0 modifications described above, the staff finds that the applicant adhered to the LCO and SR information as provided in the CE STS (digital). In addition, GTS Section 3.0 and Section B 3.0 contain “bracketed information”; LCO 3.0.9 text is bracketed. The “Reviewer’s Notes” in the Bases for LCO 3.0.9 are also bracketed; this obviates the brackets for the placeholder for the title of the COL holder, or licensee. Also, the term “licensee” is replaced by the more appropriate phrase “COL applicant” in the reviewer’s notes.

Based on the above evaluation, the staff concludes that Sections 3.0 and B 3.0 satisfy paragraphs (2) and (3) of 10 CFR 50.36(c), and paragraphs (1) and (2) of 10 CFR 50.36(a), and are therefore acceptable.

16.4.6 TS Chapter 3.0 LCOs and SRs ─ Section 3.1 Reactivity Control Systems

Section 3.1 includes requirements for the reactivity control systems, which are designed to reliably control reactivity changes and ensure that the capability to cool the core is maintained under postulated accident conditions.

The GTS Subsections for reactivity control systems correspond to the CE STS Subsections for reactivity control systems (digital plants) in the following manner:

STS	GTS	Title (STS Section 3.1 Titles append “(Digital)”; *STS Title if different)
3.1.1	3.1.1	SHUTDOWN MARGIN (SDM)
3.1.2	3.1.2	Reactivity Balance
3.1.3	3.1.3	Moderator Temperature Coefficient (MTC)
3.1.4	3.1.4	Control Element Assembly (CEA) Alignment
3.1.5	3.1.5	Shutdown Control Element Assembly (CEA) Insertion Limits
3.1.6	3.1.6	Regulating Control Element Assembly (CEA) Insertion Limits
3.1.7*	3.1.7	Part Strength Control Element Assembly (CEA) Insertion Limits (*Part Length Control Element Assembly (CEA) Insertion Limits)
─	3.1.8	Charging Flow
3.1.8	3.1.9	Special Test Exception (STE) – SHUTDOWN MARGIN (SDM)
3.1.10	3.1.10	Special Test Exception (STE) – MODES 1 and 2
─	3.1.11	Special Test Exception (STE) – Reactivity Coefficient Testing
3.4.17	─	Special Test Exception (STE) – RCS Loops
─	3.1.12	Unborated Water Source Isolation Valve – MODES 4 and 5

The applicant had initially proposed specifying two Specifications to address SDM requirements, Subsection 3.1.1 for MODES 3 and 4, and Subsection 3.1.2 for MODE 5. Since the combined requirements for these two subsections matched the requirements of STS Subsection 3.1.1, the staff requested in RAI 189-8057, Question 16-59 (ML15245A387), that the applicant revert to the STS presentation. In its revised response (ML16162A792) to RAI 189-8057, Question 16-

59, the applicant agreed to merge the two SDM Subsections (3.1.1 and 3.1.2 as proposed by DCD Revision 0) into one Subsection (3.1.1), and renumber Subsections 3.1.3 to 3.1.12 as Subsections 3.1.2 to 3.1.11. The staff finds this change acceptable because it conforms to the STS. However, the response was not complete because it did not address correction of other references to renumbered subsections throughout GTS and Bases. The staff issued follow up RAI 507-8587, Question 16-171 (ML16214A057), requesting the applicant to correct all references to Section 3.1 subsections to cite the revised numbering. The staff reviewed the applicant's revised response (ML17235B285), and considers Question 16-171 to be resolved because the markup of the affected GTS and Bases pages provided with the response corrected the subject references. Pending verification of Section 3.1 subsection references in the GTS and Bases, RAI 507-8587, Question 16-171, was tracked as a confirmatory item, and is listed once in the following table (in lieu of listing it in a similar table for each affected subsection in the evaluation of GTS Section 3.1). Based on its review of DCD Revision 2, the staff has confirmed incorporation of the changes described above; therefore, RAI 507-8587, Question 16-171, is resolved and closed.

Section 3.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-171	507-8587 ML16214A057 Responses: ML16305A436 ML17235B285	3.1.1 SDM, (follow up of 16-59 and 16-70) and Section 3.1 subsection numbering, and correction of other references to renumbered subsections throughout GTS and Bases	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsection 3.1.1 SHUTDOWN MARGIN (SDM)

Subsection 3.1.1 includes SDM requirements that are designed to provide sufficient reactivity margin to ensure that acceptable fuel design limits will not be exceeded for normal shutdown and during anticipated operational occurrences.

The following table lists the RAI questions concerning Subsection 3.1.1.

Subsection 3.1.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-51	189-8055 ML15235A003 Response: ML15301A207	3.1.1 - Corrected alignment of "<u>AND</u>" after Action B.1	CC	
16-59	189-8057 ML15245A387 Responses: ML15315A035 ML16162A792	Combined the two SDM Subsections (3.1.1 and 3.1.2 as proposed by DCD Rev. 0) into one Subsection (3.1.1), and renumbered Subsections 3.1.3 to 3.1.12 as	CU	16-171

Subsection 3.1.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Subsections 3.1.2 to 3.1.11, and Subsections B 3.1.3 to B 3.1.12 as Subsections B 3.1.2 to B 3.1.11; B 3.1.1 ASA section – deleted "half" from phrase "less than half the required SDM"		
16-60	189-8057 ML15245A387 Responses: ML15315A035 ML17236A401	3.1.1 LCO statement – Defined the term k_{N-1}	CC	
16-70	189-8057 ML15245A387 Response: ML15315A035	B 3.1.2 Background section – correct references	CR	
16-113.4a	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	B 3.1.1, "SDM," Applicability in Mode 6 ─ explained conservatism in BDAS alarm setpoint	CC	

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory
CR Closed Resolved with no DCD changes CC Closed Confirmed

The resolution of RAI 189-8057, Question 16-60, and RAI 507-8587, Question 16-171, were tracked as open items. In response (ML17236A401) to Question 16-60, the applicant revised LCO 3.1.1.b and the Applicable Safety Analyses section of the associated Bases by clarifying that the term k_{N-1} stands for the effective subcritical multiplication factor (k-effective, or k_{eff}), "calculated by considering the actual control element assembly (CEA) configuration and assuming that the fully or partially inserted full strength CEA of the highest [reactivity] worth is fully withdrawn." The k_{N-1} requirement ensures that a CEA ejection event while shutdown will not result in criticality, and therefore ensures the validity of the analysis results for this event, which satisfy the radially averaged enthalpy acceptance criterion considering power redistribution effects. Because the applicant's response provided the needed clarification, Question 16-60 is resolved. Question 16-171 is resolved for Subsections 3.1.1 and B 3.1.1 because the applicant's response (ML17235B285), corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.1 and Subsection B 3.1.1 and verified that the SDM LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the core reactivity initial conditions assumed in the accident analyses for events initiating in Mode 3, 4, or 5. Accordingly, the staff concludes that Subsection 3.1.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.1. The staff also verified that Subsections 3.1.1 and B 3.1.1 are consistent with the guidance in CE STS Subsections 3.1.1 and B 3.1.1, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open items, the staff concludes that Subsection 3.1.1 and Subsection B 3.1.1 are acceptable.

Subsection 3.1.2 Reactivity Balance

Subsection 3.1.2 includes reactivity balance requirements that are used as a measure of the predicted versus measured core reactivity during power operation. The periodic confirmation of core reactivity is necessary to ensure that safety analyses of design basis accidents (DBAs) and transients remain valid.

The following table lists the RAI questions concerning Subsection 3.1.2.

Subsection 3.1.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	SR 3.1.2.1 changed "NOTE" to "NOTES" because there are two surveillance column Notes (editorial)	CC	
16-59	189-8057 ML15245A387 Responses: ML15315A035 ML16162A792	Combined the two SDM Subsections (3.1.1 and 3.1.2 as proposed by DCD Rev. 0) into one Subsection (3.1.1), and renumbered Subsections 3.1.3 to 3.1.12 as Subsections 3.1.2 to 3.1.11, and Subsections B 3.1.3 to B 3.1.12 as Subsections B 3.1.2 to B 3.1.11.	CU	16-171
16-70	189-8057 ML15245A387 Response: ML15315A035	B 3.1.2 Background section – change reference to LCO 3.1.1 to conform to revised title	CU	16-171

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory
CR Closed Resolved with no DCD changes CC Closed Confirmed

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.2 and B 3.1.2 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.2 and Subsection B 3.1.2 and verified that the core reactivity balance LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the core reactivity initial conditions assumed in the accident analyses for events initiating in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.1.2 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.2 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.1.2. The staff also verified that Subsections 3.1.2 and B 3.1.2 are consistent with the guidance in CE STS Subsections 3.1.2 and B 3.1.2, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.1.2 and Subsection B 3.1.2 are acceptable.

Subsection 3.1.3 Moderator Temperature Coefficient (MTC)

Subsection 3.1.3 includes MTC requirements that relates a change in core reactivity to a change in reactor coolant temperature to ensure inherently stable power operation.

The following table lists the request for additional information concerning Subsection 3.1.3.

Subsection 3.1.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	SR 3.1.3.1 - surveillance column Notes 1 and 2 should be labeled “NOTES” instead of “NOTE” (editorial)	CC	
16-61	189-8057 ML15245A387 Responses: ML15315A035 ML16159A338	Clarified 3.1.3 LCO statement and SR 3.1.3.1	CC	

In RAI 189-8057, Question 16-61 (ML15245A387), the staff requested that the applicant clarify the LCO statement of Subsection 3.1.3. In its revised response (ML16159A338) to RAI 189-8067, Question 16-61, the applicant stated:

> ‘The limits’ in the LCO statement refers to the negative MTC limit in the COLR, while the positive MTC limit is specified in the LCO statement.

The response provided further clarification by making the changes indicated in the following markup:

LCO 3.1.3 The MTC shall be maintained within the ~~limits~~ lower limit specified in the COLR, and ~~a maximum positive~~ the upper limit that varies linearly from 0.9E-4 Δk/k/°C (0.5E-4 Δk/k/°F) at 0% RTP to 0.0 Δk/k/°C (0.0 Δk/k/°F) at 100% RTP.

SR 3.1.3.1 Verify MTC is within the upper limit specified in LCO 3.1.3.

With the response having clarified that the reference to the limit in the COLR is the MTC lower limit of SR 3.1.3.2, the staff concludes that RAI 189-8057, Question 16-61, is resolved.

The staff reviewed Subsection 3.1.3 and Subsection B 3.1.3 and verified that the MTC LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the MTC value assumed in the accident analyses for events initiating in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.1.3 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.3. The staff also verified that Subsections 3.1.3 and B 3.1.3 are consistent with the guidance in CE STS Subsections 3.1.3 and B 3.1.3, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.1.3 and Subsection B 3.1.3 are acceptable.

Subsection 3.1.4 Control Element Assembly (CEA) Alignment

Subsection 3.1.4 includes requirements on maximum CEA misalignment, which is an initial assumption in the safety analyses, and which directly affects core power distribution and available SDM.

The following table lists the RAI questions concerning Subsection 3.1.4.

Subsection 3.1.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-62	189-8057 ML15245A387 Responses: ML15315A035	Figure 3.1.4-1 Note (Editorial) – removed defining "RTP," since it is previously defined in Subsection 3.1.4	CU	16-158
16-70	189-8057 ML15245A387 Responses: ML15315A035	B 3.1.4 Applicability section - change reference to LCO 3.1.1 to conform to revised title	CU	16-171
16-71	189-8057 ML15245A387 Responses: ML15315A035	B 3.1.4 ASA section – added bracketed placeholder for assumption on static CEA misalignment analysis – "a single CEA withdrawn **[ ] inches** from a bank inserted to its insertion limit" – a COL action item	CC	See 16-44
16-72.1	189-8057 ML15245A387 Responses: ML15315A035 ML17200D075	B 3.1.4 SR section – Made changes to Bases for SR 3.1.4.1, SR 3.1.4.2, SR 3.1.4.3, and SR 3.1.4.4, to conform to improved TS writer's guide	CC	
16-72.2	189-8057 ML15245A387 Responses: ML15315A035 ML17200D075	Bases for SR 3.1.4.4 – Clarified discussion but changes differ from STS SR 3.1.4.4 Bases	CC	

Subsection 3.1.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-124 1st revision	439-8524 ML16074A284 Responses: ML16113A337 ML16187A240	Clarified SR 3.1.4.5 to state "Verify each full strength CEA drop time from the fully withdrawn position to the 90% insertion position is ≤ 4 seconds."	CC	
16-158	507-8587	Conform to STS formatting convention; keep unit abbreviations and the numbers to which they refer on the same line.	CC	

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory CC Closed Confirmed

In RAI 189-8057, Question 16-72 (ML15245A387), in Sub-question 2, the staff requested that the applicant clarify the Bases for SR 3.1.4.4 ("Perform a CHANNEL FUNCTIONAL TEST of each reed switch position transmitter (RSPT) channel. | 18 months"). In its response (ML15315A035) to RAI 189-8057, Question 16-72, the applicant made the following changes, which it said are based on the Bases for STS SR 3.1.4.4, as indicated by markup:

> SR 3.1.4.4
>
> Performance of a CHANNEL FUNCTIONAL TEST of each reed switch position transmitter (RSPT) channel ensures the channel is OPERABLE and capable of indicating CEA position over the entire strength of the CEA's travel. Since this test must be performed when the reactor is shut down, an ~~18-month~~ 18 month Frequency to be coincident with refueling outage was selected. Operating experience has shown that these components usually pass this Surveillance when performed at a Frequency of once every 18 months. Furthermore, the Frequency takes into account other Surveillances being performed at shorter Frequencies, which determine the OPERABILITY of the CEA Reed Switch Indication System.

The phrase inserted at the end of the first sentence used the phrase "...entire strength of CEA's travel" but appears to have meant "...entire length of CEA's travel."

The last sentence inserted by the response is not the same as the last sentence of the Bases for STS SR 3.1.4.4, which is "Therefore, the Frequency was concluded to be acceptable from a reliability standpoint."

Pending evaluation of these additional deviations from the STS SR 3.1.4.4 Bases, RAI 189-8057, Question 16-72, Sub-question 2, was tracked as an open item. In its revised response (ML17200D075) the applicant corrected the noted differences from the STS. Therefore, RAI 189-8057, Question 16-72, Sub-question 2, is resolved.

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.4 and B 3.1.4 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.4 and Subsection B 3.1.4 and verified that the CEA alignment LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the CEA positions assumed in the accident analyses for events initiating in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.1.4 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.4. The staff also verified that Subsections 3.1.4 and B 3.1.4 are consistent with the guidance in CE STS Subsections 3.1.4 and B 3.1.4, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open items, the staff concludes that Subsection 3.1.4 and Subsection B 3.1.4 are acceptable.

Subsection 3.1.5 Shutdown Control Element Assembly (CEA) Insertion Limits

Subsection 3.1.5 includes requirements on the insertion limits of the shutdown CEAs, which are initial assumptions in all safety analyses that assume CEA insertion upon reactor trip.

The following table lists the RAI questions concerning Subsection 3.1.5.

Subsection 3.1.5 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-59	189-8057 ML15245A387 Response: ML15315A035	B 3.1.5 – ASA, Applicability, corrected references to renumbered Subsections 3.1.2 to 3.1.11.	CC	16-171
16-63	189-8057 ML15245A387 Response: ML15315A035	3.1.5 and B 3.1.5 - Corrected Frequency of SR 3.1.5.1 from 24 hours to 12 hours	CC	
16-73	189-8057 ML15245A387 Response: ML15315A035	B 3.1.5 Actions section – made changes to conform to Action A	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.5 and B 3.1.5 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.5 and Subsection B 3.1.5 and verified that the shutdown CEA insertion limit LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the CEA positions initially assumed in the accident analyses for events initiating in Mode 1 or in Mode 2 with any regulating CEA not fully inserted. Accordingly, the staff concludes that Subsection 3.1.5 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.1.5. The staff also verified that Subsections 3.1.5 and B 3.1.5 are consistent with the guidance in CE STS Subsections 3.1.5 and B 3.1.5, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.1.5 and Subsection B 3.1.5 are acceptable.

Subsection 3.1.6 Regulating Control Element Assembly (CEA) Insertion Limits

Subsection 3.1.6 includes requirements on the insertion limits of the regulating CEAs, which are initial assumptions in all safety analyses that assume CEA insertion upon reactor trip. These insertion limits serve to preclude core power distributions from occurring that would violate fuel design criteria, which are summarized in the Applicable Safety Analyses section of the Bases for Subsection 3.1.6.

The following table lists the RAI questions concerning Subsection 3.1.6.

Subsection 3.1.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-51	162-8055 ML15235A003 Response: ML15301A207	3.1.6 - Corrected alignment of “<u>OR</u>” after Required Actions A.1, B.1, and D.1	CC	
16-63	189-8057 ML15245A387 Response: ML15315A035	Corrected Frequency of SR 3.1.6.1 from 24 hours to 12 hours	CC	
16-64 16-176	189-8057 ML15245A387 Response: ML15315A035 507-8587 ML16214A057 Response: ML16305A436	SR 3.1.6.1 – revised surveillance column Note to conform to STS phrasing convention by deleting the phrase “This Surveillance is not” so the Note says “Not required to be performed prior to entry into MODE 2.” This is equivalent to CE-STS SR 3.1.6.1 Note (“Not required to be performed until 12 hours after entry into MODE 2.”) because of the 12 hour Frequency.	CC	

Subsection 3.1.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-163	507-8587 ML16214A057 Response: ML16305A436	3.1.7.a, in LCO statement – capitalized “Core Operating Limit Supervisory System”	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.6 and B 3.1.6 because the applicant’s response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.6 and Subsection B 3.1.6 and verified that the regulating CEA insertion limit LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the CEA positions initially assumed in the accident analyses for events initiating in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.1.6 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.6 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.1.6. The staff also verified that Subsections 3.1.6 and B 3.1.6 are consistent with the guidance in CE STS Subsections 3.1.6 and B 3.1.6, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.1.6 and Subsection B 3.1.6 are acceptable.

Subsection 3.1.7 Part Strength Control Element Assembly (CEA) Insertion Limits

Subsection 3.1.7 includes requirements on the insertion limits of the part strength CEAs, which are initial assumptions in all safety analyses that assume CEA insertion upon reactor trip. These insertion limits serve to preclude core power distributions from occurring that would violate fuel design criteria, which are summarized in the Applicable Safety Analyses (ASA) section of the Bases for Subsection 3.1.7.

The following table lists the RAI questions concerning Subsection 3.1.7.

Subsection 3.1.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-74	189-8057 ML15245A387 Responses: ML15315A035	B 3.1.7 ASA section -- Confirmed that the proposed phrase “hot fuel rod in the core” corrects an apparent typographical error (“hot fuel CEA in the core”) in the STS B 3.1.7 ASA section	CR	
16-75	189-8057 ML15245A387	B 3.1.7 ASA section – Added sentence, “The part strength	CC	

Subsection 3.1.7 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML15315A035 ML17160A137	CEAs are required due to the potential peaking factor violations that could occur if part strength CEAs exceed insertion limits." after the LCO selection criterion applicability statement.		
16-198	509-8591 ML16214A101 Response: ML16242A439	3.1.7 – Made editorial corrections to specification formatting	CC	

Status Codes:
RC Resolved Confirmatory CR Closed Resolved with no DCD changes CC Closed Confirmed

Although the sentence added to the ASA section of the Bases for Subsection 3.1.7 conforms to the presentation in the ASA section of the Bases for STS Subsection 3.1.7, the staff believes that the STS incorrectly places the sentence after the statement about which LCO selection criterion that LCO 3.1.7 satisfies. Pending an editorial change to switch the order of the two statements, RAI 189-8057, Question 16-75 was tracked as an open item. In its revised response (ML17160A137) the applicant incorporated the requested editorial change. Therefore, RAI 189-8057, Question 16-75 is resolved.

The staff reviewed Subsection 3.1.7 and Subsection B 3.1.7 and verified that the part strength CEA insertion limit LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the CEA positions initially assumed in the accident analyses for events initiating in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.1.7 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.7 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.7. The staff also verified that Subsections 3.1.7 and B 3.1.7 are consistent with the guidance in CE STS Subsections 3.1.7 and B 3.1.7, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.1.7 and Subsection B 3.1.7 are acceptable.

Subsection 3.1.8 Charging Flow

As initially proposed in Revision 0 of the application, Subsection 3.1.8 included requirements on the charging flow restriction orifices and the associated bypass valves, which when closed, result in limiting charging flow from the Chemical and Volume Control System (CVCS) to within the flow assumed in the inadvertent RCS boron dilution event analysis. The charging flow restriction orifices prevent excessive unborated charging water to the RCS in Mode 5 during mid-loop operation, which is when water level in the reactor vessel is within the top half of the hot leg, an elevation above 117 ft 4 in and below 119 ft 1 in. There is no equivalent LCO in STS Section 3.1 or 3.9. As described below, the applicant revised Subsection 3.1.8 to limit charging flow to less than 180 gpm when at least one reactor coolant pump is running and unborated water sources are not isolated in MODES 1, 2, 3, 4 and 5.

The following table lists the RAI questions concerning Subsection 3.1.8.

Subsection 3.1.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
15.4.6-1	17-7917 ML15146A260 Responses: ML15238B709 ML17244A657	Section 3.1, Subsections 3.3.13, 3.3.14, and 3.9.7 – Evaluation of boron dilution event in Modes 4 and 5; New Subsection 3.1.12, “Unborated Water Source Isolation Valve – MODES 4 and 5,” to prohibit boron dilution when no RCPs are running in Modes 5 and 6	CC	16-139.3
15.4.6-7	216-8221 ML15259A829 Response: ML15345A378	New Subsection 3.9.7, “Unborated Water Source Isolation Valve – MODE 6,” to prohibit boron dilution in Mode 6	CC	
16-65	189-8057 ML15245A387 Response: ML15315A035	3.1.8 - clarified LCO statement	CU	16-139
16-66	189-8057 ML15245A387 Response: ML15315A035	3.1.8 – corrected the placement and clarified the content of the Note for Required Action A.1 (as presented in DCD Rev. 0) to permit operation of the auxiliary charging pump	CR	16-139
16-76	189-8057 ML15245A387 Response: ML15315A035	3.1.8 - Deleted Required Action A.2; B 3.1.8 - revised Background, ASA, LCO, Applicability, Actions, SR, and References sections for clarity and consistency with APR1400 design and safety analyses.	CU	16-139
16-139.1 16-139.2 16-139.3 16-139.4 16-139.5	478-8568 ML16131A614 Responses: ML16189A174 ML17138A937 ML17240A398 ML17296A128 ML17319A417	3.1.8 – Clarified the LCO statement, Applicability statement, Actions A and B, and SR 3.1.8.1; B 3.1.8 – Replaced Bases consistent with revised LCO, Actions, and Surveillances; 1.1 and 3.4.8 – removed “mid-loop” as a defined term	CR CR CC CR CC	

In RAI 17-7917, Question 15.4.6-1 (ML15146A260), the staff asked the applicant about the conservatism of the complete mixing model in DCD Tier 2, Section 15.4.6 for the boron dilution event during Modes 4 and 5 when all reactor coolant pumps are idle and only one shutdown cooling train is in service; under such conditions, the reactor coolant flow rate may not be sufficient to assume complete RCS mixing. The staff also requested the applicant to demonstrate that the startup range neutron flux detectors, which provide input to the Boron Dilution Alarm System (BDAS), can sense postulated incomplete mixing and still preserve adequate operator action times.

In its initial response (ML15238B709) to RAI 17-7917, Question 15.4.6-1, the applicant did not provide adequate justification that the complete mixing model is conservative including any potential effects of incomplete lower plenum mixing and the corresponding effect on time to criticality. Consequently, the staff tracked RAI 17-7917, Question 15.4.6-1, as an open item, the resolution of which was anticipated to result in changes to Subsections 3.1.8 and 3.9.7.

In RAI 189-8057, Question 16-65 (ML15245A387), the staff informed the applicant that Specification 3.1.8 (as renumbered) is unclear because the LCO statement did not appear to be consistent with the CVCS design which has three charging flow restriction orifice bypass valves—two motor operated (CV-576 and CV-577) and one manually operated (CV-575); (Question 16-66) the Note after Required Action A.1, that says “Only required after 60 EFPD” did not seem appropriate for Condition A (“Charging flow restriction orifice bypass valve is not closed.”) or Required Action A.1 (“Turn off charging pump.”); also the staff could not determine which action statement the Note applied to (A.1 or A.2, or both) because of the note’s non-standard placement; and (Question 16-76) the discussion contained in the Bases is vague and non-descriptive. Many of the sections repeat the same items, “closing the orifice bypass valve and removing power to the valve” without fully explaining how the applicable regulations are met.

In its responses (ML15315A035) to RAI 189-8057, Question 16-65, Question 16-66, and Question 16-76, the applicant collectively proposed changes to Subsection 3.1.8 as indicated by the markup below. In its response (ML16189A174) to follow up RAI 478-8568, Question 16-139, Sub-questions 1, 2, 3, 4, and 5, the applicant proposed additional changes to Subsection 3.1.8 as indicated by the markup below; the number of the question associated with the change is indicated in italics. The staff found that among the proposed changes are factual, typographical, and grammatical errors that need correction; the staff suggested changes to affected text are highlighted in gray in the markup.

LCO 3.1.8: Charging flow shall be maintained below 567.8 L/min (150 gpm) by closing charging flow restriction orifice bypass <u>valves (CV-567, CV-577)</u> ~~valve~~ and removing the power to the ~~above valve~~ <u>charging flow restriction orifice bypass valves</u>. *16-65, 16-139.1, 16-139.3*

Applicability: MODE 5 ~~during MID-LOOP operation for maintenance~~ with reactor vessel level ≤ 119 ft 1 in (hot leg level indication ≤ 100%). *16-139.5*

Condition A: A. ~~Charging flow restriction orifice bypass valve is not closed~~ One of the required charging flow restriction orifice bypass valves not closed. OR One of the required charging flow restriction orifice bypass valves with power not removed. *16-139.2*

Required Action A.1: A.1 Close ~~the~~ CV-575 ~~manually~~. | Immediately ... *16-139.2*

Condition ~~A~~B: B. ~~Both of~~ Two required charging flow restriction orifice bypass valves not closed. OR ~~Both of~~ Two required charging flow restriction orifice bypass valves with power not removed. *16-139.2*

Required Action ~~A~~B.1: B.1 NOTE Auxiliary charging pump operation is allowed. ~~Only required after 60 EFPD.~~
Turn off all charging pumps. | Immediately *16-66, 16-139.4*

~~Required Action A.2~~: ~~A.2 Suspend all operations involving positive reactivity changes.~~ | ~~Immediately~~ *16-76*

SR 3.1.8.1: Verify that required charging flow restriction orifice bypass valves are closed and power to the valves is ~~off~~ removed. | 8 hours *16-139*

The staff's evaluation of Subsection 3.1.8 was incomplete pending disposition of the above indicated staff suggested changes and resolution of RAI 478-8568, Question 16-139, Sub-questions 1, 2, 3, 4, and 5, which were tracked as open items.

In Subsection B 3.1.8, in the Background section, the applicant replaced the original paragraph with five paragraphs that describe the charging system design; the flow restricting orifices and orifice bypass valves, and their use during shutdown low RCS pressure conditions; the automatic closure of CV-576 on a Hi-Hi charging flow signal to ensure charging flow to the RCS is limited to 180 gpm or less, consistent with the assumption of the inadvertent boron dilution event in Modes 1, 2, 3, and 4—and in Mode 5 except during operation in the mid-loop condition. In the mid-loop condition, LCO 3.1.8 also requires CV-577 to be closed, and that both CV-576 and CV-577 be disconnected from their electrical power sources. With both valves closed, charging flow to the RCS is limited to 150 gpm or less, consistent with the assumption of the inadvertent boron dilution event in Mode 5 in the mid-loop condition in DCD Revision 0. In this condition, plant procedures also require CV-575 to be closed. The staff finds these changes are consistent with the DCD Tier 2, Revision 0, description of the CVCS system, and the inadvertent boron dilution event description in Revision 0 of DCD Tier 2, Section 15.4.6. Note, these changes are based on the initial responses to RAI 189-8057, Question 16-76 (ML15315A035) and RAI 478-8568, Question 16-139, Sub-question 3 (ML16189A174). Therefore, the Background section of the Bases for Subsection 3.1.8 appeared acceptable, with one exception. In the revised Background section's third and fourth paragraphs, ASA section's two paragraphs, and Applicability section's one paragraph, the term "mid-loop" is presented as a defined term, even though the response (ML16189A174) to RAI 478-8568, Question 16-139, replaced

"MODE 5 during MID-LOOP operation for maintenance" with "MODE 5 with reactor vessel level ≤ 36.7 m (119 ft 1 in) or (hot leg level indication ≤ 100%)" in the Subsection 3.1.8 Applicability statement. The staff also notes that the applicant's initial response (ML16312A528) to RAI 481-8546, Question 16-149 , appears to retain the defined term "mid-loop," and applies it in Subsection 3.4.8, "RCS Loops – MODE 5 (Loops Not Filled)." Pending the applicant providing an acceptable basis for specifying a defined term for the plant condition of mid-loop in Section 1.1 and using it in Subsection 3.4.8, when only the Bases for Subsection 3.1.8 in GTS Revision 0, uses the term, RAI 478-8568, Question 16-139, Sub-question 5, was tracked as an open item.

As discussed below, the subsequently revised Subsections 3.1.8 and B 3.1.8 rendered the issue about using "mid-loop" as a defined term in these subsections irrelevant. The applicant removed "mid-loop" from the list of defined terms in Section 1.1, and revised Subsections 3.4.8 and B 3.4.8 to only render "mid-loop" in lower case letters, and state that the "mid-loop condition" or "being in mid-loop operation" means that RCS level is ≤ 119 ft 1 in. Verification that these changes to Section 1.1 and Subsections 3.4.8 and B 3.4.8 are incorporated in Revision 2 of the DC application was tracked as a confirmatory item under RAI 478-8568, Question 16-139, Sub-question 5. See Section 16.4.2 and Section 16.4.9 of this SER for details of the mid-loop related changes to Section 1.1 and Subsections 3.4.8 and B 3.4.8.

In RAI 478-8568, Question 16-139, Sub-question 3 (ML16131A614), the staff requested that the applicant describe why an LCO is not needed to specify operability of the instrumentation for the auto-closure of CV-576 on Hi-Hi CVCS charging flow (176 gpm) in Mode 5 with loops not filled, which includes during mid-loop operation. In its response (ML16189A174) to RAI 478-8568, Question 16-139, Sub-question 3, the applicant stated:

> In Mode 5 with loops not filled, including during mid-loop operation, a closure of CV-576 is regardless of operation of the instrumentation for the auto-closure of CV-576 on Hi-Hi CVCS charging flow. The reason is specified in LCO 3.1.[8], CV-576 must be in closed state, by closing the valve and removing power. The auto-closure of CV-576 by instrument signal on Hi-Hi CVCS charging flow is not essential measure for closing CV-576. Therefore, the OPERABILITY of the instrumentation for the auto-closure of CV-576 on Hi-Hi CVCS charging flow is not required to be described in Mode 5 with loops not filled.

The staff notes that the revised discussion in the Background section of (DCD Revision 0) Subsection B 3.1.8, fifth paragraph, states

> This LCO is not necessary in all other MODES because a charging flow rate of 681.4 L/min (180 gpm) is assumed in the safety analyses and the charging flow rate is maintained below 681.4 L/min (180 gpm) by closure of the charging restricting orifice bypass valve CV-576 on ~~hi-hi~~ Hi-Hi flow.

In Modes 1, 2, and 3, and in Mode 4 before the shutdown cooling system is placed in operation, CV-576 is not required to be closed, either by a procedure or by an LCO. Were an inadvertent boron dilution event to occur in these Modes, it appears that the safety analyses would rely on the automatic closure of CV-576 on Hi-Hi charging flow to protect the 180 gpm upper limit assumption on CVCS charging flow. Pending resolution of this issue, RAI 478-8568, Question 16-139, Sub-question 3, was tracked as an open item. The staff observes that consideration of the charging flow Hi-Hi instrumentation as an LCO candidate may also need to be addressed in the resolution of RAI 154-8064, Question 16-42. However, as discussed below, the applicant added LCO 3.1.12 and revised LCO 3.1.8. These changes obviated establishing an instrumentation LCO for the automatic closure of the charging restricting orifice bypass valve CV-576 on Hi-Hi charging flow function, since LCO 3.1.8 will limit maximum charging flow to less than the analysis assumption in Modes 1, 2, 3, 4 and 5; and if no RCS loops are in operation a boron dilution even is precluded in Modes 1 and 2 by LCO 3.4.4, in Mode 3 by LCO 3.4.5, in Modes 4 and 5 by LCO 3.1.12, and in Mode 6 by LCO 3.9.7.

In its second and third revised supplemental responses to RAI 478-8568, Question 16-139 (ML17240A398 and ML17296A128 respectively), the applicant revised Subsection 3.1.8 based on the addition of Subsection 3.1.12, "Unborated Water Source Isolation Valve." (See the staff's evaluation of the applicant's revised response (ML17244A657) to RAI 17-7917, Question 15.4.6-1, in Section 15.4.6.4 of this SER.) The applicant added LCO 3.1.12 to preclude a boron dilution event whenever all RCPs are idle in Modes 4 and 5 by requiring the demineralized water supply line to the CVCS system to be isolated. Since this would also preclude a dilution event during mid-loop operation, LCO 3.1.8, as originally proposed, would no longer satisfy LCO selection criterion 2. However, when one or more RCPs are in operation, the DCD, Tier 2, Section 15.4.6 analysis of the inadvertent boron dilution event assumes that charging flow of demineralized water is no more than 180 gpm. Since an upper limit on charging flow rate is an initial condition of the event analysis, LCO selection criterion 2 requires establishing an LCO on charging flow, with an Applicability of Modes 1, 2, 3, 4, and 5. The staff notes that the restriction of LCO 3.1.12 would mean that meeting LCO 3.1.8 in Modes 4 and 5 is only needed when at least one RCS loop is in operation. And when no RCS loop is in operation in Mode 3, LCO 3.4.5 would prohibit operations that would cause reduction of the RCS boron concentration to less than required to meet the SDM of LCO 3.1.1; in addition, in Modes 1 and 2, if one or more LCO 3.4.4 required RCS loops cease operation, the reactor will trip placing the unit in Mode 3. If a required RCS loop is otherwise inoperable, the Actions of LCO 3.4.4 would require placing the unit in Mode 3 within 6 hours. Therefore, unless a boron dilution event is precluded by LCO 3.1.12, LCO 3.4.4, or LCO 3.4.5, the accident analysis assumption on maximum charging flow will be ensured by an LCO 3.1.8 revised as described.

In its latest response to Question 16-139, the applicant proposed changes to the LCO 3.1.8 charging flow limit, applicability, action, and surveillance requirements consistent with ensuring the validity of the inadvertent boron dilution event analysis, which assumes forced circulation of reactor coolant by one or more reactor coolant pumps. Should a boron dilution event occur, LCO 3.3.14 specifies operability of an alarm to alert the control room operator in time to terminate the dilution event before criticality occurs. A boron dilution event with no RCS loops in operation is precluded in Mode 6 by LCO 3.9.7, Modes 4 and 5 by LCO 3.1.12, Mode 3 by LCO 3.4.5, and in Modes 1 and 2 by LCO 3.4.4. Based on the revised Subsections 3.1.8 and B 3.1.8, "Charging Flow," being found acceptable, RAI 478-8568, Question 16-139, Sub-question 3, is resolved.

The applicant's revised Subsection 3.1.8 and B 3.1.8 rendered the staff's previous concerns about the initial version of these subsections irrelevant. Therefore, these concerns, which were documented in RAI 189-8057, Question 16-76, and RAI 478-8568, Question 16-139, Sub-questions 1, 2, and 4, and which were tracked as open items, are resolved with no changes to GTS requirements needed. As noted above, resolved Sub-question 5 was tracked as a confirmatory item to verify removal of "mid-loop" as a defined term in Revision 2 of the DC application, GTS Section 1.1 and Subsections 3.4.8 and B 3.4.8. Based on the review of Revision 2 of DCA part 4, the staff has confirmed incorporation of the changes described above; therefore, RAI 478-8568, Question 16-139, Sub-question 5, is resolved and closed.

In Subsection B 3.1.8, in the References section, the applicant added “FSAR Section 9.3” as Reference 1, which is cited in the Background section of the Bases for Subsection 3.1.8, and renumbered “FSAR Section 15.4” as Reference 2. These changes improve this section to be consistent with STS convention. Therefore, the staff concludes that the References section of the Bases for Subsection 3.1.8 is acceptable.

The staff reviewed Subsection 3.1.8 and Subsection B 3.1.8 and verified that the charging flow upper limit LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the validity of the charging flow rate initially assumed in the accident analyses for inadvertent boron dilution events initiating with one or more reactor coolant pumps in operation in Mode 1, 2, 3, 4, or 5. Accordingly, the staff concludes that Subsection 3.1.8 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.8 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.1.8. The staff also verified that Subsections 3.1.8 and B 3.1.8 are consistent with the guidance in the CE STS, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open items, the staff concludes that Subsection 3.1.8 and Subsection B 3.1.8 are acceptable.

Subsection 3.1.9 Special Test Exception (STE) – SHUTDOWN MARGIN (SDM)

Subsection 3.1.9 is to permit relaxation of selected existing LCOs to allow the performance of certain Physics Tests. These tests are conducted to determine the CEA worth and SDM. This STE LCO is required to permit the periodic verification of actual versus predicted reactivity worth of the regulating CEA and shutdown CEA.

The STS includes three special test exception (STE) Specifications:

STS Subsection 3.1.8, “STE – SHUTDOWN MARGIN (Digital)”
STS Subsection 3.1.9, “STE – MODES 1 and 2 (Digital)”
STS Subsection 3.4.17, “STE – RCS Loops”

The GTS also includes three STE Specifications:

GTS Subsection 3.1.9, “STE – SHUTDOWN MARGIN (SDM)”
GTS Subsection 3.1.10, “STE – MODES 1 and 2”
GTS Subsection 3.1.11, “STE – Reactivity Coefficient Testing”

The LCO statement of GTS 3.1.9, “STE – SDM,” differs from the LCO statement of STS 3.1.8, “STE – SDM,” as indicated in the following markup *of the STS statement:*

LCO 3.1.9~~8~~ During performance of ~~PHYSICS TESTS~~ criticality test or measurement of control element assembly (CEA) worth and SDM, the requirements of:

LCO 3.1.1, "SHUTDOWN MARGIN (SDM),"

LCO 3.1.5, "Shutdown Control Element Assembly (CEA) Insertion Limits~~,~~" ~~and~~

LCO 3.1.6, "Regulating Control Element Assembly (CEA) Insertion Limits~~,~~"

LCO 3.3.1, "Reactor Protection System (RPS) Instrumentation - Operating" (Only applied to Trip Functions 2, 14, and 15 in Table 3.3.1-1)

LCO 3.3.2, "Reactor Protection System (RPS) Instrumentation - Shutdown" (Only applied to Trip Function 1 in Table 3.3.2-1)

may be suspended ~~for measurement of CEA worth~~, provided shutdown reactivity equivalent to at least the highest estimated CEA worth (of those CEAs actually withdrawn) is available for trip insertion or the reactor is subcritical by at least the reactivity equivalent of the highest CEA worth.

The staff issued RAI 439-8524, Question 16-126 (ML16074A284), requesting that the applicant explain in more detail the need to add Subsection 3.3.1 reactor trip Functions 2, 14, and 15, and Subsection 3.3.2 reactor trip Function 1 to the list of excepted LCO requirements in LCO 3.1.9. In particular the staff requested information regarding (1) changes to operating bypass settings; (2) criticality test warranted bypass setting changes; and (3) the necessity of these additional exceptions for APR1400 over previous CE digital plant designs assumed by STS. In its response (ML16125A546) to RAI 439-8524, Question 16-26, the applicant explained:

1. Bypassing the High Logarithmic Power and High Local Power Density/Low Departure from Nucleate Boiling Ratio trips is to prevent unexpected reactor trips during the SDM test. The SDM test is performed at a critical condition before the point of [adding] heat (POAH). The power range for the test is normally from 10^{-4} % to 10^{-2} % of rated thermal power (RTP).

   The nominal high logarithmic power trip (HLPT) setpoint is 0.018% RTP, as indicated in DCD Tier 2, Table 7.2-4. This trip setpoint is very close to the test power range and, therefore, bypassing the HLPT is needed to prevent unexpected reactor trips. Having the nominal bypass setpoint within the test power range adds an unnecessary distraction to the test. When the power is decreased below 10^{-3} % RTP, the bypass is automatically removed. When the power is increased above 10^{-3} % RTP, operator action is needed to bypass the HLPT setpoint. The operator may miss a required action for the test due to the bypassing of the setpoint. Therefore, the bypass setpoint is changed to 10^{-4} % RTP for test convenience.

   The high local power density (LPD) and low departure from nucleate boiling ratio (DNBR) trips are generated in the core protection calculator (CPC). These CPC trip signals are generated when the shutdown CEA group is inserted or CEA sequencing is violated. Both of these conditions occur when performing control rod worth measurement during the SDM test. Therefore, the CPC trips should be bypassed during the test and the bypass setpoint is increased to 5% RTP.

2. There is no technical need to change the RPS bypass setpoint during the criticality test. The purpose of bypass setpoint change is to reduce the critical path of the reload startup sequences without compromising safety. Since the core is continuously monitored to estimate the criticality during the

criticality test and is controlled administratively with the criticality test procedure, it is an acceptable condition to allow the bypass setpoint change.

3. The APR1400 TS does not have LCO 3.4.17 of the CE STS, which is a special test exception of the RCS loops. LCO 3.4.17 enables the natural circulation test at power (i.e., reactor critical with less than 5% power) and defines the RPS bypassing. The RPS bypassing defined in LCO 3.4.17 is not only for the natural circulation test, but also for other physic[s] tests. The HLPT is normally bypassed at power and a special test exception is not needed for performing the natural circulation test at power. Adding the RPS bypassing in LCO 3.1.[9] corresponded to having LCO 3.4.17 in the CE STS during the previous licensing process.

The responses to Sub-questions 1, 2, and 3 are acceptable because testing in ranges that would cause a reactor trip is not practical; there is no reduction in safety due to the requirement for shutdown reactivity in LCO 3.1.9; administrative controls provided during the testing; and neutron flux level indication overlap in the startup and log safety ex-core channels. Therefore, RAI 439-8524, Question 16-126, is resolved.

The following table lists the RAI questions concerning Subsection 3.1.9.

Subsection 3.1.9 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-77	189-8057 ML15245A387 Response: ML15315A035	B 3.1.9 ASA section, second to last paragraph, last sentence – revised to match paragraph in STS B 3.1.8 ASA section to state, “The limits for these variables are specified for each fuel cycle in the COLR.”	CC	
16-79	189-8057 ML15245A387 Response: ML15315A035	B 3.1.9 SR section – added sentence about the surveillance column Note of SR 3.1.9.3; it states, “This SR is only applicable in MODE 3 as indicated in the Note.”	CC	

Subsection 3.1.9 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-126	439-8524 ML16074A284 Response: ML16125A546	Explained in more detail the need to add 3.3.1 reactor trip Functions 2, 14, and 15, and 3.3.2 reactor trip Function 1 to the list of excepted LCO requirements in LCO 3.1.9: (1) changes to operating bypass settings; (2) criticality test warranted bypass setting changes; (3) necessity of these exceptions for APR1400 over previous CE digital plant designs assumed by CE STS.	CR	

Status Codes:
CR Closed Resolved with no DCD changes CC Closed Confirmed

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.9 and B 3.1.9 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.9 and Subsection B 3.1.9 and verified that this STE LCO, and the associated applicability, action, and surveillance requirements are sufficient to allow performing a criticality test and determining CEA reactivity worth and SDM because they will ensure that a minimum amount of CEA worth is immediately available for reactivity control when CEA worth measurement tests are performed in Mode 2 or 3. Accordingly, the staff concludes that Subsection 3.1.9 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.9 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.9. The staff also verified that Subsections 3.1.9 and B 3.1.9 are consistent with the guidance in CE STS equivalent Subsections 3.1.8 and B 3.1.8, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.1.9 and Subsection B 3.1.9 are acceptable.

Subsection 3.1.10 Special Test Exception (STE) – MODES 1 and 2

Subsection 3.1.10 is to permit relaxation of selected existing LCOs to allow the performance of certain Physics Tests. These tests are conducted to determine specific reactor core characteristics. Examples of Physics Tests include determination of critical boron concentration, CEA group reactivity worths, reactivity coefficients, flux symmetry, and core power distribution. Such testing is required prior to initial criticality, after each refueling shutdown, and during startup, low power operation, power ascension, and at power operation. The Physics Tests requirements for the initial core and reload fuel cycles ensure that the operating characteristics of the core are consistent with the design predictions and that the core can operate as designed.

The LCO statement of GTS 3.1.10, "STE – MODES 1 and 2," differs from the LCO statement of STS 3.1.9, "STE – MODES 1 and 2." As a way to describe these differences, a markup of the LCO statement *from the STS* is provided:

LCO 3.1.10~~9~~ During performance of PHYSICS TESTS, the requirements of:

LCO 3.1.3, "Moderator Temperature Coefficient (MTC)~~,~~"
LCO 3.1.4, "Control Element Assembly (CEA) Alignment~~,~~"
LCO 3.1.5, "Shutdown Control Element Assembly (CEA) Insertion Limits~~,~~"
LCO 3.1.6, "Regulating Control Element Assembly (CEA) Insertion Limits~~,~~"
LCO 3.1.7, "Part ~~Length~~ Strength ~~Control Element Assembly (~~CEA~~)~~ Insertion Limits~~,~~"
LCO 3.2.2, "Planar Radial Peaking Factors (F_{xy})~~,~~"~~ and~~
LCO 3.2.3, "AZIMUTHAL POWER TILT (T_q)~~,~~"
LCO 3.2.5, "AXIAL SHAPE INDEX (ASI)"

may be suspended, provided THERMAL POWER is restricted to the test power plateau, which shall not exceed 85% RTP.

According to the deviation report, the STE for LCO 3.2.5, "ASI," is added for initial startup tests; for example, the CPC power distribution test. The staff notes that the DCD is not clear about whether this STE is expected to be removed from plant-specific TS with a license amendment by each future COL holder.

The following table lists the RAI questions concerning Subsection 3.1.10.

Subsection 3.1.10 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-78	189-8057 ML15245A387 Response: ML15315A035	B 3.1.10 ASA section, third to last paragraph, last sentence – revised to match paragraph in STS B 3.1.9 ASA section to state, "The limits for these variables are specified for each fuel cycle in the COLR."	CC	
16-80	189-8057 ML15245A387 Response: ML15315A035	B 3.1.10 LCO section – Justified omission of paragraph from STS B 3.1.9 LCO section regarding allowance to misalign the center CEA to determine the isothermal temperature coefficient (ITC), the moderator temperature coefficient (MTC), and the	CR	

Subsection 3.1.10 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		power coefficient. Misaligning the center CEA from its group may cause the CPC system to trip the reactor.		

Status Codes:
CR Closed Resolved with no DCD changes CC Closed Confirmed

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.10 and B 3.1.10 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.10 and Subsection B 3.1.10 and verified that this STE LCO, and the associated applicability, action, and surveillance requirements are sufficient to maintain power distribution and shutdown capability within limits, so that in the event an accident occurs during Physics Tests with one or more LCOs suspended in Mode 1 or 2, they will ensure that fuel damage criteria are not exceeded. This STE LCO will allow performing tests to (1) ensure the unit has been adequately designed; (2) validate analytical models used in design and analysis; (3) verify assumptions used for predicting unit response; (4) ensure installation of equipment in the unit has been accomplished in accordance with design; and (5) verify operating and emergency procedures are adequate. Accordingly, the staff concludes that Subsection 3.1.10 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.10 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.10. The staff also verified that Subsections 3.1.10 and B 3.1.10 are consistent with the guidance in CE STS equivalent Subsections 3.1.9 and B 3.1.9, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.1.10 and Subsection B 3.1.10 are acceptable.

Subsection 3.1.11 Special Test Exception (STE) – Reactivity Coefficient Testing

Subsection 3.1.11 is to permit relaxation of selected existing LCOs to allow the performance of certain Physics Tests. These tests are conducted to determine isothermal temperature coefficient (ITC), moderator temperature coefficient (MTC), and power coefficient.

The following table lists the RAI questions concerning Subsection 3.1.11.

Subsection 3.1.11 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-78	189-8057 ML15245A387 Response: ML15315A035	B 3.1.11 ASA section, second to last paragraph, last sentence – revised to match paragraph in STS B 3.1.9 ASA section to state, "The	CC	

Subsection 3.1.11 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		limits for these variables are specified for each fuel cycle in the COLR.”		
16-125	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329 ML17191B212	3.1.11 • LCO statement – revised to list referenced LCO 3.2.1 and LCO 3.2.4; • Simplified Condition A • SR 3.3.11.1 replaced with revised SR 3.1.11.1 and new SR 3.1.11.2	CC	
16-129	439-8524 ML16074A284 Response: ML16145A537	• LCO 3.1.11 STE to LCO 3.4.1.b regarding limits on cold leg temperature; • B 3.1.11 Applicable Safety Analyses section	CR	

Status Codes:
CR Closed Resolved with no DCD changes CC Closed Confirmed
RC Resolved Confirmatory

In RAI 439-8524, Question 16-125 (ML16074A284), the applicant was requested to clarify the phrasing of LCO 3.1.11 and SR 3.1.11.1 because the references to SR 3.2.1.1 and SR 3.2.4.1 in SR 3.1.11.1 appeared to be ambiguous. In its response (ML16125A546) the applicant stated:

> The LCO 3.3.1 defines the conditions for operation of the Reactor Protection System (RPS). According to LCO 3.3.1, having only one operable LHR or DNBR channel is not acceptable. The pre-requisite for reactivity coefficient testing requires that all CPC channels be operable and the COLSS be in service.

The applicant also revised LCO 3.1.11, Condition A, and SR 3.1.11.1 as indicated by the following markup:

LCO 3.1.11 “... may be suspended, provided Linear Heat Rate (LHR) and Departure from Nucleate Boiling Ratio (DNBR) do not exceed the limits specified in: ~~their LCOs.~~

LCO 3.2.1, “Linear Heat Rate (LHR)”; and
LCO 3.2.4, “Departure from Nucleate Boiling Ratio (DNBR).”

Action A: A. LHR or DNBR ~~outside the~~ not within limits ~~specified in their LCOs~~. | A.1 Reduce THERMAL POWER to restore LHR and DNBR to within limits. | 15 minutes

~~SR 3.1.11.1~~ ~~Verify LHR and DNBR do not exceed limits by performing SR 3.2.1.1 and SR 3.2.4.1.~~ | ~~Continuously~~

SR 3.1.11.1 NOTE Only required to be performed when COLSS is out of service. With COLSS in service, LHR is continuously monitored.

Verify LHR, as indicated on any OPERABLE Core Protection Calculator local power density channel, is within the limit specified in the COLR. | 15 minutes

SR 3.1.11.2 NOTE Only required to be performed when COLSS is out of service. With COLSS in service, DNBR is continuously monitored.

Verify DNBR, as indicated on any OPERABLE Core Protection Calculator DNBR channel, is within the limits of Figure 3.2.4-2 or Figure 3.2.4-3 of the COLR, as applicable. | 15 minutes

Based on the above statement and the indicated changes to Subsection 3.1.11 from the applicant's response, the staff concludes that using "any" OPERABLE local power density channel in SR 3.1.11.1, and "any" OPERABLE DNBR channel in SR 3.1.11.2 is acceptable. The staff also concludes that the indicated changes eliminate the previous ambiguity and make the requirements clear. Therefore, the staff finds that RAI 439-8524, Question 16-125, as it relates to Subsection 3.1.11, is resolved.

In RAI 439-8524, Question 16-129 (ML16074A284), the staff requested that the applicant explain in more detail the justification for the exception to LCO 3.4.1.b and 3.4.1.c for cold leg temperature in LCO 3.1.11. The staff finds that the applicant's response (ML16145A537) is acceptable because a variation in cold leg temperature nearly the size of the allowed cold leg temperature band is planned to measure the MTC. There is not a reduction in safety because cold leg temperature limits help to maintain DNBR limits, and DNBR and LHR are continuously monitored during reactivity coefficient testing per SR 3.1.11.1. Therefore, RAI 439-8524, Question 16-129 is resolved with no DCD changes needed.

As stated previously, RAI 507-8587, Question 16-171, was tracked as an open item. Question 16-171 is resolved for Subsections 3.1.11 and B 3.1.11 because the applicant's response (ML17235B285) corrected the Section 3.1 subsection references in these subsections.

The staff reviewed Subsection 3.1.11 and Subsection B 3.1.11 and verified that this STE LCO, and the associated applicability, action, and surveillance requirements are sufficient to maintain power distribution and shutdown capability within limits, so that in the event an accident occurs during Physics Tests with one or more LCOs suspended in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. This STE LCO will allow performing reactivity coefficient Physics Tests to determine the isothermal temperature coefficient, moderator temperature coefficient, and power coefficient. Accordingly, the staff concludes that Subsection 3.1.11 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.1.11 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.1.11. The staff also verified that Subsections 3.1.11 and B 3.1.11 are consistent with the guidance in CE STS, and the APR1400 design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.1.11 and Subsection B 3.1.11 are acceptable.

Subsection 3.1.12 Unborated Water Source Isolation Valve – MODES 4 and 5

This subsection resulted from the staff's concerns in RAI 17-7917, Question 15.4.6-1 (ML15146A260), about adequate mixing of injected unborated water and reactor coolant in the reactor vessel were an inadvertent boron dilution event to occur when all reactor coolant pumps (RCPs) are idle, with the unit in Mode 4 or 5. In the final revised response to Question 15.4.6-1 (ML17244A657) the applicant added LCO 3.1.12 to preclude a boron dilution event whenever all RCPs are idle in MODES 4 and 5 by requiring the demineralized water supply line to the CVCS to be isolated.

This Subsection is similar to Subsection 3.9.7, "Unborated Water Source Isolation Valve – MODE 6," which was added in response (ML15345A378) to RAI 216-8221, Question 15.4.6-7. See Section 16.4.14 of this SER for the discussion of Question 15.4.6-7 and Subsection 3.9.7. Also see above in this section of this SER for a discussion of Subsection 3.1.8, "Charging Flow." LCO 3.1.8 limits charging flow when at least one RCS loop is in operation in Modes 1, 2, 3, 4 and 5, based on the flow assumed in the boron dilution event analysis in FSAR Section 15.4.6.

The staff reviewed the proposed Specification 3.1.12 and Bases and found that they conform to STS conventions for content and format. LCO 3.1.12 is also adequate to ensure an inadvertent boron dilution event will be prevented when all RCPs are idle in Modes 4 and 5. Therefore, the staff concludes that Subsection 3.1.12 and Subsection B 3.1.12 are acceptable.

The staff verified that RAI 17-7917, Question 15.4.6-1, and RAI 216-8221, Question 15.4.6-7, are both resolved, based in part on the requirements of LCO 3.1.12 and LCO 3.9.7, that preclude an inadvertent boron dilution event with no RCPs running in Modes 4, 5, and 6.

Conclusion for GTS Section 3.1 and Section B 3.1

The applicant adhered to the general reactivity control system provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.1 and Section B 3.1 are acceptable.

16.4.7 TS Chapter 3.0 LCOs and SRs ─ Section 3.2 Power Distribution Limits

Section 3.2 includes requirements for the reactor core power distribution limits; core operation within these limits ensures the assumptions of the accident analyses remain valid.

The GTS Subsections for core power distribution limits correspond to the CE STS Subsections for core power distribution limits (digital plants) in the following manner:

STS	GTS	Title (Note that STS Titles append "(Digital)")
3.2.1	3.2.1	Linear Heat Rate (LHR)
3.2.2	3.2.2	Planar Radial Peaking Factors (F_{xy})
3.2.3	3.2.3	AZIMUTHAL POWER TILT (T_q)
3.2.4	3.2.4	Departure from Nucleate Boiling Ratio (DNBR)
3.2.5	3.2.5	AXIAL SHAPE INDEX (ASI)

Subsection 3.2.1 Linear Heat Rate (LHR)

Subsection 3.2.1 is to limit core power distribution to the initial values assumed in the accident analyses, which would limit the damage to the fuel cladding during an accident by ensuring that the plant is operating within acceptable bounding conditions at the onset of a transient.

The following table lists the RAI questions concerning Subsection 3.2.1.

Subsection 3.2.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-83	190-8058 ML15245A719 Response: ML15292A550	B 3.2.1 – Removed phrase “protection and” from Bases for the Frequency of SR 3.2.1.2 because the COLSS LHR margin alarm is not part of the PPS.	CC	
16-84	190-8058 ML15245A719 Response: ML15292A550	B 3.2.1 Background section – Pointed out that an apparently missing STS 3.2.1 Bases sentence is in fact not missing	CR	
16-85	190-8058 ML15245A719 Response: ML15292A550	B 3.2.1 Actions section -- Removed the sentence, “If LHR cannot be monitored every 15 minutes, assume that there is an adverse trend” from the Bases for Required Actions B.1, B.2.1, and B.2.2 because Bases cannot modify associated TS requirements.	CC	
16-125	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329 ML17191B212	In SR 3.2.1.1 and Bases; and SR 3.2.4.1, clarified the meaning of “any” OPERABLE CPC LHR channel and “any” OPERABLE CPC DNBR channel.	CC	

Status Codes:
CR Closed Resolved with no DCD changes RC Resolved Confirmatory
CC Closed Confirmed

In RAI 190-8058, Question 16-83 (ML15245A719), the staff inquired about the omission of a sentence in the STS Section 3.2 Bases for the 31 day Frequency of SR 3.2.1.2, SR 3.2.3.3, and SR 3.2.4.2 from the GTS Section 3.2 Bases for SR 3.2.1.2, SR 3.2.3.3, and SR 3.2.4.2. The STS Subsection B 3.2.1 Bases paragraph with the omitted sentence indicated in italics, states:

> The 31 day Frequency for performance of this SR is consistent with the historical testing frequency of reactor protection and monitoring systems. *The Surveillance Frequency for testing protection systems was extended*

to 92 days by CEN 327. Monitoring systems were not addressed in CEN 327; therefore, this Frequency remains at 31 days."

In its response (ML15292A550) to Question 16-83, the applicant stated that it could not locate the omitted sentence in STS Section 3.2 Bases. Since the sentence is not necessary to justify the 31 day Frequency of the listed GTS SRs, the staff concluded that the omissions are acceptable. However, the applicant noted an apparent inaccuracy in the first sentence of the above paragraph, and proposed to remove the phrase "protection and" from the Bases for the 31 day Frequency of

- SR 3.2.1.2 because the COLSS LHR margin alarm is not part of the Plant Protection System (PPS) instrumentation;
- SR 3.2.3.2 because the alarm on the COLSS calculated Azimuthal Power Tilt (T_q) is not a part of the PPS instrumentation; and
- SR 3.2.4.2 because the COLSS DNBR margin alarm is not part of the PPS instrumentation.

Consequently, the Bases for the 31 day Frequency for each of these SRs will state: "The 31 day Frequency for performance of this SR is consistent with the historical testing frequency of reactor monitoring systems." This change is appropriate, since the COLSS indication and alarm functions are not included in the PPS instrumentation. Finding the applicant's response acceptable, the staff concludes that RAI 190-8058, Question 16-83 is resolved.

In RAI 190-8058, Question 16-84 (ML15245A719), the staff inquired about the following statement in the eighth paragraph of the Background section of the Bases for STS Subsection 3.2.1 that appeared to be missing from GTS Subsection B 3.2.1: "This penalty is correlated with the amount of rod bow determined from the maximum average assembly burnup of the batch." In its response (ML15292A550) the applicant rightly pointed out that the sentence is not missing. Therefore, RAI 190-8058, Question 16-84 is closed.

In RAI 190-8058, Question 16-85 (ML15245A719), the staff inquired about what appeared to be an action statement in the Actions section of the Bases for Subsection 3.2.1; this statement is not included in the STS Subsection B 3.2.1 Actions section. In its response (ML15292A550) the applicant agreed to remove the sentence, "If LHR cannot be monitored every 15 minutes, assume that there is an adverse trend" from the Bases for Required Actions B.1, B.2.1, and B.2.2 because Bases cannot modify associated TS requirements. However, the staff considers the direction provided by this statement to be conservative because it would lead to following Required Action B.2.1, which requires restoring LHR to within limit within 1 hour when there is an adverse trend in LHR; this direction would be appropriate for unit operating procedures. Finding the response acceptable, the staff concludes that RAI 190-8058, Question 16-85 is resolved.

See the evaluation of RAI 439-8524, Question 16-125, in the discussion of Subsection 3.2.4 below; based on that evaluation, Question 16-125, as it relates to Subsection 3.2.1, is resolved.

The staff reviewed Subsection 3.2.1 and Subsection B 3.2.1 and verified that this core power distribution limit LCO on LHR, and the associated applicability, action, and surveillance requirements are sufficient to maintain the core power distribution within the limits specified in the Core Operating Limits Report (COLR), so that in the event an accident occurs in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. Accordingly, the staff concludes that Subsection 3.2.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.2.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.2.1. The staff also verified that Subsections 3.2.1 and B 3.2.1 are consistent with the guidance in CE STS Subsections 3.2.1 and B 3.2.1, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.2.1 and Subsection B 3.2.1 are acceptable.

Subsection 3.2.2 Planar Radial Peaking Factors (F_{xy})

Subsection 3.2.2 is to limit the core power distribution to the initial values assumed in the accident analyses, which would limit the damage to the fuel cladding during an accident by ensuring that the plant is operating within acceptable bounding conditions at the onset of a transient.

The following table lists the RAI-question concerning Subsection 3.2.2.

Subsection 3.2.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-81	190-8058 ML15245A719 Response: ML15292A550	Justified SR 3.2.2.1 Frequency of "Once after each fuel loading with Thermal Power > 40% RTP but prior to operations above 80% RTP"	CR	

Status Code:
CR Closed Resolved with no DCD changes

In RAI 190-8058, Question 16-81 (ML15245A719), the staff requested that the applicant explain the reasons for the deviation from the STS regarding the Frequency for SR 3.2.2.1, which states

Surveillance: Verify measured F_{xy}^{M} obtained using Incore Detector System is equal to or less than value of calculated F_{xy}^{C} used in COLSS and CPCs.

Frequency: Once after each fuel loading with THERMAL POWER > 40% RTP but prior to operations above 80% RTP AND 31 EFPD thereafter

The STS Frequency for this surveillance states "…but prior to operations above 70% RTP…"

In its response (ML15292A550) the applicant stated:

> The 80% RTP value was determined from the ANSI/ANS-19.6.1-2005, "Reload Startup Physics Tests for Pressurized Water Reactors." There is no compromise in plant safety, since all the design analysis, (including COLSS/CPCS overall uncertainty analysis), will be based on 80% RTP and a conservative F_{xy}. An additional penalty will be installed at the COLSS/CPCS prior to the 80% F_{xy} measurement during the startup test period. It is also judged to be more economical to measure F_{xy} at a higher power plateau since it can take several hours to perform the measurement due to the requirement for equilibrium Xenon conditions.

The staff finds that the response is acceptable because it is consistent with the cited ANSI/ANS-19.6.1-2005 as well as analysis documentation for the COLSS/CPCS. Therefore, RAI 190-8058, Question 16-81 is resolved.

The staff reviewed Subsection 3.2.2 and Subsection B 3.2.2 and verified that this core power distribution limit LCO on the measured planar radial peaking factors (F^M_{xy}), and the associated applicability, action, and surveillance requirements are sufficient to maintain the F^M_{xy} at or less than the calculated planar radial peaking factors (F^C_{xy}) used in the Core Operating Limit Supervisory System (COLSS) and core protection calculators (CPCs), so that in the event an accident occurs in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. Accordingly, the staff concludes that Subsection 3.2.2 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.2.2 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.2.2. The staff also verified that Subsections 3.2.2 and B 3.2.2 are consistent with the guidance in CE STS Subsections 3.2.2 and B 3.2.2, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.2.2 and Subsection B 3.2.2 are acceptable.

Subsection 3.2.3 AZIMUTHAL POWER TILT (T_q)

Subsection 3.2.3 is to limit the core power distribution to the initial values assumed in the accident analyses, which would limit the damage to the fuel cladding during an accident by ensuring that the plant is operating within acceptable bounding conditions at the onset of a transient.

The following table lists the RAI questions concerning Subsection 3.2.3.

Subsection 3.2.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-82	190-8058 ML15245A719 Response: ML15292A550	3.2.3 Note for Required Actions B.1, B.2 and B.3 – Revised Note to state: “All subsequent Required Actions ~~up to B.3~~ must be completed ...” to improve clarity and to conform to the same Note in STS 3.2.3	CC	
16-83	190-8058 ML15245A719 Response: ML15292A550	B 3.2.3 – Removed the phrase “protection and” from Bases for the Frequency of SR 3.2.3.2 because the alarm on the COLSS calculated Azimuthal Power Tilt (T_q) is not a part of the PPS instrumentation.	CC	

Subsection 3.2.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-86	190-8058 ML15245A719 Response: ML15292A550	B 3.2.3 Actions section – corrected discussion of Action B required action Note to be consistent with change made in response to Question 16-82	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

In its response (ML15292A550) to RAI 190-8058, Question 16-82, the applicant agreed to change the required action Note for Action B to match the STS Subsection 3.2.3 version of the Note. Because the revised Note is clear, the change is acceptable, and Question 16-82 is resolved. In the same response letter, the applicant responded to Question 16-86 by changing the associated Bases for the Action B required action Note to be consistent with the revised Note. Therefore, Question 16-86 is also resolved.

See evaluation of Subsection 3.2.1 above for discussion of RAI 190-8058, Question 16-83.

The staff reviewed Subsection 3.2.3 and Subsection B 3.2.3 and verified that this core power distribution limit LCO on the measured Azimuthal Power Tilt (T_q), and the associated applicability, action, and surveillance requirements are sufficient to maintain the measured T_q at or less than the T_q allowance used in the core protection calculators (CPCs), so that in the event an accident occurs in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. Accordingly, the staff concludes that Subsection 3.2.3 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.2.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.2.3. The staff also verified that Subsections 3.2.3 and B 3.2.3 are consistent with the guidance in CE STS Subsections 3.2.3 and B 3.2.3, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.2.3 and Subsection B 3.2.3 are acceptable.

Subsection 3.2.4 Departure from Nucleate Boiling Ratio (DNBR)

Subsection 3.2.4 is to limit the core power distribution to the initial values assumed in the accident analyses, which would limit the damage to the fuel cladding during an accident by ensuring that the plant is operating within acceptable bounding conditions at the onset of a transient.

The following table lists the RAI questions concerning Subsection 3.2.4.

Subsection 3.2.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-83	190-8058 ML15245A719 Response:	B 3.2.4 - Removed the phrase "protection and" from Bases for the Frequency of	CC	

Subsection 3.2.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML15292A550	SR 3.2.4.2 because the COLSS DNBR margin alarm is not part of the PPS.		
16-109.1	295-8263 ML15314A020 Response ML16006A511	Revise LCO 3.2.4 and Bases to match CPC system design with two CEACs per CPC channel	CC	16-125
16-109.2	295-8263 ML15314A020 Response: ML16006A511	Provided draft COLR Figures 3.2.4-1, 3.2.4-2, and 3.2.4-3 to verify references in LCO 3.2.4	CR	
16-125	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329 ML17191B212	In SR 3.2.1.1 and SR 3.2.4.1, clarified the meaning of "any" OPERABLE CPC LHR channel and "any" OPERABLE CPC DNBR channel.	CC	

Status Codes:
RC Resolved Confirmatory
CC Closed Confirmed
CR Closed Resolved with no DCD changes

See evaluation of Subsection 3.2.1 above for discussion of RAI 190-8058, Question 16-83.

Conformance to APR1400 Core Protection Calculator System Design

In RAI 295-8263, Question 16-109 (ML15314A020), the staff requested that KHNP revise LCO 3.2.4 and the associated LCO section of the Bases to reflect the APR1400 Core Protection Calculator (CPC) System (CPCS) design in which each of the four CPC channels contains two control element assembly calculators (CEACs). The GTS Subsection 3.2.4 had mistakenly adopted the requirements of STS LCO 3.2.4, which are based on a previous CPCS design in which two CEACs are shared among the four CPC channels. Since the APR1400 CPCS design is similar to the CPCS design previously implemented on the three CE digital units of the Palo Verde Nuclear Generating Station, in response (ML16006A511) to Question 16-109 the applicant proposed adopting the Palo Verde LCO 3.2.4, as follows; the only notable difference is the addition of references to three Figures to be specified in Section 3.2.4 of the APR1400 Core Operating Limits Report (COLR).

LCO 3.2.4 The DNBR shall be maintained by one of the following methods:

a. Core Operating Limit Supervisory System (COLSS) In Service:

1. Maintaining COLSS calculated core power less than or equal to COLSS calculated core power operating limit based on DNBR when at least one Control Element Assembly Calculator (CEAC) is OPERABLE in each OPERABLE Core Protection Calculator (CPC) channel; or

2. Maintaining COLSS calculated core power less than or equal to COLSS calculated core power operating limit based on DNBR decreased by the allowance specified in Figure 3.2.4-1 of the Core Operating Limits Report (COLR) when the CEAC requirements of LCO 3.2.4.a.1 are not met.

b. COLSS Out of Service:

1. Operating within the region of acceptable operation of Figure 3.2.4-2 specified in the COLR using any OPERABLE CPC channel when at least one CEAC is OPERABLE in each OPERABLE CPC channel; or

2. Operating within the region of acceptable operation of Figure 3.2.4-3 specified in the COLR using any OPERABLE CPC channel (with both CEACs inoperable) when the CEAC requirements of LCO 3.2.4.b.1 are not met.

Note that the CEAC requirements of LCO 3.2.4.a.1 and LCO 3.2.4.b.1 are not met when both CEACs of any OPERABLE CPC channel are inoperable. Based on the changes provided in the response, RAI 295-8236, Question 16-109, is resolved.

In RAI 439-8524, Question 16-125 (ML16074A284), the applicant was requested to clarify the phrasing of LCO 3.1.11 and SR 3.1.11.1 because the references to SR 3.2.1.1 and SR 3.2.4.1 in SR 3.1.11.1 appeared to be ambiguous. In its initial response (ML16125A546) the applicant stated:

> The LCO 3.3.1 defines the conditions for operation of the Reactor Protection System (RPS). According to LCO 3.3.1, having only one operable LHR or DNBR channel is not acceptable. The pre-requisite for reactivity coefficient testing requires that all CPC channels be operable and the COLSS be in service.

In addition to revising Subsection 3.1.11, the applicant also proposed conforming changes as indicated by the following markup to clarify SR 3.2.1.1 and SR 3.2.4.1 (Note inclusion of gray highlighted markup for correction of a typographical error):

SR 3.2.1.1 Verify LHR, as indicated on ~~each~~ <u>any</u> OPERABLE local power density channel, is within its limit. | 2 hours

SR 3.2.4.1 Verify DNBR, as indicated on ~~all~~ <u>any</u> OPERABLE DNBR channel~~s~~, is within limit<u>s</u> of Figure 3.2.4-2 or 3.2.4-3 of COLR, as applicable. | 2 hours

Based on the above statement and the indicated changes from the applicant's response, the staff concludes that using "any" operable local power density channel in SR 3.2.1.1, and "any" operable DNBR channel in SR 3.2.4.1 is acceptable. Therefore, the staff concludes that the applicant's response to RAI 439-8524, Question 16-125, as it relates to Subsections 3.2.1 and 3.2.4, is acceptable.

The staff's completion of the evaluation of Subsection 3.2.4 was pending correction of the errors in SR 3.2.4.1, which was tracked as an open item under RAI 439-8524, Question 16-125. In its second revised response (ML17191B212) the applicant corrected the noted errors in SR 3.2.4.1. Therefore, RAI 439-8524, Question 16-125, is resolved.

The staff reviewed Subsection 3.2.4 and Subsection B 3.2.4 and verified that this core power distribution limit LCO on DNBR and the associated applicability, action, and surveillance requirements are sufficient to maintain DNBR within the specified limits, so that in the event an accident occurs in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. Accordingly, the staff concludes that Subsection 3.2.4 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.2.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.2.4. The staff also verified that Subsections 3.2.4 and B 3.2.4 are consistent with the guidance in CE STS Subsections 3.2.4 and B 3.2.4, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.2.4 and Subsection B 3.2.4 are acceptable.

Subsection 3.2.5 AXIAL SHAPE INDEX (ASI)

Subsection 3.2.5 is to limit the core power distribution to the initial values assumed in the accident analyses, which would limit the damage to the fuel cladding during an accident by ensuring that the plant is operating within acceptable bounding conditions at the onset of a transient.

The following table lists the RAI question concerning Subsection 3.2.5.

Subsection 3.2.5 ***Question.Sub-Question No.***	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-186	508-8592 ML16214A058 Response: ML16243A519	B 3.2.5 Background - clarified two sentences by adopting equivalent sentences from STS Bases	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The staff reviewed Subsection 3.2.5 and Subsection B 3.2.5 and verified that this core power distribution limit LCO on ASI and the associated applicability, action, and surveillance requirements are sufficient to maintain ASI within the specified limits, so that in the event an accident occurs in Mode 1 above 20 percent of Rated Thermal Power, they will ensure that fuel damage criteria are not exceeded. Accordingly, the staff concludes that Subsection 3.2.5 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.2.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.2.5. The staff also verified that Subsections 3.2.5 and B 3.2.5 are consistent with the guidance in CE STS Subsections 3.2.5 and B 3.2.5, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.2.5 and Subsection B 3.2.5 are acceptable.

Conclusion for GTS Section 3.2 and Section B 3.2

The applicant adhered to the general LCO, Action, and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.2 and Section B 3.2 are acceptable.

16.4.8 TS Chapter 3.0 LCOs and SRs ─ Section 3.3 Instrumentation

GTS Section 3.3 provides requirements for safety-related instrumentation and controls that are designed for actuating the reactor protection system to trip the reactor; the engineered safety features (ESF) systems to mitigate the consequences of postulated events; and some nonsafety-related instrumentation (Diverse Protection System) to initiate these actuations to protect against common-cause failure of the Plant Protection System (PPS).

In general, GTS Section 3.3 is modeled after STS Section 3.3, with differences to reflect APR1400 unique design features. These unique design features, which are described in deviation report Section III.1.2, include:

(1) STS Subsection 3.3.1B, Function 12, Loss of Load (turbine stop valve control oil pressure) RPS reactor trip Function is not used (III.1.2.1);

(2) STS Subsection 3.3.5B, Function 5a, Recirculation Actuation Signal on Refueling Water Storage Tank Level – Low, is not used (III.1.2.2);

(3) STS Subsection 3.3.6B, Function 4, Recirculation Actuation Signal ESFAS logic, is not used (III.1.2.2).

(4) STS Subsection 3.3.5B, Function 2b, Containment Cooling Actuation Signal (CCAS) on Automatic Safety Injection Actuation Signal (SIAS), is not used (III.1.2.2);

(5) STS Subsection 3.3.6B, Function 3, Containment Cooling Actuation Signal (CCAS) ESFAS logic, is also not used

> From DR III.1.2.2 “[In the APR1400,] The CCAS ESFAS [~~trip~~ actuation] Function is included in the Containment Spray Actuation Signal (CSAS) Function.”

(6) From DR III.1.2.2: GTS Subsection 3.3.5, Functions 5a and 6a, Auxiliary Feedwater Actuation Signal on respective Steam Generator Level (Wide Range) – Low is used instead of the “Emergency Feedwater Actuation Signal.”

(7) From DR III.1.2.3: GTS Subsections 3.3.1 and 3.3.2, RPS reactor trip Functions 2 and 1, respectively, Logarithmic Power Level – High, has different operating bypass permissive and removal setpoints; these are ≥ 10^{-3} % RTP and < 10^{-3} % RTP, respectively. Surveillance column Note 2 for SR 3.3.1.7 (“Perform CHANNEL FUNCTIONAL TEST for each RPS instrumentation channel in accordance with Setpoint Control Program. | 31 days”) is being changed as indicated to state:

> 2. Not required to be performed for Logarithmic Power Level – High until 2 hours after reducing ~~THERMAL POWER~~ logarithmic power below 1E-3% ~~RTP~~ and only if the ~~RTSGs~~ reactor trip circuit breakers (RTCBs) are open.”

The STS uses 1E-4% RTP, which is less restrictive than the GTS value of 1E-3% logarithmic power.

(8) From DR III.1.2.4: GTS Subsection 3.3.1, RPS reactor trip Function 4, Pressurizer Pressure – Low, and Subsection 3.3.5, ESFAS actuation Function 1b, Safety Injection Actuation Signal (SIAS) on Pressurizer Pressure – Low, and Function 3b, Containment Isolation Actuation Signal (CIAS) on Pressurizer Pressure – Low, all specify in table footnotes that the minimum setting for Pressurizer Pressure – Low is 100 psia (7 kg/cm^{2}A), and that its operating bypass permissive and [automatic] removal setpoints are 400 psia (28 kg/cm^{2}A) and 500 psia (35 kg/cm^{2}A), respectively. These values are different from the STS values.

(9) RPS logic and ESFAS logic each uses four coincidence logic channels instead of the typical digital CE plant's six matrix logic channels (III.1.2.5);

(10) From DR III.1.2.6: Actuation logic subgroup testing as stipulated in the surveillance column Note of SR 3.3.6.2 (Perform a verification of the OPERABILITY of subgroup for Actuation signal of each Actuation Logic channel. | 31 days on a STAGGERED TEST BASIS); the Note states:

> 2. Subgroup of Actuation Logic channel A, C and B, D shall be tested on a staggered basis.

The deviation report also says, "The 31-day frequency on a staggered test basis is consistent with the operating experience of Korean [nuclear power plants (NPPs)]. The APR1400 ESF-CCS does not have subgroup relays, but contains the logic for subgroup control."

(11) From DR III.1.2.7: The APR1400 I&C systems provide Diverse Manual ESF Actuation controls and indications to provide protection against accidents and concurrent common cause failure of PPS and/or ESF-CCS. STS Section 3.3 does not specify operability of any Diverse Manual ESF Actuation controls. GTS includes them in Table 3.3.6-1, as Function 7, Diverse Manual ESF Actuation Signal for SI, CS, AFW, MSIV closure, and CI.

(12) From DR III.1.2.8: Two control element assembly calculators (CEACs) are provided for each core protection calculator (CPC) system (CPCS) channel for a total of eight CEACs. In a typical CE plant, just two CEACs support all four CPC channels.

The GTS Subsections for instrumentation correspond to the CE STS Subsections for instrumentation in the following manner:

STS	GTS	Title (*STS Title, if different)
3.3.1B*	3.3.1	Reactor Protection System (RPS) Instrumentation – Operating (*Reactor Protective System (RPS) Instrumentation – Operating)
3.3.2B*	3.3.2	Reactor Protection System (RPS) Instrumentation – Shutdown (*Reactor Protective System (RPS) Instrumentation – Shutdown)
3.3.3B	3.3.3	Control Element Assembly Calculators (CEACs)
3.3.4B*	3.3.4	RPS Logic and Trip Initiation (*RPS Logic and Trip Initiation (Digital))

3.3.5B	3.3.5	Engineered Safety Features Actuation System (ESFAS) Instrumentation
3.3.6B	3.3.6	ESFAS Logic and Manual Trip
3.3.7B*	3.3.7	Emergency Diesel Generator – Loss of Voltage Start (EDG-LOVS) (*Diesel Generator – Loss of Voltage Start (DG-LOVS))
3.3.8B*	3.3.8	Containment Purge Isolation Actuation Signal (CPIAS) (*Containment Purge Isolation Signal (CPIS))
3.3.9B*	3.3.9	Control Room Emergency Ventilation Actuation Signal (CREVAS) (*Control Room Isolation Signal (CRIS))
3.3.10*	3.3.10	Fuel Handling Area Emergency Ventilation Actuation Signal (FHEVAS) (*Fuel Handling Isolation Signal (FHIS))
3.3.11*	3.3.11	Accident Monitoring Instrumentation (AMI) (*Post Accident Monitoring (PAM) Instrumentation)
3.3.12*	3.3.12	Remote Shutdown Display and Control (*Remote Shutdown System (RSS))
3.3.13	3.3.13	Logarithmic Power Monitoring Channels
—	3.3.14	Boron Dilution Alarms

The following table lists selected RAI questions concerning two or more Subsections of GTS Section 3.3.

Section 3.3 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.1, 3.3.2, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.10, 3.3.11, 3.3.12, 3.3.13, 3.3.14 and Bases	CU	16-137
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103	Replaced “reactor trip switchgear (RTSG)” with “reactor trip circuit breaker (RTCB)” —to be consistent with STS and remainder of DCD Tier 2, Chapter 16—in • 3.3.1 and B 3.3.1, • 3.3.2 and B 3.3.2, • B 3.3.3, • 3.3.4 and B 3.3.4, and • 3.3.13 and B 3.3.13	CC	

Section 3.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-137	470-8552 ML16117A247 Responses: ML16295A319 ML17233A395 ML17249A954	RPS and ESFAS testing 1. DCD 7.2.2.5 2. DCD Figure 7.2-11 3. Channel Functional Test 4. DCD Figure 7.2-11	CC	

Status Codes:
CU Closed Unresolved (has follow up question)
RC Resolved Confirmatory
CR Closed Resolved with no DCD changes
CC Closed Confirmed

Equivalence of Instrumentation Testing Described in DCD Tier 2, Chapter 7, "Instrumentation," and Instrumentation Function Surveillance Requirements Specified by GTS Section 3.3

The staff determined that the descriptions of the testing requirements for RPS instrumentation in DCD Tier 2, Section 7.2, "Reactor Trip System," and for engineered safety features actuation system (ESFAS) instrumentation in DCD Tier 2, Section 7.3, "Engineered Safety Features Systems," do not clearly explain the correspondence of the described tests to the technical specification SRs—in particular the defined surveillances of Channel Check, Channel Functional Test, and Channel Calibration.

In RAI 239-8076, Question 16-89 (ML15282A602), the staff requested that the applicant describe the correspondence between the testing depicted in DCD Tier 2, Figure 7.2-11, "PPS Testing Overlap," and the Section 3.3 SRs that implement Channel Check, Channel Calibration, and Channel Functional Test. For these SRs, the applicant was requested to provide discussions applicable to:

(a) RPS and ESFAS Functions with two-out-of-four coincidence logic;

(b) Balance of plant (BOP) ESFAS Functions with one-out-of-two coincidence logic; and

(c) Diverse protection system (DPS) Functions included in GTS Section 3.3.

Also requested were

(d) Function-specific discussions for functions with features which need testing beyond that of a typical function; and

(e) A detailed description of how each Channel Functional Test specified in Section 3.3 and elsewhere in the generic TS, corresponds, by name, to the PPS tests described in DCD Tier 2, Section 7.2. If a Channel Functional Test SR is not specified to be performed "in accordance with the setpoint control program (SCP)," state the reason why.

In its response (ML16028A482) to Question 16-89 the applicant made the following statements (statement enumeration added for ease of reference) (test correspondence between DCD Tier 2, Figure 7.2-1 and Section 7.2.2.5 added in brackets for clarity); the staff's assessment follows each statement:

The following discussions are applicable to: (a) RPS and ESFAS Functions with two-out-of-four coincidence logic and (b) balance of plant (BOP) ESFAS Functions with one-out-of-two coincidence logic included in the generic TS Section 3.3.

1. The diverse protection system (DPS) Functions are not included in either NUREG-1432 or the generic TS Section 3.3. The APR1400 does not have any functions with features which need testing beyond that of a typical function.

   Assessment: The staff accepts these statements and has no further questions related to requests (c) and (d) above.

2. CHANNEL CHECK corresponds to the range of "Manual Transmitter Test" depicted in DCD Tier 2, Figure 7.2-11, "PPS Testing Overlap" (Figure 7.2-11) and specifically means "Sensor Check" described in DCD Tier 2, Section 7.2.2.5.a [DCD 7.2.2.5.a].

   Assessment: The staff accepts this statement and has no further questions.

3. CHANNEL FUNCTIONAL TEST performed *during power operation* corresponds to the tests depicted in Figure 7.2-11 and listed on the left. (LCL stands for Local Coincidence Logic.)

   - "Bistable Logic Test" .... [Bistable Logic Test of DCD 7.2.2.5.b]
   - "RT LCL Logic Test"... [LCL Test of DCD 7.2.2.5.d]
   - "ESF LCL Logic Test"....................................... [LCL Test of DCD 7.2.2.5.d]
   - "RT initiation Test".......... [Initiation Logic and Circuit Test of DCD 7.2.2.5.e]

   Assessment: The staff acknowledges this statement and has further questions.

4. CHANNEL CALIBRATION encompassing the entire channel includes the following tests depicted in Figure 7.2-11 and listed on the left.

   - "Manual Transmitter Test"......................... [Sensor Check of DCD 7.2.2.5.a]
   - "Analog Input Test"................................... [Sensor Check of DCD 7.2.2.5.a]
   - "Bistable Logic Test" .... [Bistable Logic Test of DCD 7.2.2.5.b]
   - "RT LCL Logic Test"... [LCL Test of DCD 7.2.2.5.d]
   - "ESF LCL Logic Test"....................................... [LCL Test of DCD 7.2.2.5.d]
   - "RT initiation Test"......... [Initiation Logic and Circuit Test of DCD 7.2.2.5.e]

   Assessment: The staff acknowledges this statement and has further questions.

5. RPS CHANNEL FUNCTIONAL TEST depicted in Figure 7.2-11, which includes the tests listed on the left, corresponds to the tests listed on the right, which are described in DCD Tier 2, Section 7.2.2.5, "System Testing and Inoperable Surveillance."

   - "Bistable Logic Tests" .... "Bistable Logic Test"

- "RT and ESF LCL Tests" .... "RT and ESF LCL Test"
- "Trip Path Test" ...."Initiation Logic and Circuit Test"
- "CPCS Test" ...."CPCS Test"
- "Manual Trip Test" ...."Manual Trip Test"

Assessment: The staff acknowledges this statement and has further questions.

6. The Setpoint Control Program (SCP) establishes the requirements for ensuring that setpoints for automatic protective devices are initially within and remain within the assumptions of the applicable safety analyses. Therefore, the "Bistable Logic Test" and the "CPCS Test" of the RPS CHANNEL FUNCTIONAL TEST are performed in accordance with the SCP.

   Assessment: The staff acknowledges this statement and has further questions.

7. The remaining tests specified in the SCP such as Nominal Trip Setpoint, Allowable Value, As-Found Tolerance, and As-Left Tolerance are not directly related to setpoints.

   Assessment: The staff does not understand this statement and has further questions.

As noted, the staff had further questions, and sent the applicant follow up RAI 470-8552, Question 16-137, Sub-questions 1, 2, 3, and 4 (ML16117A247). For each sub-question, the staff's request is stated, followed by an evaluation of the applicant's response (ML16295A319).

1. (Sub-question 16-137.1) The applicant is requested to submit a table that shows the following for each component, segment, and portion of the instrument loop from the process sensor through bistable logic, coincidence logic, initiation logic, actuation logic, the component interface module, or reactor trip logic to the reactor trip circuit breakers, or the actuated end device in the ESFAS circuits:

   - Component name or description
   - Name of test as depicted on DCD Figure 7.2-11
   - Name of test as stated in DCD 7.2.2.5
   - Corresponding generic TS Section 3.3 surveillance requirement as defined in generic TS Section 1.1 (CHANNEL CHECK; CHANNEL FUNCTIONAL TEST, CHANNEL CALIBRATION)

   The NRC staff included a draft of the requested table in the agenda notes for the meeting between the NRC staff and Applicant staff on February 24 and 25, 2016 (See the meeting summary dated May 19, 2016, at ADAMS Accession Nos. ML16131A089, ML16131A068, ML16131A045, ML16131A057, and ML16131A038.). That table was based on information in the DCD and in the response to RAI 239-8076, Question 16-89. The applicant may use that draft table as a guide in preparing the requested table; however, the staff does not consider the table to be fully accurate because the DCD descriptions are unclear.

Evaluation of Response to Question 16-137, Sub-question 1: The applicant provided the requested RPS-related information by changing the title of DCD Tier 2, Figure 7.2-11, to "~~PPS~~ RPS Testing Overlap," and by revising this figure to (1) focus only on RPS testing, (2) depict the Core Protection Calculator System (CPCS) and its associated digital input module to the serial data link (SDL) input to the local coincidence logic (LCL), and (3) show the span (test overlap) of the CPCS test. Based on the revised Figure 7.2-11, the applicant prepared Table 1, "Components List and Corresponding Test between Figure 7.2-11 and Section 7.2.2.5," to list each depicted component, the component's depicted test name, for which test overlap is shown, the name of the equivalent test described in DCD Tier 2, Section 7.2.2.5, and the type of surveillance test required by the generic TS; also indicated on Table 1 is the surveillance performance interval (Frequency), either once per 3 months during power operation, or once per 18 months, presumably during each refueling outage.

The staff found that Table 1 accurately described the correspondence of the three test depictions or descriptions for each listed component. However, the staff observed the following items that need to be considered for additional DCD changes or explanations.

(A) In Table 1, the sixth row mentions the Channel Functional Test for the BP to LCL serial data link (SDL) communication. However, the staff was not able to identify in Table 1 the Channel Functional Test for the CPCS's CEA position processor (CPP) SDL. The Background section of the Bases for Subsection 3.3.1 and Subsection 3.3.3 mentions the CPP SDLs as follows; staff-suggested clarifying edits are indicated by italic font highlighted in gray:

> The CEACs perform the calculations required to determine the position of CEAs within their subgroups for the CPCs. Two independent CEACs*, designated CEAC1 and CEAC2,* within each CPC channel compare the position of each CEA to its subgroup position. If a deviation is detected by either CEAC, an annunciator sounds and ~~*appreciate*~~ *appropriate* "penalty factors" are transmitted to the CPC in the affected channel. These penalty factors conservatively adjust the effective operating margins to the DNBR – Low and LPD – High ~~*trips*~~ *reactor trip setpoints*.
>
> Each CEA has two separate reed switch position transmitter (RSPT) assemblies mounted outside the RCPB, designated RSPT1 and RSPT2. CEA position from the RSPTs is processed by two CEA position processors (CPPs) located in each CPC channel. The CPPs transmit CEA position to *the* appropriate CEAC in ~~*all*~~ *each of the* four CPC channels over optically isolated *serial* data links, such that CEAC1 in all channels receives the position of all CEAs based upon RSPT1, and CEAC2 receives the position of all CEAs based upon RSPT2. Thus the positions of all

CEAs are independently monitored by both CEACs in each CPC channel.

The staff also observes that the “Response Time Analysis of Safety I&C System” technical report, APR1400-Z-J-NR-14013-P, Revision 0, Section 7.11.7.1, “CPCS,” lists the CPP SDL safety-related response time as “SDL = 13 ms.”

The applicant is requested to revise its response to Question 16-137, Sub-question 1, by (1) adding to Table 1 a row (with indentation) for the component “SDL Communication to CEACs from CPPs” after the table row for the CPCS, with appropriate entries for the associated tests and surveillances, (2) indicating the testing of the CPP to CEAC SDL on Figure 7.2-11, (3) describing this testing in DCD Tier 2, Section 7.2.2.5, (4) describing in the Surveillance Requirements section of the Bases for Subsection 3.3.1 and Subsection 3.3.3, for the appropriate SRs, the testing of the CPP to CEAC SDL, (5) adding Table 1 to DCD Tier 2, Section 7.2 or technical report APR1400-Z-J-NR-14001-P, “Safety I&C System,” Revision 0, and (6) removing the depicted testing and circuitry of ESFAS instrument Functions and ESFAS Coincidence and Initiation Logic Functions from Figure 7.2-11, and adding it to Figure 7.3-24 (discussed below).

The applicant is also requested to ensure that the above described changes to DCD Tier 2, Section 7.2 and Figure 7.2-11 are consistent with all applicable APR1400 design certification application documents including Figure 4-6, “Overlap in Functional Testing for the PPS,” of proprietary technical report APR1400-Z-J-NR-14001-P, “Safety I&C System,” Revision 0.

(B) Since Figure 7.2-11 shows test overlap for PPS components associated with ESFAS instrument Functions including 2-out-of-4 Local Coincidence Logic (LCL) and the SDL to the Group Controller (GC), Table 1 includes the depicted ESFAS related PPS components in the indicated table rows, as follows;

- Process sensor (row 1)
- TU switch (row 2)
- Bistable Processor (BP) Rack Analog Input (AI) Module Analog to Digital (A/D) [converter] (row 3)
  - BP – partial trip signal (row 4)
  - SDL Communication to LCL Rack (row 5)
- LCL Rack – SDL Signal Distribution (row 14)
  - LCL ESFAS 2/4 → ESFAS (coincidence) Initiation Signal (row 15)
- SDL to Group Controller (GC) Station (ESF-CCS) (row 16)

> As noted above, Figure 7.2-11 was revised in part to focus exclusively on RPS reactor trip circuits, yet it still depicts overlap of tests for the above ESFAS related portions of the PPS circuit. The applicant is requested to revise its response to Question 16-137, Sub-question 1, by also moving these table rows to Table 2, and moving the related parts of the Figure 7.2-11 circuit diagram showing the overlap of the ESFAS instrument tests to the overlap depicted by Figure 7.3-24 for the Actuation Logic Test (GC selective 2-out-of-4 logic and emergency diesel generator (EDG) start and sequential loading logic), Component Logic Test (component Loop Controller, which implements system-based priority logic), and Component Interface Module (CIM) Test (ESF actuation signal priority logic). Likewise, the applicant is requested to include descriptions of tests common to RPS and ESFAS instrument circuits, from the process sensor to the LCL output, in DCD Tier 2, Section 7.3.2.5 as well as in Section 7.2.2.5. The applicant is also requested to state on Figure 7.2-11 and Figure 7.3-24 what the acronym “TU” stands for, and to also provide an appropriate explanation in the appropriate locations in these DCD Sections, such as the description of the Manual Transmitter Test. Pending an adequate revised response, RAI 470-8552, Question 16-137, Sub-question 1, was tracked as an open item.

In the initial response (ML16295A319) to RAI 470-8552, Question 16-137, Sub-question 1, the applicant also provided the requested ESFAS-related information in a new DCD Tier 2 figure, Figure 7.3-24, “ESF-CCS Actuation Test Logic Diagram.” The component names and descriptions in the figure are identified by their relationship with the testing type provided in DCD Tier 2, Section 7.3.2.5, “System Testing and Inoperable Surveillance.” Based on Figure 7.3-24, the applicant prepared Table 2, “Components List and Corresponding Test between Figure 7.3-24 and Section 7.3.2.5,” to list each depicted component, the component’s depicted test name, for which test overlap is shown, the name of the equivalent test described in DCD Tier 2, Section 7.3.2.5, and the type of surveillance test required by the generic TS; also indicated on Table 2 is the surveillance performance interval (Frequency) of once per 3 months during power operation.

Lastly, in its initial response to Question 16-137, Sub-question 1, the applicant added to DCD Tier 2, Section 7.3.2.5, descriptions of the Component Logic Test, and the CIM Test, which are tests that cannot be performed by the PPS, and which are shown on Figure 7.3-24. These changes are acceptable because they are technically accurate.

Pending receipt of a revised response that is consistent with the above stated requests by the staff, RAI 470-8552, Question 16-137, Sub-question 1, was tracked as an open item. Information provided in response to Sub-question 4 explains the logical OR symbols on Figure 7.2-11 and Figure 7.3-24. Inclusion of this information in DCD Tier 2, Section 7.2.2.5 and Section 7.3.2.5 is considered to be within the scope of the open item for Sub-question 1.

2. (Sub-question 16-137.2) The staff noticed that DCD Figure 7.2-11 does not depict "CPCS Test" and "Manual Trip Test," which are described in DCD Section 7.2.2.5. The applicant is requested to revise DCD Tier 2, Section 7.2 so that Section 7.2.2.5 and Figure 7.2-11 are correctly aligned. In addition, consider adding a discussion in DCD Tier 2, Section 7.3 that describes the testing for the ESFAS instrumentation loops with the same level of detail as the requested revised description in DCD Tier 2, Section 7.2.2.5, and also a figure equivalent to Figure 7.2-11. Notice that Figure 7.2-11 depicts no tests for ESFAS related components beyond the input to the actuation logic in the group controller.

   <u>Evaluation of Response to Question 16-137, Sub-question 2</u>: The applicant provided the requested RPS-related information by (1) adding depictions of the CPCS and CPCS Test to DCD Tier 2, Figure 7.2-11, as previously discussed; (2) revising Item f) of Section 7.2.2.5 by adding the statement, "Figure 7.2-16 ["Manual Reactor Trip Initiation Diagram"] shows the signal path for the manual trip test"; and (3) adding Figure 7.3-24, as previously discussed. The response pointed out that Figure 7.3-22, "ESF-CCS Simplified Test Logic Diagram" shows the Actuation Logic Test of the Group Controller (GC) portion of the Engineered Safety Features – Component Control System (ESF-CCS). Based on this response having adequately updated the DCD with the requested details, Sub-question 2 is resolved.

3. (Sub-question 16-137.3) The last two sentences of the response to RAI-Question 16-89 said,

   > ... the "Bistable Logic Test" and the "CPCS Test" of the RPS CHANNEL FUNCTIONAL TEST are performed in accordance with the Setpoint Control program (SCP). The remaining tests specified in the SCP such as Nominal Trip Setpoint, Allowable Value, As-Found Tolerance, and As-Left Tolerance are not directly related to setpoints.

   The applicant is requested to explain what is meant by these statements. For example, the NTSP, AV, AFT, and ALT are not tests. Also, the ESFAS CHANNEL FUNCTIONAL TEST and the CHANNEL CALIBRATION are not mentioned.

   <u>Evaluation of Response to Question 16-137, Sub-question 3</u>: In its response, the applicant stated, "Except for DNBR and LPD trip setpoints, which are programmed in the CPCS to perform the RPS function, all trip setpoints for the RPS and ESFAS functions are set into the PPS bistable logics. For the RPS CHANNEL FUNCTIONAL TEST, the 'Bistable Logic Test' and the 'CPCS Test' are performed to verify RPS trip setpoints to be within the corresponding Allowable Values. In addition, for the ESFAS CHANNEL FUNCTIONAL TEST, the 'Bistable Logic Test' is performed to verify ESFAS trip setpoints to be within the corresponding Allowable Values. The NTSP, AV, AFT, and ALT stated in the Setpoint Control Program (SCP) are used for performing the CHANNEL FUNCTIONAL TEST and CHANNEL CALIBRATION for RPS and ESFAS functions. Therefore, it was intended to specify that the 'Bistable Logic Test' and the 'CPCS Test' are performed in

accordance with the SCP since the purpose of the SCP is to establish the requirements for ensuring that setpoint[s] for automatic protective devices are initially within and remain within the assumptions of the applicable safety analyses."

The staff accepts that the intent of the applicant's previous response to RAI-Question 16-89 was to state the fact that the 'Bistable Logic Test' and the 'CPCS Test' are performed in accordance with the SCP. However, the 'Bistable Logic Test' is meant to verify that the actual trip setting is within the AFT and AV for each RPS reactor trip Function channel, and for each ESFAS instrument Function channel. Therefore, the Channel Functional Test must also account for uncertainties in the sensor transmitter signal, and for the ESFAS instrument Functions, the uncertainties associated with the analog signal from the auxiliary process cabinet – safety (APC-S), which is input to the A/D converter in the analog input module. Verification of the setpoint value in the BP memory (or in the CPCS memory) is not sufficient to verify a channel would trip within the AV. Note that for the APR1400 RPS and ESFAS setpoint methodology, the draft trip setpoint is equivalent to the limiting trip setpoint (LTSP), as described in Regulatory Information Summary (RIS) 2006-17, dated August 24, 2006 (ML051810077). The APR1400 setpoint methodology defines the AV by only considering setpoint drift associated with an analog bistable. Since the setpoint of a bistable implemented using software in the bistable processor rack does not drift, the LTSP and AV have the same value. The LTSP calculation, however, does account for signal drift associated with the analog portion of the instrument channel. Therefore, the staff contends that a Channel Functional Test should also account for drift in the analog circuit's output signal, which is sent to the channel's analog input module, when verifying that the instrument Function's actual trip setting is within the AFT and AV. See evaluation of the APR1400 setpoint methodology in Chapter 7 of this SER, and evaluation of Subsection 5.5.19, "SCP," in Section 16.4.16 of this SER.

In its first revised response (ML17233A395) to RAI 470-8552, Question 16-137, Sub-question 3, the applicant inserted the following passage into the Background section of Subsections B 3.3.1 and B 3.3.5 in order to highlight that the NTSPs for RPS and ESFAS instrumentation Functions must account for all loop uncertainties from the process sensor to the bistable processor:

> The NTSPs listed in the SCP are based on the NRC approved setpoint methodology referenced in the SCP, which incorporates all of the known uncertainties applicable for each channel. The magnitudes of these uncertainties are factored into the determination of each NTSP. All field sensors and signal processing equipment for these channels are assumed to operate within the allowances of these uncertainty magnitudes. Transmitter and signal processing equipment calibration tolerances and drift allowances must be specified in plant calibration procedures, and must be consistent with the values used in the setpoint methodology.

The staff concludes that RAI 470-8552, Question 16-137, Sub-question 3, is resolved because the revised response is consistent with the setpoint methodology technical reports, which are listed by title in the SCP, and enhances the clarity of the setpoint background discussion in the Bases. Pending completion of the staff's review of the APR1400 setpoint methodology, the SCP was tracked as an open item as described in Subsection 7.1.4.24.4 of this SER for RAI 301-8280 (ML15314A045) and

- Question 7.1-41 based on the applicant's initial and revised responses (ML16113A458 and ML16176A382). The staff concluded that the second revised response (ML17261A455) was adequate to resolve Question 7.1-41, and designated Question 7.1-41 as a confirmatory item.

- Question 7.1-52, based on the applicant's initial response (ML16113A458). The staff concluded that the first and second revised responses (ML17262A336 and ML17319A341) were adequate to resolve Question 7.1-52, and designated Question 7.1-52 as a confirmatory item.

Based on the satisfactory review of the APR1400 setpoint methodology technical reports, which are listed in Subsection 5.5.19, "SCP," as documented in Subsection 7.1.4.24.4 of this SER, the staff has confirmed incorporation of the changes described above; therefore, RAI 301-8280, Questions 7.1-41 and 7.1-52 are resolved and closed. Section 16.4.16 of this SER contains additional discussion about instrumentation setpoints under the evaluation of Subsection 5.5.19, "SCP."

4. (Sub-question 16-137.4) The applicant is requested to explain what meaning the "OR" logical gate symbols on Figure 7.2-11 are intended to convey; especially with respect to depicting testing overlap.

Evaluation of the Second Revised Response to Question 16-137, Sub-question 4: In its response (ML17249A954), the applicant stated:

> The logical OR symbols on Figures 7.2-11 and 7.3-24 will be explained in DCD Tier 2. In Figure 7.2-11, the logical OR in the receiving stage of bistable processor (BP) indicates that the downstream logic processes either the actual process input signal or the simulated test input signal. The logical OR in the receiving stage of LCL indicates that local coincidence logic (LCL) logic i~~s processed~~ processes either ~~by~~ the actual signal or ~~by~~ the test signal.
>
> The logical OR in the transmitting stage of LCL or the receiving stage of the digital output module indicates that the digital output module generates the output from either ~~by~~ the actual signal or ~~by~~ the test signal.

The staff finds that the response provides the requested explanation, but associated technical edits to DCD Tier 2, Section 7.2.2.5 and

Section 7.3.2.5, consistent with the requested changes to Figure 7.2-11 and Figure 7.3-24, are still outstanding. Since the disposition of these recommended edits is considered to be within the scope of the open item for Sub-question 16-137.1, the staff concludes that RAI 470-8552, Question 16-137, Sub-question 4, is resolved.

In its second revised response (ML17249A954) to RAI 470-8552, Question 16-137, Sub-question 1, the applicant addressed the issues described above regarding the initial response to Sub-question 1, as follows:

1. Table 1 is prepared based on DCD Tier 2 Figure 7.2-11, which shows the testing overlap for the periodic manual tests required to verify the integrity of the RPS functions during power operation of the plant. The component names and descriptions in the figure are identified by relationship with the testing type provided in DCD Tier 2 Section 7.2.2.5, "System Testing and Inoperable Surveillance". Additionally, the "CPCS" and "CPCS test" will be included in DCD Tier 2 Figure 7.2-11.

   Table 2 is prepared based on a new figure, DCD Tier 2 Figure 7.3-24, "ESF-CCS Actuation Test Logic Diagram." The component names and descriptions in the figure are identified by relationship with the testing type provided in DCD Tier 2 Section 7.3.2.5, "System Testing and Inoperable Surveillance."

   DCD Tier 2 Figure 7.3-24 will be added and Section 7.3.2.5 will include items i) and j) for the component logic test and component interface module (CIM) test.

The staff reviewed the two tables provided in the second revised response and compared them with the revised Figures 7.2-11 and 7.3-24, and the revised descriptions of instrumentation testing in DCD, Tier 2, Subsection 7.2.2.5 for RPS and Subsection 7.3.2.5 for ESFAS. Together this information accurately describes each test to be performed on each instrument loop component and the corresponding type of surveillance requirement test specified in Section 3.3. Test overlap is also clearly depicted on Figure 7.2-11 and Figure 7.3-24. The tables also indicate which SRs should only be performed during shutdown conditions. In summary, the following tables display the approximate correspondence between the Chapter 7 tests and the surveillance requirements in Subsections 3.1.4, 3.1.9, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, and 3.3.7:

CHANNEL CHECK - RPS			
Surveillance	Figure 7.2-11 Test	DCD 7.2.2.5 Test	Components as depicted on Fig. 7.2-11
SR 3.3.1.1 SR 3.3.2.1	Manual Transmitter Test	a. Sensor check	Process Sensor
SR 3.3.1.1 SR 3.3.2.1	Analog Input Test	a. Sensor check	Termination Unit (TU)
SR 3.3.1.1 SR 3.3.2.1	Analog / Digital Input Test	a. Sensor check	BP Rack AI Module A/D [Converter], DI Module
SR 3.3.1.3* SR 3.3.3.1 SR 3.3.3.2*	CPCS test	c. CPCS test	CPCS

* Check CPC System event log. | 12 hours

CHANNEL CALIBRATION – RPS			
Surveillance	Figure 7.2-11 Test	DCD 7.2.2.5 Test	Components as depicted on Fig. 7.2-11
SR 3.3.1.8 SR 3.3.1.9 SR 3.3.2.4	Manual Transmitter Test	a. Sensor check	Process Sensor
SR 3.3.1.2 SR 3.3.1.4 SR 3.3.1.5* SR 3.3.1.8 SR 3.3.1.9 SR 3.3.1.11** SR 3.3.3.4	CPCS test	c. CPCS test	CPCS
SR 3.3.1.8 SR 3.3.1.9 SR 3.3.2.4	Analog Input Test	a. Sensor check	Termination Unit (TU)

* Verify total RCS flow rate indicated by each CPC is less than or equal to RCS flow rate determined by secondary calorimetric calculations. | 31 days

** Using incore detectors, verify shape annealing matrix elements to be used by the CPCs in accordance with Setpoint Control Program. | Once after each refueling prior to exceeding 80% RTP

CHANNEL CALIBRATION – RPS – Manual Transmitter Test			
Surveillance	Figure 7.2-11 Test	DCD 7.2.2.5 Test	Components as depicted on Fig. 7.2-11
SR 3.3.1.8 SR 3.3.1.9 SR 3.3.2.4	Analog Input Test	a. Sensor check	Termination Unit (TU)
SR 3.3.1.8 SR 3.3.1.9 SR 3.3.2.4	Analog / Digital Input Test	a. Sensor check	BP Rack AI Module A/D [Converter], DI Module

CHANNEL FUNCTIONAL TEST – RPS			
Surveillance	Figure 7.2-11 Test	DCD 7.2.2.5 Test	Components as depicted on Fig. 7.2-11
SR 3.3.1.7 SR 3.3.1.10 SR 3.3.3.3 SR 3.3.3.5	CPCS test	c. CPCS test	CPCS
SR 3.3.1.7 SR 3.3.1.12 SR 3.3.2.2 SR 3.3.2.3	Bistable Logic Test	b. Bistable logic test	Bistable Processor (BP) – partial trip signal
SR 3.3.1.7	Bistable Logic Test	b. Bistable logic test	SDL Communication to LCL Rack
SR 3.3.4.1	Bistable Logic Test	b. Bistable logic test	LCL Rack – SDL Signal Distribution
SR 3.3.4.1	RT LCL Logic Test	d. LCL test	LCL RPS 2/4 → RPS (coincidence) Initiation Signal
SR 3.3.4.1	RT LCL Logic Test	d. LCL test	RPS Digital Output
SR 3.3.4.1	RT Initiation Test	e. Initiation logic and circuit test	RPS Digital Output
SR 3.3.4.2	RT LCL Logic Test	d. LCL test	Hardwire to RT Initiation Logic (selective 2/4)

CHANNEL FUNCTIONAL TEST – RPS			
Surveillance	Figure 7.2-11 Test	DCD 7.2.2.5 Test	Components as depicted on Fig. 7.2-11
SR 3.3.4.2	RT Initiation Test	e. Initiation logic and circuit test	Hardwire to RT Initiation Logic (selective 2/4)
SR 3.3.4.2	RT Initiation Test	e. Initiation logic and circuit test	Interposing Relay & Contacts
SR 3.3.4.1 SR 3.3.4.2 SR 3.3.4.3	RT Initiation Test	e. Initiation logic and circuit test	RTSS-1 and RTSS-2
SR 3.3.4.1 SR 3.3.4.2 SR 3.3.4.3	RT Initiation Test	e. Initiation logic and circuit test	RTCB Undervoltage Trip Device

The staff notes that the SRs for the CEACs and the CPPs (Subsection 3.3.3) are included in the RPS tables by their association with the CPCS. Other surveillances requiring a CHANNEL FUNCTIONAL TEST, which are not in Section 3.3, are the following

SR 3.1.4.1 Perform a CHANNEL FUNCTIONAL TEST of each reed switch position transmitter channel. | 18 months

SR 3.1.9.4 Perform a CHANNEL FUNCTIONAL TEST of each logarithmic and variable overpower neutron flux monitoring channel. | Within 12 hours prior to reactor startup or PHYSICS TESTS

CHANNEL CHECK - ESFAS			
Surveillance	Figure 7.2-11 Test	DCD 7.3.2.5 Test	Test Components as depicted on Fig. 7.3-24
SR 3.3.5.1 SR 3.3.7.1	Manual Transmitter Test	a. Sensor Check	Process Sensor
SR 3.3.5.1 SR 3.3.7.1	Analog Input Test	a. Sensor Check	Termination Unit (TU)
SR 3.3.5.1	Analog / Digital Input Test	a. Sensor Check	BP Rack AI Module A/D [Converter], DI Module

CHANNEL CALIBRATION – ESFAS			
Surveillance	Figure 7.3-24 Test	DCD 7.3.2.5 Test	Test Components as depicted on Fig. 7.3-24
SR 3.3.5.3 SR 3.3.7.3	Manual Transmitter Test	a. Sensor Check	Process Sensor
SR 3.3.5.3 SR 3.3.7.3	Analog Input Test	a. Sensor Check	Termination Unit (TU)

CHANNEL CALIBRATION – ESFAS – Manual Transmitter Test			
Surveillance	Figure 7.3-24 Test	DCD 7.3.2.5 Test	Test Components as depicted on Fig. 7.3-24
SR 3.3.5.3 SR 3.3.7.3	Analog Input Test	a. Sensor Check	Termination Unit (TU)
SR 3.3.5.3 SR 3.3.7.3	Analog / Digital Input Test	a. Sensor Check	BP Rack AI Module A/D [Converter], DI Module

CHANNEL FUNCTIONAL TEST – ESFAS			
Surveillance	Figure 7.3-24 Test	DCD 7.3.2.5 Test	Components as depicted on Fig. 7.3-24
SR 3.3.5.2 SR 3.3.5.5	Bistable Logic Test	b. Bistable logic test	Bistable Processor (BP) – partial trip signal
SR 3.3.5.2 SR 3.3.5.5	Bistable Logic Test	b. Bistable logic test	SDL Communication to LCL Rack
SR 3.3.5.2 SR 3.3.5.5	Bistable Logic Test	b) Bistable logic test	LCL Rack – SDL Signal Distribution
SR 3.3.6.1	ESF LCL Logic Test	c) LCL test	LCL ESFAS 2/4 → ESFAS (coincidence) Initiation Signal
SR 3.3.6.1	ESF LCL Logic Test	d) Initiation logic test	SDL to Group Controller (GC) Station (ESF-CCS)
SR 3.3.6.1 SR 3.3.7.2	Actuation Logic Test	e) Actuation logic test	GC Station – Selective 2/4 Logic
SR 3.3.6.1	EDG Logic Test	e) Actuation logic test h) EDG loading sequencer test	GC Station – EDG [start] Logic
SR 3.3.6.2	Selective Subgroup Test	f) Selective Group Test i) Component logic test	SDL to Loop Controller (Component Control Logic)
SR 3.3.6.2	Component Interface Module (CIM) Test	j) CIM test	Component Interface Module (CIM)

The staff notes that the ESF Function priority logic is verified by the Actuation Logic Test of the Group Controller and the CIM. Based on its review of the second revised response and changes to DCD, Tier 2, Sections 7.2 and 7.3, the staff concludes that Sub-question 1 of Question 16-137 is resolved.

Subsection 3.3.1 Reactor Protection System (RPS) Instrumentation – Operating

Subsection 3.3.1 specifies TS requirements for instrumentation functions that are assumed to initiate a reactor trip by the safety analyses of design basis accidents and postulated events occurring with the unit in Mode 1 or 2. A reactor trip occurs when a measured process parameter reaches the specified limiting safety system setting (LSSS) (the nominal trip setpoint) for the associated reactor trip function. The nominal trip setpoint (NTSP) is determined in accordance with the NRC approved setpoint methodology specified in Subsection 5.5.19, “Setpoint Control Program,” so that protective action occurs before the measured process parameter exceeds the assumed value in the safety analysis, the analytical limit. This ensures that reactor core and reactor coolant pressure boundary safety limits are not violated.

In its response (ML16093A021) to the staff’s request in RAI 295-8263, Question 16-110, Sub-questions 2 and 4, the applicant revised its setpoint methodology to define the NTSP as the LSSS instead of the allowable value, which is the LSSS stated in the STS Bases. The GTS designation of the NTSP as the LSSS is consistent with the staff’s preference as described in Regulatory Information Summary (RIS) 2006-17, dated August 24, 2006 (ML051810077). Therefore, RAI 295-8263, Question 16-110, Sub-questions 2 and 4, are resolved.

The following table lists the APR1400 RPS reactor trip Functions and equivalent STS RPS reactor trip Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.1	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.1
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.1 Reactor Protection System (RPS) Instrumentation – Operating	3.3.1B Reactor Protective System (RPS) Instrumentation – Operating
1. Variable Overpower 1,2	1. Linear Power Level – High 1,2
2. Logarithmic Power Level – High[(a)] 2	2. Logarithmic Power Level – High[(a)] 2
3. Pressurizer Pressure – High 1,2	3. Pressurizer Pressure – High 1,2
4. Pressurizer Pressure – Low[(b)] 1,2	4. Pressurizer Pressure – Low[(b)] 1,2
5. Containment Pressure – High 1,2	5. Containment Pressure – High 1,2
6. Steam Generator (SG) #1 Pressure – Low 1,2	6. Steam Generator (SG) #1 Pressure – Low 1,2
7. SG #2 Pressure – Low 1,2	7. SG #2 Pressure – Low 1,2
8. SG #1 Water Level – Low 1,2	8. SG #1 Water Level – Low 1,2
9. SG #2 Water Level – Low 1,2	9. SG #2 Water Level – Low 1,2
10. SG #1 Water Level – High 1,2	—
11. SG #2 Water Level – High 1,2	—
12. Reactor Coolant Flow, SG #1 – Low 1,2	[10. Reactor Coolant Flow, SG #1 – Low[(c)]] 1,2
13. Reactor Coolant Flow, SG #2 – Low 1,2	[11. Reactor Coolant Flow, SG #2 – Low[(c)]] 1,2
—	[12. Loss of Load (turbine stop valve control oil pressure)[(d)]] 1
14. Local Power Density – High[(c)] [(d)] 1,2	13. Local Power Density – High[(c)] 1,2
15. Departure From Nucleate Boiling Ratio (DNBR) – Low[(c)] [(d)] 1,2	14. DNBR – Low[(c)] 1,2
Table 3.3.1-1 Footnotes (a) **Trip may be bypassed** when logarithmic power is > **1E-3%**. **Operating** bypass shall be **automatically** removed **when** logarithmic power **is** ≤ **1E-3%**. Trip may be manually bypassed during **PHYSICS TESTS** pursuant to **LCO 3.1.9, “Special Test Exception (STE) – SHUTDOWN MARGIN (SDM).”**	Table 3.3.1-1 Footnotes: (a) Bypass may be enabled when logarithmic power is > [1E-4]% and shall be capable of automatic removal whenever logarithmic power is > [1E-4]%. Bypass shall be removed prior to reducing logarithmic power to a value ≤ [1E-4]%. Trip may be manually bypassed during physics testing pursuant to LCO 3.4.17, "RCS Loops - Test Exceptions."

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.1	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.1
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
Table 3.3.1-1 Footnotes (b) **Pressurizer Pressure – Low trip** setpoint may be decreased as pressurizer pressure is reduced **to 7.0 kg/cm^{2}A (100 psia)**. The margin between pressurizer pressure and the setpoint **shall be** maintained **at** ≤ 28.1 kg/cm^2 (400 psi). **The operating** bypass shall be removed **automatically** at ≥ 35.2 kg/cm^{2}A (500 psia). The setpoint shall be **increased automatically** to the normal setpoint as pressurizer pressure is increased.	Table 3.3.1-1 Footnotes (b) The setpoint may be decreased to a minimum value of [300] psia, as pressurizer pressure is reduced, provided the margin between pressurizer pressure and the setpoint is maintained ≤ [400] psi. Bypass may be enabled when pressurizer pressure is < [500] psia and shall be capable of automatic removal whenever pressurizer pressure is < [500] psia Bypass shall be removed prior to raising pressurizer pressure to a value ≥ [500] psia. The setpoint shall be automatically increased to the normal setpoint as pressurizer pressure is increased.
Table 3.3.1-1 Footnotes (c) **Trip may be manually bypassed** when logarithmic power is < 1E-4%. **Operating** bypass shall be **automatically** removed **when** logarithmic power **is** ≥ 1E-4%. (continued) During testing pursuant to **LCO 3.1.9, trip may be bypassed below** 5% RTP. **Operating** bypass shall be **automatically** removed **when logarithmic power is >** 5% RTP.	Table 3.3.1-1 Footnotes (c) Bypass may be enabled when logarithmic power is < [1E-04]% and shall be capable of automatic removal whenever logarithmic power is < [1E-4]%. Bypass shall be removed prior to raising logarithmic power to a value ≥ [1E-4]%. (continued) During testing pursuant to LCO 3.4.17, bypass may be enabled when THERMAL POWER is < [5]% RTP and shall be capable of automatic removal whenever THERMAL POWER is < [5]% RTP. Bypass shall be removed above 5% RTP.
Table 3.3.1-1 Footnotes —	Table 3.3.1-1 Footnotes (d) Bypass may be enabled when THERMAL POWER is < [55]% RTP and shall be capable of automatic removal whenever THERMAL POWER is < [55]% RTP. Bypass shall be removed prior to raising THERMAL POWER to a value ≥ [55]% RTP.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.1	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.1
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
Table 3.3.1-1 Footnotes (d) The OPERABILITY of the Local Power Density – High and DNBR – Low Functions includes the CPC auxiliary trips.	Table 3.3.1-1 Footnotes —

Although GTS Subsection 3.3.1 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.1 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.1.

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	SR 3.3.1.4, SR 3.3.1.7 - surveillance column Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-87	239-8076 ML15282A602 Response: ML16028A482	3.3.1, corrected the placement of Actions table Note	CC	
16-88	239-8076 ML15282A602 Response: ML16028A482	3.3.1, removed Actions table Note 2	CC	
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.1 and B 3.3.1	CU	16-137
16-90 3rd response 16-99 2nd response 16-104 1st response	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	• Consistent nomenclature for “associated automatic operating bypass removal function channel(s)” associated with RPS and ESFAS instrument Functions: LCO 3.3.1, 3.3.1 Conditions C and D, Required Action C.2.2, SR 3.3.1.9, Bases for SR 3.3.1.12 • 3.3.1 Required Actions C.1 and D.1 revised to say	CC	

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		"Disable affected bypass channel / channels." • Changed 3.3.1 Required Action C.2.2 Completion Time to match STS: "Prior to entering MODE 2 following next MODE 5 entry" • Corrected indentation of logical connector "AND" for 3.3.1 Required Actions C.2.1 and C.2.2		
16-91	239-8076 ML15282A602 Response: ML16028A482	B 3.3.1 SR section - Trip Path Tests discussion - clarified to state, "These tests are performed for only one channel and one initiation logic at a time."	CC	
16-92	239-8076 ML15282A602 Responses: ML16028A482 ML16300A344 ML17233A392	Table 3.3.1-1 Footnote (a) for Function 2, and Footnote (c) for Functions 14 and 15; and Table 3.3.2-1 Footnote (a) for Function 1 – reconciled differences with STS Table 3.3.1-1 and Table 3.3.2-1 Footnotes; – changed "THERMAL POWER" to "logarithmic power"; SR 3.3.1.7 surveillance column Note 2 – changed "THERMAL POWER" to "logarithmic power"; B 3.3.1 LCO section – clarified reason for changing operating bypass removal setpoint during low power physics test for Function 2 – corrected error in discussion of Function 14; B 3.3.1 ASA and LCO sections – changed "THERMAL POWER" to "logarithmic	CC	

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		power" in discussion of Function 2 B 3.3.2 Applicability section – corrected inequality symbols in discussion of Applicability Note		
16-93	239-8076 ML15282A602 Response: ML16028A482	B 3.3.1 SR section – for SR 3.3.1.9 clarified to say "Channel Calibration must be performed consistent with the SCP."	CC	
16-94	239-8076 ML15282A602 Response: ML16050A266	SR 3.3.1.6 surveillance column Note revised to say "Not required to be performed until 12 hours after THERMAL POWER ≥ 15% RTP." consistent with STS	CC	
16-95	239-8076 ML15282A602 Response: ML16057A828	SR 3.3.1.4; and B 3.3.1 SR section – Bases for SR 3.3.1.4, SR 3.3.1.5, and SR 3.3.1.8 – make calorimetric terminology consistent	CU	16-138
16-96.a	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	SR 3.3.1.7 – changed surveillance column Note 1 to match STS phrasing to say: "The CPC CHANNEL FUNCTIONAL TEST shall include verification that the correct values of address-able constants are installed in each OPERABLE CPC."	CC	
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	Replaced "reactor trip switchgear (RTSG)" with "reactor trip circuit breaker (RTCB)" in • 3.3.1 SR 3.3.1.7 Note 2; • B 3.3.1 Background, Applicable Safety Analyses (ASA), LCO, Applicability, and SR sections	CC	

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-99.1	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 – revised Required Action A.1 to say “Place <u>trip</u> channel in bypass or trip.”	CC	
16-99.2	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 Required Actions A.2 and C.2.2 – changed completion times to be consistent with STS to say, “Prior to entering MODE 2 following next MODE 5 entry”	CC	
16-99.3	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 - revised Condition B to match STS to say “One or more Functions with two <u>automatic RPS</u> trip channels inoperable.”	CC	
16-99.4	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 – revised Conditions C and D to say “...<u>automatic</u> operating bypass removal channel...”	CC	
16-99.5 2nd response	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 Action B – removed an irrelevant Note from Required Action column and associated discussion from B 3.3.1 Actions section	CC	
16-99.6	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 Action C – corrected alignment of logical connector “<u>AND</u>” after Required Action C.2.1	CC	
16-99.7 2nd response	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	3.3.1 Action D – removed an unnecessary Note (excepting LCO 3.0.4) from Required Action column and associated discussion from B 3.3.1 Actions section	CC	

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-90 3rd response 16-99.8	239-8076 ML15282A602 Responses: ML16028A48 ML16155A103 ML16200A342	3.3.1 – Clarified Required Action C.1 to say “Disable affected bypass channel” and Required Action D.1 to say “Disable affected bypass channels”	CC	
16-110.1	295-8263 ML15314A020 Response: ML16093A021	B 3.3.1 Background section – editorial change to define “RPS” on first use, and define acronym for specified acceptable fuel design limits as “SAFDLs”	CC	
16-110.2	295-8263 ML15314A020 Response: ML16093A021	B 3.3.1 Background section – replaced third paragraph with a discussion of limiting safety system settings (LSSS) that is consistent with Subsection 5.5.19, Setpoint Control Program (SCP)	CC	
16-110.3	295-8263 ML15314A020 Response: ML16093A021	B 3.3.1 Background section – Used the term “Nominal Trip Setpoint (NTSP)” instead of “limiting trip setpoint (LTSP)” to be consistent with the SCP	CC	
16-110.4	295-8263 ML15314A020 Response: ML16093A021	B 3.3.1 Background section – inserted missing but generally applicable paragraphs, that are included in STS B 3.3.1B Background section, and replaced “[LTSP]” with “NTSP”	CC	
16-112.1	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	Used phrase “coincidence logic state” on Bases pages B 3.3.1-8, B 3.3.4-3, B 3.3.5-3, and B 3.3.6-2 for improved clarity	CC	
16-122.1	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Subsections B 3.3.1, B 3.3.4, B 3.3.5, and B 3.3.6; first paragraph of SR Section: Clarified that the “interface and test processor (ITP)” is	CC	

Subsection 3.3.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		needed to perform Channel Functional Test in Bases of SR 3.3.1.7, SR 3.3.1.10, and SR 3.3.1.12.		
16-138	470-8552 ML16117A247 Response: ML16148A714	SR 3.3.1.4 and B 3.3.1 SR Section – for SR 3.3.1.4, SR 3.3.1.5, and SR 3.3.1.8, changed to use the term "daily power calibration"	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CU Closed Unresolved (has follow up question)

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137.

Clarification of 3.3.1 Actions C and D

Regarding 3.3.1 Condition C and Condition D, the staff noted that reference to the automatic bypass removal feature of 3.3.1 Functions 2, 14, and 15 was inconsistent with other references to this feature in Section 3.3. The staff issued RAI 239-8076, Question 16-90 (ML15282A602) requesting that the applicant consistently refer to the automatic operating bypass removal function channel(s) associated with RPS and ESFAS instrument Functions, which have the automatic operating bypass removal feature, in LCO, Condition, Required Action, and Surveillance statements in GTS Section 3.3. In its second revised response (ML16200A344) to Question 16-90 the applicant stated:

> LCOs and Required Actions C.1 and D.1, which are stated in generic TS 3.3.1, 3.3.2, and 3.3.5 and associated TS Bases, will be revised to be consistent with corresponding STS sections.

The response also presented markups of Subsections 3.3.1, B 3.3.3, 3.3.2, B 3.3.2, 3.3.5, and B 3.3.5 depicting the changes needed to consistently reference the automatic operating bypass removal features associated with Subsection 3.3.1 Functions 2, 14, and 15; Subsection 3.3.2 Function 1; and Subsection 3.3.5 Functions 1.b and 3.b. The resulting affected requirements (with changes shown; note the gray highlight for missing word "automatic" for quotation of 3.3.1 Action C, and correction of a typographical error in quotation of 3.3.5 Action D) are as follows:

LCO 3.3.1: Four RPS trip and associated <u>automatic</u> operating bypass removal channels for each Function in Table 3.3.1-1 shall be OPERABLE.

3.3.1 Action C: C. One or more Functions with one <u>*automatic*</u> operating bypass removal channel inoperable. | C.1 Disable <u>affected</u> bypass channel. | 1 hour <u>OR</u> C.2.1 Place affected automatic trip channel in bypass or trip. | 1 hour <u>AND</u> C.2.2 Restore <u>automatic</u> operating bypass removal channel and associated automatic trip channel to OPERABLE status. | Prior to entering MODE 2 following next MODE 5 entry ~~Prior to next entry into MODE 2 following entry into MODE 5~~

3.3.1 Action D: D. One or more Functions with two automatic operating bypass removal channels inoperable. | D.1 Disable affected bypass channel. | 1 hour OR D.2 Place one affected automatic trip channel in bypass and place the other in trip.

SR 3.3.1.9: Perform CHANNEL CALIBRATION on each trip channel, including automatic operating bypass removal functions in accordance with Setpoint Control Program. | 18 months

LCO 3.3.2: Four RPS trip and associated automatic operating bypass removal channels for each Function in Table 3.3.2-1 shall be OPERABLE.

3.3.2 Action A: A. One or more Functions with one automatic RPS trip channel inoperable. | A.1 Place trip channel in bypass or trip. | 1 hour AND A.2 Restore trip channel to OPERABLE status. | Prior to entering MODE 2 following next MODE 5 entry ~~Prior to next entry into MODE 2 following entry into MODE 5~~

3.3.2 Action C: C. One automatic operating bypass removal channel inoperable. | C.1 Disable affected bypass channel. | 1 hour OR C.2.1 Place affected automatic trip channel in bypass or trip. | 1 hour AND C.2.2 Restore automatic operating bypass removal channel and associated automatic trip channel to OPERABLE status. | Prior to entering MODE 2 following next MODE 5 entry ~~Prior to next entry into MODE 2 following entry into MODE 5~~

3.3.2 Action D: D. Two automatic operating bypass removal channels inoperable. | D.1 Disable affected bypass channel. | 1 hour OR D.2 Place one affected automatic trip channel in bypass and place the other in trip. | 1 hour

SR 3.3.2.3: Perform CHANNEL FUNCTIONAL TEST on each automatic operating bypass removal function. | Once within 31 days prior to each reactor startup

SR 3.3.2.4: Perform CHANNEL CALIBRATION on each RPS trip channel, including automatic operating bypass removal function in accordance with the Setpoint Control Program. | 18 months

LCO 3.3.5: Four ESFAS trip ~~channels~~ and associated automatic operating bypass removal channels for each Function in Table 3.3.5-1 shall be OPERABLE.

3.3.5 Action C: C. One or more Functions with one automatic operating bypass removal channel inoperable. | C.1 Disable affected bypass channel. | 1 hour OR C.2.1 Place affected automatic

trip channel in bypass or trip. | 1 hour AND C.2.2 Restore automatic operating bypass removal channel and associated automatic trip channel to OPERABLE status. | Prior to entering MODE 2 following next MODE 5 entry
~~Prior to next entry into MODE 2 following entry into MODE 5~~

3.3.5 Action D: D. One or more Functions with two automatic operating bypass removal channels inoperable. | D.1 Disable affected bypass channels. | 1 hour OR D.2 Place one affected automatic trip channel in bypass and place the other in trip.

SR 3.3.5.3: Perform CHANNEL CALIBRATION of each ESFAS channel, including automatic operating bypass removal function in accordance with Setpoint Control Program. | 18 months

The staff also asked the applicant for additional information that is similar to information requested in Question 16-90 about Subsections 3.3.1, 3.3.2, and 3.3.5; for each of these Subsections, in RAI 239-8076, Question 16-99, Sub-question 8, the staff inquired about the meaning of Required Actions C.1 and D.1; in Question 16-104, the staff requested clarification of the LCO statements; and in Question 16-105, the staff requested conforming the phrasing of the Completion Times of Required Actions A.2 and C.2.2 of Subsection 3.3.2 to the STS phrasing. The staff finds that the responses to Question 16-90 had incorporated changes proposed in response to these other questions. Since the above changes, and the related changes in the associated Bases, proposed in response to Question 16-90 are acceptable, the staff considers RAI 239-8076, Questions 16-90, 16-99, 16-104, and 16-105 resolved.

Equivalence of GTS 3.3.1 Function 1, Variable Overpower - High, and STS 3.3.1 Function 1, Linear Overpower - High, reactor trip Functions

DCD Tier 2, Section 15.4.2.2 states that "The net reactivity insertion rate accompanying the uncontrolled CEA withdrawal [at power anticipated operational occurrence (AOO) with a loss of offsite power coincident with a turbine trip] is dependent upon the CEA withdrawal rate and reactivity feedback mechanisms present at the time of the CEA withdrawal at power conditions. Depending on the reactivity insertion rate and the system initial conditions, the uncontrolled CEA withdrawal transient at power is terminated by a core protection calculator (CPC) variable overpower trip (VOPT) [which is a CPC auxiliary trip Function listed in DCD Tier 2, Table 7.2-4], CPC low DNBR trip [(Function 15)], CPC high local power density (LPD) trip [(Function 14)], or the high pressurizer pressure trip (HPPT) [(Function 3)]." DCD Tier 2, Section 15.4.2.2 states that the "reactor is immediately tripped at the CPC variable overpower analysis setpoint of 115 percent of nominal power ..."

The [RPS] variable overpower trip signal initiates a reactor trip when the indicated [excore] neutron flux power increases at a rate greater than a predetermined value or reaches a high preset value, whereas the linear overpower trip signal initiates a reactor trip only when the indicated neutron flux power reaches a high preset value. The additional protection afforded by the Variable Overpower - High reactor trip Function's neutron flux rate of change and step change trip settings may initiate a reactor trip before the high power trip setting, in the event of an uncontrolled CEA withdrawal with the unit at low power (~10^{-3} % RTP) with a loss of offsite power concurrent with a reactor trip (DCD Tier 2, Section 15.4.1). DCD Tier 2, Section 15.4.1.3.2, paragraph "e" states: "An initial power level of 1×10^{-3} percent of rated core power, 0.03983 MWt, results in the closest approach to the fuel design limits during the CEA withdrawal transient. Subcritical or zero-power CEA withdrawal transients initiated from below 1×10^{-3} percent rated power are terminated by the high logarithmic power trip [Table 3.3.1-1 Function 2]." DCD Tier 2, Section 15.4.1.3.3 states in part, that the power transient caused by withdrawal of CEAs from low-power (0.03983 MWt) conditions produces the closest approach to the specified acceptable fuel design limit on DNBR and results in reaching a variable overpower trip setpoint at 29.19 seconds. [It is not clear whether this is the CPC or RPS VOPT setpoint.]

Regarding a CEA ejection (CEAE) accident with a loss of offsite power coincident with a turbine trip, DCD Tier 2, Section 15.4.8.2 states "...following the CEAE, reactor shutdown is initiated by a CPC or RPS variable overpower trip (VOPT) on high neutron power."

Since the RPS Variable Overpower – High trip Function is a safety improvement over the Linear Overpower – High trip Function, it is acceptable.

Based on the above quoted material from DCD Tier 2, Section 15.4, and the applicant's response (ML16034A074) to RAI 340-8395, Question 15.4.8-5, it appears that the CPC VOPT Function, as well as the RPS VOPT Function, ought to be explicitly required by LCO 3.3.1 in Table 3.3.1-1. See Section 16.4.1 of this SER for evaluation of the application of LCO selection criteria and the response to RAI 154-8064, Question 16-42, which was tracked as an open item. Question 16-42 is resolved and closed as described in Section 16.4.1.

<u>Differences between Table 3.3.1-1 Footnotes (a), (b), and (c) and STS Table 3.3.1-1 Footnotes (a), (b), (c), and (d)</u>

The staff issued RAI 239-8076, Question 16-92 (ML15282A602) requesting that KHNP explain why Table 3.3.1-1, Footnote (a) for RPS Function 2, Logarithmic Power Level – High, and Footnote (c) for RPS Function 14, Local Power Density – High, and Function 15, Departure from Nucleate Boiling Ratio – Low, differ from the equivalent requirements in STS Table 3.3.1-1 (See comparison of these footnotes in the beginning of this evaluation of Subsection 3.3.1.). These RPS reactor trip Functions are each provided with an automatic operating bypass removal feature.

In its response (ML16028A482) to Question 16-92, regarding Footnote (a) and Function 2, Logarithmic Power Level – High, KHNP stated that operating bypass permissive and removal setpoints are Thermal Power $\geq 10^{-3}$ % RTP and $< 10^{-3}$ % RTP, respectively, to be consistent with those stated in DCD Tier 2, Table 7.2-1, "Reactor Protection System Operating Bypass Permissive." The corresponding STS 3.3.1 Function 2 operating bypass permissive and removal setpoints are logarithmic power > [1E-4]% and ≤ [1E-4]%, respectively. Conformance to the DCD operating bypass permissive and removal setpoint value for Function 2 is expected, but does not explain why the GTS value (1) is a factor of ten greater than the STS value, (2) is expressed in terms of Thermal Power instead of logarithmic power, and (3) uses "$\geq 10^{-3}$ % and $< 10^{-3}$ %" instead of "> [1E-4]% and ≤ [1E-4]% "; that is, why is the inequality moved from the automatic bypass removal setpoint value, as in the STS, to the permissive setpoint value.

In its response to Question 16-92, regarding Footnote (c) and Functions 14, Local Power Density – High, and Function 15, Departure from Nucleate Boiling Ratio – Low, operating bypass permissive and removal setpoint values, KHNP did not explain why the GTS (1) expresses the value in terms of Thermal Power instead of logarithmic power, and (2) uses "$\leq 10^{-4}$ % RTP and $> 10^{-4}$ % RTP" instead of "< [1E-4]% and ≥ [1E-4]% "; that is, why is the inequality moved from the automatic bypass removal setpoint value, as in the STS, to the permissive setpoint value.

The applicant revised its response to RAI 239-8076, Question 16-92 (ML16300A345), to address the issues described above, as follows:

> Regarding TS Table 3.3.1-1 Footnote (a), the operating bypass permissive and removal setpoints for Logarithmic Power Level – High function are for protection against a high reactivity insertion event during startup and low power condition. Since the trip setpoint is very low, this trip function should be bypassed to enter the power operation mode and the bypass function is introduced to avoid an unwanted reactor trip. During the preliminary design of the Yonggwang 3 and 4 plant, the operating bypass setpoint was increased from 10^{-4} % to 10^{-3} % because CEA withdrawal event did not meet the acceptance criteria below the 10^{-3} % power initial condition. There was no specific need to change the operating bypass setpoint from 10^{-3} % to 10^{-4} %. The only inconvenience is that the operating bypass setpoint is temporarily changed to 10^{-4} % during low power physics test. Therefore, the operating bypass setpoint of 10^{-3} % power is applied in APR 1400.
>
> The logarithmic power unit and the inequality, which are used for "Logarithmic Power Level - High," "Local Power Density - High," and "Departure from Nucleate Boiling Ratio - Low" functions will be revised to be consistent with STS.

The revised response (ML16300A345) to Question 16-92 provided the requested rationale for choosing the operating bypass permissive and automatic bypass removal setpoints for the Logarithmic Power Level – High reactor trip function to be 1E-3 percent of RTP, a factor of ten greater than the STS value of 1E-4 percent of RTP. The staff finds the proposed value acceptable because it is more restrictive than the STS. Footnote (a) allows manually bypassing the Logarithmic Power Level – High reactor trip function during physics tests pursuant to Subsection 3.1.9, "Special Test Exception (STE) – SHUTDOWN MARGIN (SDM)." However, the staff finds no provision in the GTS or Bases that explicitly says "the operating bypass setpoint is temporarily changed to 10^{-4} % during low power physics tests." The staff also noted that the markup of Subsections 3.3.1, B 3.3.1, 3.3.2, and B 3.3.2, provided in the response letter enclosure's attachment, did not change "THERMAL POWER" to "logarithmic power" as indicated by the response, quoted above. Pending receipt of a revised response from the applicant to correct these two inconsistencies, RAI 239-8076, Question 16-92, was tracked as an open item. In its supplemental revised response (ML17233A392) the applicant stated (The markup denotes the actual text indicated for addition on page B 3.3.1-20 in the LCO section of Subsection B 3.3.1.):

> The Logarithmic Power Level – High Reactor Trip may be manually bypassed during PHYSICS TESTS pursuant to LCO 3.1.9, "Special Test Exception (STE) – SHUTDOWN MARGIN (SDM).
>
> The operating bypass setpoint for Logarithmic Power Level – High Reactor Trip needs to be temporarily changed to 1E-4% during the low power physics test <u>in order to reduce the possibility of spurious trip.</u> ~~because there may be a spurious trip during the low power physics test if the bypass is not modified.~~ This phrase will be added to page B 3.3.1-20.
>
> The use of "THERMAL POWER" as stated in Subsections 3.3.1, B 3.3.1, 3.3.2, and B 3.3.2 will be changed to "logarithmic power" to be consistent with STS.

The attachment markup of Subsection B 3.3.1 also corrected the LCO section regarding reactor trip Function 14, “Local Power Density (LPD) – High,” by inserting the missing words as indicated:

> The [CPC channel operating] bypass effectively removes the DNBR – Low and LPD – High trips from the RPS logic circuitry. The operating bypass is automatically removed when enabling bypass conditions are no longer satisfied.

The attachment markup of Subsection B 3.3.2 also corrected the Applicability section, regarding reactor trip Function 1, “Logarithmic Power Level – High,” by changing “≥” to “>” and “<” to “≤” so that the sentence labeled “c” states, consistent with Table 3.3.2-1 Footnote (a):

> c. The Applicability is modified by a Note that allows the trip to be bypassed when logarithmic power is > 1E-3%, and the bypass is automatically removed when logarithmic power is ≤ 1E-3%.

Finding that these changes corrected the noted deficiencies in Subsections 3.3.1, 3.3.2, B 3.3.1, and B 3.3.2, the staff concludes that RAI 239-8076, Question 16-92, is resolved.

Other differences between Footnotes (a) and (c) of GTS Table 3.3.1-1 for Function 2, and Functions 14 and 15, respectively, and Footnotes (a) and (c) in STS Table 3.3.1-1 for Function 2, and Functions 13 and 14, respectively, are considered editorial in nature because the GTS phrasing conveys the same meaning as the STS phrasing. Since these editorial differences improve the clarity of the GTS footnotes over the STS footnotes, they are acceptable.

Similarly, the editorial differences between Footnote (b) of GTS Table 3.3.1-1 for Function 4, Pressurizer Pressure – Low, and Footnote (b) of STS Table 3.3.1-1 for Function 4, Pressurizer Pressure – Low, are acceptable because they are considered editorial in nature and improve the clarity of the GTS footnote over the STS footnote.

The GTS Table 3.3.1-1 does not include a reactor trip function corresponding to STS 3.3.1 Function 12, Loss of Load (turbine stop valve control oil pressure) and associated Footnote (d) of STS Table 3.3.1-1. This omission is acceptable because the APR1400 RPS design does not include a “loss of load” reactor trip function.

The staff reviewed Subsection 3.3.1 and Subsection B 3.3.1 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the specified RPS instrumentation reactor trip Functions, so that in the event an accident occurs in Mode 1 or 2, and monitored process variables or conditions satisfy specified trip setpoints, the affected functions will generate trip signals to the RPS logic, which if satisfied, will cause the RTCBs to open resulting in all CEAs dropping into the core and shutting down the reactor, as assumed in the transient and accident analyses. The trip setpoints are determined in accordance with the NRC approved setpoint methodology, which is specified in Subsection 5.5.19, “Setpoint Control Program,” and will ensure that each trip function will actuate before exceeding the analytical limit for the trip setting assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.3.1 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.3.1. The staff also verified that Subsections 3.3.1 and B 3.3.1 are consistent with the guidance in CE STS Subsections 3.3.1B and B 3.3.1B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.1 and Subsection B 3.3.1 are acceptable.

Subsection 3.3.2 RPS Instrumentation – Shutdown

Subsection 3.3.2 specifies TS requirements for instrumentation functions that are assumed to initiate a reactor trip by the safety analyses of postulated events occurring with any reactor trip circuit breakers (RTCBs) closed, any control element assembly (CEA) capable of being withdrawn, and fuel loaded in reactor when the unit is in Mode 3, 4, or 5.

The following table lists the APR1400 RPS reactor trip Functions and equivalent STS RPS reactor trip Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.2	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.2
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.2 RPS Instrumentation - Shutdown	3.3.2B RPS Instrumentation - Shutdown
1. Logarithmic Power Level – High[(a)] ..... 3[(b)],4[(b)],5[(b)]	Logarithmic Power Level – High[(a)] .... Modes 3, 4, and 5 with any reactor trip circuit breakers (RTCBs) closed and any control element assembly capable of being withdrawn.
2. SG #1 Pressure – Low[(c)].......................... 3[(b)],4[(b)]	--
3. SG #2 Pressure – Low[(c)].......................... 3[(b)],4[(b)]	--
Table 3.3.2-1 Footnotes: (a) **Trip may be bypassed when logarithmic power is** > **1E-3%.** **Operating** bypass shall be **automatically removed** **when logarithmic power is** ≤ **1E-3%.**	3.3.2B Applicability Note: Bypass may be enabled when logarithmic power is > [1E-4]% and shall be capable of automatic removal whenever logarithmic power is > [1E-4]%. Bypass shall be removed prior to reducing logarithmic power to a value ≤ [1E-4]%.
Table 3.3.2-1 Footnotes: (b) With any RTCBs closed, any control element assembly (CEA) capable of being withdrawn, and fuel loaded in reactor.	3.3.2B Applicability Modes 3, 4, and 5 with any RTCBs closed and any control element assembly capable of being withdrawn.
Table 3.3.2-1 Footnotes: (c) Steam Generator Pressure – Low trip setpoint may be manually decreased as steam generator pressure is reduced in Mode 3 and 4, provided the margin between steam generator pressure and the setpoint is maintained at 14.1 kg/cm^2 (200 psi). The setpoint shall be increased automatically as steam generator pressure is increased.	--

Although GTS Subsection 3.3.2 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.2 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.2.

Subsection 3.3.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	3.3.2 Actions table - Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-88	239-8076 ML15282A602 Response: ML16028A482	3.3.2, removed Actions table Note 2	CC	
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.2 and B 3.3.2	CU	16-137
16-92	239-8076 ML15282A602 Responses: ML16028A482 ML16300A344 ML17233A392	Table 3.3.1-1 Footnote (a) for Function 2, and Footnote (c) for Functions 14 and 15; and Table 3.3.2-1 Footnote (a) for Function 1 – reconciled differences with STS Table 3.3.1-1 and Table 3.3.2-1 Footnotes; – changed “THERMAL POWER” to “logarithmic power”; SR 3.3.1.7 surveillance column Note 2 – changed “THERMAL POWER” to “logarithmic power”; B 3.3.1 LCO section – clarified reason for changing operating bypass removal setpoint during low power physics test for Function 2 – corrected error in discussion of Function 14; B 3.3.1 ASA and LCO sections – changed “THERMAL POWER” to “logarithmic power” in discussion of Function 2 B 3.3.2 Applicability section	CC	

Subsection 3.3.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		– corrected inequality symbols in discussion of Applicability Note		
16-90 3rd response	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	• Consistent nomenclature for "associated automatic operating bypass removal function channel(s)" associated with RPS and ESFAS instrument Functions: LCO 3.3.2, Conditions C and D, Required Action C.2.2, SR 3.3.2.3, SR 3.3.2.4, Bases for Required Actions C.1, C.2.1, C.2.2, D.1, and D.2, and SR 3.3.2.3 • 3.3.2 – Clarified Required Actions C.1 and D.1 to say "Disable <u>affected</u> bypass channel / channels." • 3.3.2 - Changed Required Action C.2.2 Completion Time to match STS: "Prior to entering MODE 2 following next MODE 5 entry" • 3.3.2 - Corrected indent of logical connector "<u>AND</u>" for Actions C.2.1 and C.2.2	CC	
16-104	239-8076 ML15282A602 Response: ML16028A482 ML16200A342	See 16-90 3rd response above	CC	
16-105	239-8076 ML15282A602 Response: ML16028A482 ML16200A342	See 16-90 3rd response above	CC	
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103	Replaced "reactor trip switchgear (RTSG)" with "reactor trip circuit breaker (RTCB)" in • 3.3.2 Action E.1, Table 3.3.2-1 Footnote (b),	CC	

Subsection 3.3.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		• B 3.3.2 Background, ASA, LCO, Applicability, Actions, and SR sections		

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137. Refer to the evaluation of Subsection 3.3.1 for discussion and disposition of RAI 239-8076, Question 16-92.

Clarification of 3.3.2 Actions C and D

Regarding Subsection 3.3.2 Condition C and Condition D, the staff noted that reference to the automatic bypass removal feature of 3.3.2 Function 1 was inconsistent with other references to this feature in Section 3.3. The staff issued RAI 239-8076, Question 16-90 (ML15282A602) requesting that the applicant consistently refer to the automatic operating bypass removal function channel(s) associated with RPS and ESFAS instrument Functions, which have the automatic operating bypass removal feature, in LCO, Condition, Required Action, and Surveillance statements in GTS Section 3.3. In its second revised response (ML16200A344) to Question 16-90 the applicant stated:

> LCOs and Required Actions C.1 and D.1, which are stated in generic TS 3.3.1, 3.3.2, and 3.3.5 and associated TS Bases, will be revised to be consistent with corresponding STS sections.

The evaluation of Subsection 3.3.1 addresses the changes proposed for Subsection 3.3.2 in the second revised response to Question 16-90. That discussion also addressed Questions 16-99, 16-104, and 16-105, all of which are resolved.

The staff reviewed Subsection 3.3.2 and Subsection B 3.3.2 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the specified RPS instrumentation reactor trip Functions, so that in the event an accident occurs in Mode 3, 4, or 5 with any RTCBs closed and any CEA capable of being withdrawn, and monitored process variables or conditions satisfy specified trip setpoints, the affected functions will generate trip signals to the RPS logic, which if satisfied, will cause the RTCBs to open resulting in all CEAs dropping into the core and shutting down the reactor, as assumed in the transient and accident analyses. Accordingly, the staff concludes that Subsection 3.3.2 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.2 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.3.2. The staff also verified that Subsections 3.3.2 and B 3.3.2 are consistent with the guidance in CE STS Subsections 3.3.2B and B 3.3.2B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.2 and Subsection B 3.3.2 are acceptable.

Subsection 3.3.3 Control Element Assembly Calculators (CEACs)

The CEACs are considered components in the measurement channels of the DNBR – Low and LPD – High reactor trip instrumentation Functions. Each CPC receives CEA deviation penalty factors from both CEACs in that channel and uses the larger of the penalty factors from the two CEACs in the calculation of DNBR and LPD.

The CEACs perform the calculations required to determine the position of CEAs within their subgroups for the CPCs. Two independent CEACs in each CPCS channel compare the position of each CEA to its subgroup position. If a deviation is detected by either CEAC, an alarm occurs and appropriate "penalty factors" are transmitted to the associated CPC processor in that channel. These penalty factors conservatively adjust the effective operating margins to the DNBR – Low and LPD – High nominal trip setpoints.

The following table lists the APR1400 CEAC Functions and equivalent STS CEAC Functions, along with the specified applicable Modes.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.3	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.3
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.3 Control Element Assembly Calculators (CEACs)............................ Modes 1 and 2.	3.3.3B Control Element Assembly Calculators (CEACs)................................Modes 1 and 2.

Although GTS Subsection 3.3.3 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.3 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.3.

Subsection 3.3.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.3 and B 3.3.3	CU	16-137
16-96.b	239-8076 ML15282A602 Response: ML16028A482 ML16155A103	Replaced "reactor trip switchgear (RTSG)" with "reactor trip circuit breaker (RTCB)" in • B 3.3.3 Background section	CC	
16-103.1	239-8076 ML15282A602 Response: ML16028A482 ML17241A155	3.3.3– Revised Completion Times for • Required Actions A.1 and A.2.1 to be equal • Required Actions B.1 and B.2.5 to be equal, and renumbered B.2.5 as B.2.1,	CC	

Subsection 3.3.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		consistent with Section 1.3 regarding completion times for required actions connected by “OR”; and the writer’s guide on the preferred ordering of required actions based on shortest to longest completion time.		
16-103.2	239-8076 ML15282A602 Response: ML16028A482 ML17241A155	3.3.3 and B 3.3.3 – Clarified interpretation of Required Actions A.1 and B.1, and clarified associated Bases	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CU Closed Unresolved (has follow up question)

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137.

Clarification of Required Actions A.1 and B.1

The Actions of Subsection 3.3.3 are modeled after the Actions of Subsection 3.3.3 of the plant-specific TS for the Palo Verde Nuclear Generating Station’s three digital CE units. The CEAC design for these units is the same as proposed for the APR1400. Since each CPCS channel has its own pair of CEACs, the Actions allow separate condition entry for each CPCS channel. The staff finds this allowance acceptable because it simplifies the condition statements while still providing effective remedial measures.

In RAI 239-8076, Question 16-103 (ML15282A602), in Sub-question 1, the staff asked the applicant to renumber Required Action B.2.5 as B.2.1; and B.2.1 to B.2.4 as B.2.2 to B.2.5 to follow the STS convention of stating the required action with the shorter completion time before those with longer completion times. This request stemmed from another change to conform to STS convention for writing two required actions connected by the logical connector “OR”; each required action must have the same completion time. The staff suggested revising the Completion Times for Required Action A.2.1 and Required Action B.2.5 from “4 hours” to “1 hour AND once per 4 hours thereafter.” In its response (ML16028A482) the applicant made the suggested change. Therefore, Question 16-103, Sub-question 1 is resolved.

The following discussion reflects the changes made in response to Sub-question 1.

In RAI 239-8076, Question 16-103 (ML15282A602), in Sub-question 2, the staff asked the applicant to consider several scenarios (or cases) involving one or more CPCS channels with one CEAC inoperable, and one or more CPCS channels with both CEACs inoperable, and state the conditions in which declaring the affected CPCS channel inoperable would be the preferred course of action. By way of background, the requirements of proposed Actions A and B of Subsection 3.3.3 are summarized, as follows:

- Subsection 3.3.3 Condition A (one inoperable CEAC), Required Action A.1 offers the option of declaring the associated CPCS channel inoperable within 1 hour, in lieu of performing (the equivalent of) SR 3.1.4.1 within 1 hour and once per 4 hours thereafter (Required Action A.2.1) and restoring the CEAC to operability within 7 days (Required Action A.2.2).

  Note that SR 3.1.4.1 states "Verify indicated position of each full and part strength CEA is within 16.8 cm (6.6 in) of all other CEAs in its group. | 12 hours".

- Subsection 3.3.3 Condition B (two inoperable CEACs), Required Action B.1 offers the option of declaring the associated CPCS channel inoperable within 1 hour, in lieu of performing (the equivalent of) SR 3.1.4.1 within 1 hour and once per 4 hours thereafter (Required Action B.2.1, as renumbered), and also once per 4 hours performing the following Required Actions (as renumbered)

  B.2.2 Verify departure from nucleate boiling ratio requirement of LCO 3.2.4 is met and Reactor Power Cutback System (RPCS) is disabled;

  B.2.3 Verify all full strength and part strength CEA groups are fully withdrawn and maintained fully withdrawn, except during Surveillance testing pursuant to SR 3.1.4.3, or for power control, when CEA group #5 may be inserted to a maximum of 323.9 cm (127.5 in);

  B.2.4 Verify addressable constant in each affected CPC is set to indicate that both CEACs are inoperable and "RSPT/CEAC inoperable" status is indicated.

  B.2.5 Verify Digital Rod Control System (DRCS) is placed in "standby" and maintained in "standby," except during CEA motion permitted by Required Action B.2.3.

Choosing to take Required Action A.1 or B.1 means entering Condition A of Subsection 3.3.1 for the LPD - High and DNBR – Low reactor trip Functions, for which 3.3.1 Required Action A.1 states "Place trip channel in bypass or trip. | 1 hour." The staff noted that there exists some ambiguity with this arrangement, because in actuality, with one or both CEACs inoperable, the CPCS channel technically remains operable, but with reduced operating margin to the LPD and DNBR nominal trip setpoints. Because of this, an operator might reason that the Actions would permit returning the LPD - High and DNBR – Low reactor trip Function channels to a standby status, exiting LCO 3.3.1, Condition A, and taking LCO 3.3.3 Required Action A.2.1─or more likely─ taking Required Actions B.2.1 through B.2.5 (for the Condition B statement of "Required Action and associated Completion Time of Condition A not met"). This interpretation might appear advantageous if a second or third LPD – High or DNBR – Low reactor trip Function channel is discovered inoperable (for other reasons), in order to avoid a unit shutdown in accordance with the action requirements of Subsection 3.3.1.

In Sub-question 2, the staff described Cases 1 and 4 as follows:

Case 1 - One CPCS channel with one CEAC inoperable

If one CEAC is inoperable in one CPCS channel, generic TS 3.3.3 Condition A is entered and Required Action A.1, which says "Declare affected

CPCS channel(s) inoperable." with a Completion Time of 1 hour, results in entering generic TS 3.3.1 Condition A ("One or more Functions with one automatic RPS trip channel inoperable.") and, within 1 hour, placing in bypass or trip the corresponding Reactor Protection System (RPS) trip channel for the RPS Functions of Local Power Density (LPD) - High and Departure From Nucleate Boiling Ratio (DNBR) - Low. By generic TS 3.3.1 Required Action A.2, the trip channel, which was declared inoperable, for the LPD - High and DNBR - Low trip Functions, and the associated CPCS channel, which was declared inoperable, must be restored to operable status prior to entering Mode 2 following next Mode 5 entry.

a. With one channel in trip, the coincidence logic for each of these two RPS Functions in all four PPS divisions changes from 2-out-of-4 to 1-out-of-3;

b. With one channel in [trip channel] bypass, the coincidence logic changes from 2-out-of-4 to 2-out-of-3.

In either logic configuration, these RPS Functions can withstand another single failure and still initiate a reactor trip consistent with the safety analyses. Since operation with the unit in either of these configurations until the next Mode 5 entry has minimal safety impact, Case 1 is acceptable.

...The staff notes that the Case 1a ... configurations are susceptible to a spurious reactor trip from a single failure that results in tripping one remaining operable channel in either RPS Function.

Case 4 - One CPCS channel with both CEACs inoperable

Upon discovery that both CEACs in one CPCS channel are concurrently inoperable, generic TS 3.3.3 Condition A is not entered again, if it was already entered, because the same CPCS channel is affected. Choosing Required Action A.1, which says "Declare affected CPCS channel(s) inoperable" with a Completion Time of 1 hour, results in the unit entering generic TS 3.3.1 Condition A ("One or more Functions with one automatic RPS trip channel inoperable.") and, within 1 hour, placing in bypass or trip the corresponding RPS trip channel for the RPS Functions of LPD - High and DNBR - Low. By generic TS 3.3.1 Required Action A.2, the trip channel, which was declared inoperable, for the LPD - High and DNBR - Low trip Functions, and the associated CPCS channel, which was declared inoperable, must be restored to operable status prior to entering Mode 2 following next Mode 5 entry.

a. With one channel in trip, the coincidence logic for each of these two RPS Functions in all four PPS divisions changes from 2-out-of-4 to 1-out-of-3;

b. With one channel in [trip channel] bypass, the coincidence logic changes from 2-out-of-4 to 2-out-of-3.

The above resulting configurations are the same as reached in Case 1. However, upon discovery that both CEACs in one CPCS channel are concurrently inoperable, generic TS 3.3.3 Condition B ("Both CEACs inoperable in one or more CPCS channels.") is also entered. Choosing

Required Action B.1, which says “Declare affected [CPCS] channel(s) inoperable” with a Completion Time of 1 hour, also results in the unit entering generic TS 3.3.1 Condition A and, within 1 hour, placing in bypass or trip the corresponding RPS trip channel for the RPS Functions of LPD - High and DNBR - Low. Therefore, Case 1 and Case 4 result in the same states for the affected channel of the DNBR - Low and LPD - High RPS Functions. The staff concludes that Case 4 is acceptable.

In its initial response (ML16028A482) to the concerns raised in RAI 239-8076, Question 16-103, Sub-question 2, the applicant stated:

> The CPCS has redundant CEACs and CPPs [CEA position processors] in a channel to ensure high availability in the event of a processor failure. The preferable option for Case 1b and 4b described in the NRC question is to take Required Action A.1 and Required Action B.1 of LCO 3.3.3 to declare the affected CPCS channel inoperable. Taking Required Action A.1 and Required Action B.1 of LCO 3.3.3 would not be the preferable option for cases other than for the 1b and 4b Cases.
>
> As mentioned in the questions posed, either action will place the unit just one failure away from a spurious reactor trip or lead to a plant shutdown. The Bases for Actions A.1 and B.1 in B 3.3.3 states that if the failure affects more than two CPCS channels, then Required Action A.2.1 and A.2.2 (or B.2.1 through B.2.5) would be preferable. Therefore, if the failure affects more than two CPCS channels, the operator would select Required Actions A.2.1 and A.2.2 (or B.2.1 through B.2.5) rather than Required Action A.1 and Required Action B.1 to prevent against a spurious reactor trip or plant shutdown.

Since Case 1b and Case 4b both result in placing the affected LPD – High trip channel and DNBR – Low trip channel in bypass, and involve only one CPCS channel, it appears there is an error in the above response and in the passage in the Bases for 3.3.1 Required Action B.1, to which it refers; instead of “more than two CPCS channels” the Bases should say “two or more CPCS channels.” The staff also notes that the Bases for Required Actions A.1 and B.1 need clarification, as indicated by the following markup:

> A.1, A.2.1, and A.2.2
>
> Condition A applies to the failure of one CEAC in one or more CPCS channels. A CEAC failure affecting a single channel could result from failure within a CEAC processor module, whereas a CEAC failure in multiple channels could be caused by failure of redundant CPPs within a CPCS channel. Thus, Condition A ~~Required Actions~~ addresses both possibilities.
>
> A.1
>
> Required Action A.1 provides for declaration of affected CPCS channel inoperability within 1 hour, ~~and~~ followed by immediate entry into the applicable Conditions and Required Actions associated with LCO 3.3.1 for the DNBR – Low and LPD – High reactor trip functions. This Required Action treats failure of a single CEAC ~~failure~~ in one or more CPCS channels in a manner consistent with other ~~RPS~~ failures in one or more

RPS trip function channels.~~ channels, and~~ Required Action A.1 may be the preferred action if only one CPCS channel is affected. If the failure affects ~~more than~~ two or more CPCS channels, Required Actions A.2.1 and A.2.2 would be preferable.

...

B.1, B.2.1, B.2.2, B.2.3, B.2.4, and B.2.5

Condition B applies if ~~the~~ a Required Action and associated Completion Time of Condition A are not met, or if both CEACs are inoperable in one or more CPCS channels. The Required Actions associated with this Condition involve two choices.

a. Required Action B.1 ~~immediately renders~~ requires that the affected CPCS channels be considered inoperable within 1 hour, thus requiring entry into the applicable Conditions and Required Actions associated with LCO 3.3.1.

b. ...

The Required Actions are as follows.

B.1

Required Action B.1 provides for declaration of affected CPCS channel inoperability within 1 hour, ~~and~~ followed by immediate entry into the applicable Conditions and Required Actions associated with LCO 3.3.1 for the DNBR – Low and LPD – High reactor trip functions. This Required Action treats failure of both CEACs in one or more CPCS channels in a manner consistent with other ~~RPS~~ failures in one or more RPS trip function channels.~~ Similarly, this~~ Required Action B.1 also applies if a Required Action and associated Completion Time of Condition A are not met, and similarly permits ~~immediate~~ declaration of CPCS channel inoperability within 1 hour ~~and~~ followed by immediate entry into the applicable Conditions and Required Actions of LCO 3.3.1~~ if the Required Actions and associated Completion Times of Condition A are not met~~. Required Action B.1 may be the preferred action if only one CPCS channel is affected. If the CEAC failures affect ~~more than~~ two or more CPCS channels, Required Action B.2.1 through B.2.5 would be preferable.

Finally, the staff points out that the potential ambiguity in the action requirements, which is described above, can be resolved by including in the Bases a statement that LCO 3.3.1 Conditions that were entered (for LPD – High and DNBR – Low) because of LCO 3.3.3 Required Action A.1 or B.1, may only be exited by restoring the inoperable CEAC(s) to operable status, and not by “undeclaring” the inoperability of the CPCS channel(s) with the inoperable CEAC(s).

Pending resolution of the above follow up issues, RAI 239-8076, Question 16-103, Sub-question 2, was tracked as an open item. In its revised response (ML17241A155) to Question 16-103, Sub-question 2, the applicant incorporated the suggested edits into

Subsection B 3.3.3. In addition, under the Bases for Action A.1 and Action B.1, the applicant added a statement to clarify that the intent of Action A.1 and Action B.1 is that the Actions of LCO 3.3.1, entered according to these actions, may only be exited by restoring the inoperable CEAC(s) to operable status. Therefore, RAI 239-8076, Question 16-103, Sub-question 2, is resolved.

The staff reviewed Subsection 3.3.3 and Subsection B 3.3.3 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the CEACs, which support the CPC derived RPS instrumentation reactor trip Functions of LPD – High and DNBR – Low, so that in the event an accident occurs in Mode 1 or 2, and monitored process variables or conditions satisfy specified trip setpoints, these Functions will generate trip signals to the RPS logic, which if satisfied, will cause the RTCBs to open resulting in all CEAs dropping into the core and shutting down the reactor, as assumed in the transient and accident analyses. Accordingly, the staff concludes that Subsection 3.3.3 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.3. The staff also verified that Subsections 3.3.3 and B 3.3.3 are consistent with the guidance in CE STS Subsections 3.3.3B and B 3.3.3B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff concludes that Subsection 3.3.3 and Subsection B 3.3.3 are acceptable.

Subsection 3.3.4 RPS Logic and Trip Initiation

Subsection 3.3.4 includes requirements on RPS logic which initiates a reactor trip to protect against violating the core specified acceptable fuel design limits and breaching the reactor coolant pressure boundary (RCPB) during anticipated operational occurrences (AOOs). By tripping the reactor, the RPS also assists the engineered safety features (ESF) systems in mitigating accidents. This subsection also includes requirements for the RTCBs and the RPS Manual Trip Function.

The following table lists the APR1400 RPS logic and trip initiation Functions and equivalent STS RPS logic and trip initiation Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.4	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.4
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.4 RPS Logic and Trip Initiation...................... Modes 1 and 2, Modes 3, 4, and 5, with any RTCBs closed and any control element assemblies capable of being withdrawn.	3.3.4 RPS Logic and Trip Initiation (Digital).................. Modes 1 and 2, Modes 3, 4, and 5, with any RTCBs closed and any control element assemblies capable of being withdrawn.
— RPS **Coincidence** Logic	— RPS Matrix Logic
— RPS Initiation Logic	— RPS Initiation Logic
— RTCBs	— [RTCBs]
— Manual Trip	— Manual Trip

Although GTS Subsection 3.3.4 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.4 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.4.

Subsection 3.3.4 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.4 and B 3.3.4	CU	16-137
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103	Replaced “reactor trip switchgear (RTSG)” with “reactor trip circuit breaker (RTCB)” in • 3.3.4 LCO, Applicability, Conditions A, B, C, D, Required Actions A.1, B.1, C.1, D.2, SR 3.3.4.1, SR 3.3.4.2, SR 3.3.4.4 • B 3.3.4 Background, ASA, LCO, Applicability, Actions, and SR sections	CC	
16-112.1	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	Use “coincidence logic state” on pages B 3.3.1-8, B 3.3.4-3, B 3.3.5-3, and B 3.3.6-2	CC	
16-115.3	295-8263 ML15314A020 Response: ML16134A009	3.3.4 Action C – deleted; B 3.3.4 Actions section – deleted discussion of Required Action C.1; B 3.3.6 Background section on page B 3.3.6-3 – Added discussion explaining meaning of a “trip leg” in the ESF Initiation Logic	CC	
16-118	295-8263 ML15314A020 Response: ML16093A021	Clarified discussion of reactor switchgear system (RTSS) and reactor trip circuit breakers in Background section of B 3.3.4	CC	
16-122.1	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Subsections B 3.3.1, B 3.3.4, B 3.3.5, and B 3.3.6; first paragraph of SR Section: Clarified that the “interface and test processor (ITP)” is needed to perform Channel	CC	

Subsection 3.3.4 Question.Sub-Question No.	NRC Letter No.–RAI No.; ADAMS Accession Nos.	Affected Generic TS or DCD Tier 2 Description	Status	Follow up Question.Sub-Question No.
		Functional Test in Bases of SR 3.3.4.1 and SR 3.3.4.2.		

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CU Closed Unresolved (has follow up question)

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137.

In RAI 295-8263, Question 16-115 (ML15314A020), in Sub-question 3, the applicant was requested to discuss what is meant by an ESFAS "trip leg" in the Background section of the Bases on page B 3.3.5-4 and page B 3.3.6-3. In its response (ML16134A009) the applicant observed that the logical arrangement of the APR1400 reactor trip circuit breakers (RTCBs) into two reactor trip switchgear systems (RTSSs) does not use the "trip leg" concept, and stated:

> Since the reactor trip switchgear system (RTSS) is composed of full two-out-of-four logic, the term "trip leg" is not necessary to be used for the ACTIONS of LCO 3.3.4. Therefore, Condition C of LCO 3.3.4 will be deleted along with the corresponding TS Bases.

Revision 0 of GTS Subsection 3.3.4, Action C states "C. Two channels of Manual Trip, RTSG, or RPS logic affecting the same trip leg inoperable. | C.1 Open affected RTSGs. | Immediately"; note that reactor trip switchgear (RTSG) means and was replaced by RTCB, as discussed in RAI 239-8076, Question 16-96, Sub-question b (ML15282A602). The staff finds removal of Action C and associated Bases is acceptable because the design only permits one RTCB channel (involving two RTCBs) to be open without causing a reactor trip. The staff noted that Footnote (d) of Table 3.3.12-1, "Remote Shutdown Display and Control Functions," was also revised to remove the phrase, "in opposite trip legs to meet the selective two-out-of-four logic for a reactor trip," which is likewise acceptable. Therefore, RAI 295-8263, Question 16-115, Sub-question 3, in so far as it relates to Subsections 3.3.4, B 3.3.4, 3.3.12, and B 3.3.12, is resolved.

The staff reviewed Subsection 3.3.4 and Subsection B 3.3.4 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the RPS reactor trip coincidence and initiation logic and the RTCBs, so that in the event an accident occurs in Mode 1 or 2; or in Mode 3, 4, or 5 with any RTCB closed or any CEAs capable of being withdrawn, upon receipt of a valid trip signal from at least two channels of at least one RPS instrumentation reactor trip Function, the RPS logic will cause the RTCBs to open resulting in all CEAs dropping into the core and shutting down the reactor, as assumed in the transient and accident analyses. Similarly, the operability of the manual Trip Function is ensured so that the control room operator can initiate opening of the RTCBs upon failure of one or more RTCBs to open automatically on a valid trip actuation signal. Accordingly, the staff concludes that Subsection 3.3.4 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.4. The staff also verified that Subsections 3.3.4 and B 3.3.4 are consistent with the guidance in CE STS Subsections 3.3.4B and B 3.3.4B, and the

APR1400 design as described in the DCD. Therefore, based on its review and the above evaluation, the staff concludes that Subsection 3.3.4 and Subsection B 3.3.4 are acceptable.

Subsection 3.3.5 Engineered Safety Features Actuation System (ESFAS) Instrumentation

Subsection 3.3.5 specifies TS requirements for instrumentation functions that are assumed to initiate an engineered safety features actuation signal by the safety analyses of design basis accidents and postulated events occurring with the unit in Mode 1, 2, 3, or 4. An ESF actuation occurs when a measured process parameter reaches the specified limiting safety system setting (LSSS) (the nominal trip setpoint) for the associated ESFAS function. The nominal trip setpoint (NTSP) is determined in accordance with the NRC approved setpoint methodology specified in Subsection 5.5.19, "Setpoint Control Program," so that protective action occurs before the measured process parameter exceeds the assumed value in the safety analysis, the analytical limit. This ensures that the radiological dose consequences of design basis accidents are within regulatory limits.

The instrumentation sensors, transmitters, and bistable processors used by both the ESFAS and RPS instrumentation are (SIAS stands for safety injection actuation signal and CIAS stands for containment isolation actuation signal.):

Pressurizer Pressure – Low

RPS reactor trip Function 3.3.1.4
ESFAS SIAS Function 3.3.5.1b
ESFAS CIAS Function 3.3.5.3b

Containment Pressure – High

RPS reactor trip Function 3.3.1.5
ESFAS SIAS Function 3.3.5.1a
ESFAS CIAS Function 3.3.5.3a

In addition to Modes 1 and 2 required by RPS Functions 3.3.1.4 and 3.3.1.5, these instruments are required to be operable to support the SIAS Function in Modes 3 and 4, and the CIAS Function in Modes 3 and 4.

The following table lists the APR1400 ESFAS instrumentation Functions and equivalent STS ESFAS instrumentation Functions, along with the specified applicable Modes or other specified conditions. Note that NR and WR stand for narrow range and wide range, respectively. The acronym MSIS stands for main steam isolation signal, CSAS stands for containment spray actuation signal, and AFAS stands for auxiliary feedwater actuation signal.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.5	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.5
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.5 Engineered Safety Features Actuation System (ESFAS) Instrumentation	3.3.5B Engineered Safety Features Actuation System (ESFAS) Instrumentation
1. Safety Injection Actuation Signal a. Containment Pressure (NR) – High ... 1,2,3,**4** b. Pressurizer Pressure – Low[(a)] 1,2,3,**4**	1. Safety Injection Actuation Signal[(a)] a. Containment Pressure – High ....1,2,3 b. Pressurizer Pressure – Low[(b)]....................1,2,3

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.5	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.5
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
2. Containment Spray Actuation Signal a. Containment Pressure – High High ... 1,2,3,**4** --	2. Containment Spray Actuation Signal a. Containment Pressure – High High ....1,2,3 b. Automatic SIAS 1,2,3
3. Containment Isolation Actuation Signal a. Containment Pressure (NR) – High ... 1,2,3,**4** b. Pressurizer Pressure – Low[(a)] 1,2,3,**4**	3. Containment Isolation Actuation Signal a. Containment Pressure – High ....1,2,3 b. Pressurizer Pressure – Low[(b)] 1,2,3
4. Main Steam Isolation Signal a. Steam Generator Pressure – Low[(c)] .... 1,2[(b)],3[(b)],**4**[(b)(d)] b. Containment Pressure (NR) – High .... 1,2[(b)],3[(b)],**4**[(b)(d)] c. Steam Generator Level (NR)– High .... 1,2[(b)],3[(b)],4[(b)(d)]	4. Main Steam Isolation Signal a. Steam Generator Pressure – Low[(c)] .... 1,2[(d)],3[(d)] b. Containment Pressure – High .... 1,2[(d)],3[(d)] --
-- --	5. Recirculation Actuation Signal a. Refueling Water Storage Tank Level – Low 1,2,3
5. Auxiliary Feedwater Actuation Signal SG #1 (AFAS-1) a. Steam Generator Level (WR) – Low .... 1,2,3,**4**[(b)(d)] -- --	6. Emergency Feedwater Actuation Signal SG #1 (EFAS-1) a. Steam Generator Level – Low........................... ....1,2,3 b. SG Pressure Difference – High ....1,2,3 [c. Steam Generator Pressure – Low .... 1,2,3]
6. Auxiliary Feedwater Actuation Signal SG #2 (AFAS-2) a. Steam Generator Level (WR) – Low .... 1,2,3,**4**[(b)(d)] -- --	7. Emergency Feedwater Actuation Signal SG #2 (EFAS-2) a. Steam Generator Level – Low ....1,2,3 b. SG Pressure Difference – High ....1,2,3 [c. Steam Generator Pressure – Low .... 1,2,3]
Table 3.3.5-1 Footnotes: --	Table 3.3.5-1 Footnotes: (a) Automatic SIAS also initiates a Containment Cooling Actuation Signal (CCAS).
Table 3.3.5-1 Footnotes: (a) The setpoint may be **manually** decreased to a minimum value of 7.0 kg/cm^{2}A (100 psia), as pressurizer pressure is reduced, provided the margin between pressurizer pressure and the setpoint is maintained ≤ 28.1 kg/cm^2 (400 psi). Trips may be bypassed when pressurizer pressure is < 28.1 kg/cm^{2}A (400 psia). Bypass shall be automatically removed when pressurizer pressure is ≥ 35.2 kg/cm^{2}A (500 psia). The setpoint shall be automatically increased to the normal setpoint as pressurizer pressure is increased.	Table 3.3.5-1 Footnotes: (b) The setpoint may be decreased to a minimum value of [300] psia, as pressurizer pressure is reduced, provided the margin between pressurizer pressure and the setpoint is maintained ≤ [400] psia. Trips may be bypassed when pressurizer pressure is < [400] psia. Bypass shall be automatically removed when pressurizer pressure is ≥ [500] psia. The setpoint shall be automatically increased to the normal setpoint as pressurizer pressure is increased.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.5	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.5
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
Table 3.3.5-1 Footnotes: (b) Main Steam Isolation Signal (MSIS) Function (Steam Generator Pressure – Low, Containment Pressure – High, and Steam Generator Level – High signals) is not required to be Operable when all associated valves isolated by the MSIS Function are closed and deactivated.	Table 3.3.5-1 Footnotes: --
Table 3.3.5-1 Footnotes: (c) The setpoint may be decreased as steam pressure is reduced, provided the margin between steam pressure and the setpoint is maintained ≤ 14.1 kg/cm^2 (200 psi). The setpoint shall be automatically increased to the normal setpoint as steam pressure is increased.	Table 3.3.5-1 Footnotes: (c) The setpoint may be decreased as steam pressure is reduced, provided the margin between steam pressure and the setpoint is maintained ≤ [200] psig. The setpoint shall be automatically increased to the normal setpoint as steam pressure is increased.
(d) When a steam generator is relied upon for heat removal.	--

In the APR1400 design, there is no automatic initiation of RCS makeup / safety injection on low hot leg level.

Although GTS Subsection 3.3.5 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.5 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.5.

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-88	239-8076 ML15282A602 Response: ML16028A482	3.3.5, removed Actions table Note 2	CC	
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.5 and B 3.3.5	CU	16-137
16-90 3rd response 16-104 1st response	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	• Consistent nomenclature for “associated automatic operating bypass removal function channel(s)” associated with RPS and ESFAS instrument Functions: LCO 3.3.5, 3.3.5 Required Action C.2.2, SR 3.3.5.3;	CC	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Bases LCO section, Bases for SR 3.3.5.3 • 3.3.5 Required Actions C.1 and D.1 revised to say “Disable affected bypass channel / channels.” • Changed 3.3.5 Action C.2.2 Completion Time to match STS: “Prior to entering MODE 2 following next MODE 5 entry” • Corrected indentation of logical connector “AND” for 3.3.5 Required Actions C.2.1 and C.2.2		
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103	3.3.5 and B 3.3.5 – to match STS, replaced “RTSG” with “RTCB” throughout the GTS and Bases, where appropriate	CC	
16-111.1	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Required Action C.2.2 and Bases - Consistently use “automatic operating bypass removal channel”	CC	
16-111.2	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5, changed Required Actions A.2 and C.2.2 Completion Times to match STS; “Prior to entering MODE 2 following next MODE 5 entry”	CC	
16-111.3	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Condition B edited to match Condition C: “automatic ESFAS trip channels inoperable”	CC	
16-111.4	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Actions E and F, Required Action Notes - changed to “Functions”	CC	
16-111.5	295-8263 ML15314A020	3.3.5 Action B, Required Action Note (exception to	CC	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML16093A021 ML16268A005	LCO 3.0.4) is not needed and is removed		
16-111.6	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Required Actions C.2.1 and C.2.2 Logical Connector "AND" indentation corrected	CC	
16-111.7	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Action D, Required Action Note (exception to LCO 3.0.4) is not needed and is removed	CC	
16-111.8	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.5 Required Actions C.1 and D.1 – phrase "disable bypass channel / channels" is unclear	CU	16-90 3rd response 16-153.1
16-111.9 16-90	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005 239-8076 ML15282A602 Responses: ML16028A482 ML16155A103 ML16200A342	Revised SR 3.3.5.2 and SR 3.3.5.3 with phrase "the SCP"; revised SR 3.3.5.3 with phrase "associated automatic operating bypass removal" function or channel	CC	
16-111.10	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	Table 3.3.5-1 Applicability format is incorrect	CC	See 16-153.2
16-111.11	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	Justify 3.3.5 omission of Mode 4 from Applicability of Functions 3a and 3b; and 3.3.6 Functions 3a and 3b	CC	See 16-153.3
16-111.12	295-8263 ML15314A020 Responses:	3.3.5 Actions E and F - corrected placement of Required Action Note	CC	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16093A021 ML16268A005			
16-112.1	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	Used “coincidence logic state” on Pages B 3.3.1-8, B 3.3.4-3, B 3.3.5-3, and B 3.3.6-2	CC	
16-112.2	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on Page B 3.3.5-5, revised two paragraphs for clarity	CC	
16-112.3a	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on page B 3.3.5-5 – Clarified ESF logic description	CC	
16-112.3b	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on page B 3.3.5-5 – Removed paragraph describing ESF-CCS cabinet components	CC	See 16-117 in evaluation of 3.3.6
16-112.4	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on page B 3.3.5-5 – Clarified discussion of ESFAS Function subgroups	CC	
16-112.5	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on page B 3.3.5-5 – Clarified discussion about the roles of the all-bypass function and the trip channel bypass	CC	
16-112.6	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.5 Background section on page B 3.3.5-5 – Clarified effects of an enabled automatic operating bypass function	CC	
16-115.4a	295-8263 ML15314A020 Response: ML16134A009	B 3.3.5 and B 3.3.6 Background section – Used initial upper case letters for “Reactor Coolant System”	CC	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-115.4b	295-8263 ML15314A020 Response: ML16134A009	B 3.3.5 and B 3.3.6 Back-ground section – On pages B 3.3.5-1 and B 3.3.6-1, applied STS ordered list format convention to list of ESFAS functions	CC	
16-115.4c	295-8263 ML15314A020 Response: ML16134A009	B 3.3.5 and B 3.3.6 Back-ground section, fourth paragraph on pages B 3.3.5-1 and B 3.3.6-1 – Revised for clarity and for acronym definition and usage consistency	CC	
16-115.4d	295-8263 ML15314A020 Response: ML16134A009	Made editorial improvements to pages B 3.3.5-1 & 2, and page B 3.3.6-2	CC	
16-115.4e	295-8263 ML15314A020 Response: ML16134A009	On pages B 3.3.5-2 & 3 – changed “Bistable Logics” to “Bistable Logic Processors”	CC	
16-115.4f	295-8263 ML15314A020 Response: ML16134A009	On page B 3.3.6-2 and page B 3.3.5-4 – Made editorial improvements for global consistency of GTS Section B 3.3 Subsection Background sections	CC	
16-122.1	295-8263 ML15314A020 Response: ML16134A009 ML17241A118	Subsections B 3.3.1, B 3.3.4, B 3.3.5, and B 3.3.6; first paragraph of SR Section: Clarified that the “interface and test processor (ITP)” is needed to perform Channel Functional Test in Bases of SR 3.3.5.2, SR 3.3.5.3, and SR 3.3.5.5.	CC	
16-122.2	295-8263 ML15314A020 Response: ML16134A009 ML17241A118	B 3.3.5 SR section – Made editorial improvements to first five paragraphs of Bases for SR 3.3.5.2	CC	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-153.1	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	3.3.5 – Explained effect of operating bypass and its automatic operating bypass removal function on Operability of SIAS & CIAS on Pressurizer Pressure – Low	CR	
16-153.2	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Table 3.3.5-1 – corrected the applicable Modes format	CC	See revised response to 16-111.10
16-153.3	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Justified adding Mode 4 to applicability of SIAS, CSAS, and MSIS in 3.3.5 & 3.3.6	CR	See revised response to 16-111.12
16-153.3a	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Explained operability of Containment Pressure – High, and Pressurizer Pressure – Low in Mode 4 vs Mode 3 (SIAS vs CIAS)	CR	See revised response to 16-111.12
16-153.3b	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	3.3.5 - Explained operability of Containment Pressure – High in Mode 4 vs Mode 3 (SIAS & MSIS vs CIAS)	CR	See revised response to 16-111.12
16-153.3c	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Discussed difference in Applicability of 3.3.5 instrument functions and supported 3.3.6 CIAS actuation logic & manual trip	CR	
16-153.3d	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Discussed difference in Applicability of 3.3.5 instrument functions and supported 3.3.6 AFAS actuation logic & manual trip	CC	
16-153.3e	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Discussed difference in Applicability of 3.3.6 CIAS and STS 3.3.6 CIS initiation logic	CR	

Subsection 3.3.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-153.3f	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Discussed difference in Applicability of 3.3.6 SIAS, CSAS, MSIS and STS 3.3.6 SIAS, CSAS, MSIS initiation logic	CR	
16-153.3g	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	3.3.5 & 3.3.6 - Justified need for SIAS, CSAS, MSIS in Mode 4 and added “Mode 4 when a SG is relied upon for heat removal” to applicability for AFAS Functions 5a, AFAS-1, and 6a, AFAS-2.	CC	16-154.2
16-153.3h	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Explained why automatic SIAS not needed to meet LCO 3.5.3 SIS train operability.	CR	
16-154.2	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	Confirmed that automatic actuation of the required AFW motor driven train on Steam Generator Level - Low is required in Mode 4	CR	16-153.2 16-153.3g

Status Codes:
RC Resolved Confirmatory
CU Closed Unresolved (has follow up question)
CR Closed Resolved with no DCD changes
CC Closed Confirmed

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137.

See evaluation of Subsection 3.3.1 for the staff’s evaluation of the applicant’s response (ML16200A342) to RAI 239-8076, Question 16-90, regarding the change to the action statement “disable bypass channel” to “disable affected bypass channel” in Required Action C.1 of Subsections 3.3.1, 3.3.2, and 3.3.5; and the change to the action statement “disable bypass channels” to “disable affected bypass channels” in Required Action D.1 of Subsections 3.3.1, 3.3.2, and 3.3.5.

In RAI 295-8263, Question 16-111 (ML15314A020), in Sub-question 8, the staff requested that the applicant clarify the meaning of Subsection 3.3.5 Required Actions C.1 and D.1, which say “Disable [automatic operating] bypass [removal] channel(s).” Since the function being disabled is to automatically remove the bypass and enable the associated ESFAS trip channel, unbypassing the ESFAS trip channel would need to be done manually before reaching the reset setting. In its response (ML16093A021) to Question 16-111, regarding Sub-question 8, the applicant did not fully clarify the meaning of the action statement “disable bypass channel.”

Consequently, the staff issued follow up RAI 498-8595, Question 16-153 (ML16182A332), Sub-question 1a, requesting that the applicant either confirm or correct the following draft conclusion by the staff about the relationship between the operability of ESFAS instrument Functions 3.3.5.1.b and 3.3.5.3.b (and also RPS instrument Function 3.3.1.4 and Required Action C.1) and the associated operating bypass and automatic operating bypass removal Function:

> An [RPS/]SIAS/CIAS on Pressurizer Pressure – Low Function trip channel is inoperable when it is in bypass; it continues to be inoperable if it cannot be automatically removed from bypass above the 500 psia setpoint. However, once the bypass has been manually removed, the trip channel is considered operable.

In its initial response (ML16295A249) to RAI 498-8595, Question 16-153, Sub-question 1a, the applicant stated:

> The response to Sub-question No. 8 of Question No. 16-111 (RAI 295-8263) will be clarified as follows (emphasis added):
>
> a. Although the bypass removal function for the SIAS/CIAS on Pressurizer Pressure – Low Function trip channel cannot be restored to Operable, the trip channel is considered Operable only if the operating bypass is not in effect. In this case, no manual operating bypass action should be taken for the affected trip channel.
>
> However*, if the operating bypass is in effect and the automatic operating bypass removal function is inoperable, the trip channel is still inoperable even though the bypass is manually removed*. Therefore, the trip channel is not considered Operable by manually removing the bypass without restoring the affected operating bypass removal channel.

The staff finds this response acceptable and notes that it corrected an error in the above draft conclusion. Therefore, Question 16-153, Sub-question 1a is resolved.

In RAI 498-8595, Question 16-153 (ML16182A332), in Sub-question 1b, the staff requested that the applicant either confirm or correct a markup in the applicant's response to RAI 295-8263, Question 16-111, Sub-question 8. In its response (ML16295A249) to RAI 498-8595, Question 16-153, Sub-question 1b, the applicant stated:

> b. The revised response to Sub-question 8 of Question No. 16-111 (RAI 295-8263) is as follows:
>
> Required Action C.1, which states "Disable bypass channel." means that if the inoperable automatic operating bypass removal function for the associated SIAS/CIAS on Pressurizer Pressure – Low Function trip channel cannot be restored to OPERABLE status within 1 hour (except for the case that the operating bypass is not in effect), the associated SIAS/CIAS on Pressurizer Pressure – Low Function trip channel must be declared inoperable and Condition A must be entered.
>
> Required Action D.1, which states "Disable bypass channels." means that if the inoperable automatic operating bypass removal function for two associated SIAS/CIAS on Pressurizer Pressure – Low Function trip channels

cannot be restored to OPERABLE status within 1 hour (except for the case that each operating bypass is not in effect), two associated SIAS/CIAS on Pressurizer Pressure – Low Function trip channels must be declared inoperable and Condition B must be entered.

The staff finds this response acceptable because it provides the requested clarification of the action requirements for inoperable automatic bypass removal function(s). Therefore, Question 16-153, Sub-question 1b is resolved.

In RAI 498-8595, Question 16-153 (ML16182A332), in Sub question 1c, the staff requested that the applicant clarify the Actions section of the Bases for Subsection 3.3.5, to be consistent with the intended meaning of Required Actions C.1, C.2.1, and C.2.2. In its response (ML16295A249) to Question 16-153, Sub-question 1c, the applicant stated:

c. The Bases for generic TS Subsection 3.3.5, Required Actions C.1, C.2.1, and C.2.2 will be revised to clarify its meaning.

The revised Bases for Subsection 3.3.5 Action C, in the response letter's attachment replaced the existing content with the following:

> Condition C applies to an inoperable automatic operating bypass removal function of any operating bypass channel. The only automatic operating bypass removal function on an ESFAS Function is on the Pressurizer Pressure – Low signal, which is used to actuate SIAS and CIAS. This automatic operating bypass removal function is shared with the RPS Reactor Trip on Pressurizer Pressure - Low automatic operating bypass removal function.
>
> If the automatic operating bypass removal function of any operating bypass channel cannot be restored to OPERABLE status, the associated ESFAS Pressurizer Pressure - Low Function trip channel may be considered OPERABLE only if the operating bypass is not in effect (disabled). Otherwise the affected ESFAS Pressurizer Pressure - Low Function trip channel must be declared inoperable, and Condition A must be entered. Action C requires within 1 hour either removing (disabling) the operating bypass, or placing the affected automatic trip channel in bypass or trip; it also requires repairing the automatic operating bypass removal channel before entering MODE 2 following the next MODE 5 entry. The Bases for the Required Actions and associated Completion Times of Condition C are consistent with Condition A.

This revised passage clearly describes the meaning of Action C and addresses all implications that an operator must account for. Therefore, the revised Bases for Action C is acceptable, and Question 16-153, Sub-question 1c is resolved.

In RAI 295-8263, Question 16-111 (ML15314A020), in Sub-question 10, the staff requested that the applicant state the Applicability of each ESFAS instrumentation function in Table 3.3.5-1, instead of just for the supported ESF actuation function. In its response (ML16093A021) the applicant declined to make the requested change. This is not acceptable because it is inconsistent with STS Table 3.3.5-1 format. The applicant provided a revised response (ML16268A005) to Question 16-111, Sub-question 10 by conforming the format of the applicable modes field of Table 3.3.5-1 to the STS format, as requested. Therefore, RAI 295-8263, Question 16-111, Sub-question 10 is resolved.

In its response (ML16093A021) to RAI 295-8263, Question 16-111, Sub-question 11, the applicant stated that "Applicable Modes for ESFAS functions such as SIAS, CSAS, and MSIS in generic TS Table 3.3.5-1 are extended from Modes 1, 2, and 3 to Modes 1, 2, 3, and 4 in order to enhance the safety of nuclear power plants. This approach is more conservative than NUREG-1432, Revision 4; however, it is not necessary to add Mode 4 to CIAS based on operating experience from the Korean operating fleet. Therefore, no revision pertaining to Applicable Modes is necessary." The staff considers that no practical benefit results from not including Mode 4 in the Applicability of GTS Table 3.3.5-1 Functions 3a, Containment Isolation Actuation Signal (CIAS) on Containment Pressure – High and 3b, CIAS on Pressurizer Pressure – Low; and revising the Required Action Notes for Actions E and F and associated Bases discussions accordingly. The applicant revised its response (ML16268A005) to Question 16-111, Sub-question 11, by extending the applicability of the CIAS related instrument Functions and CIAS related ESF coincidence logic and initiation logic Functions to Mode 4. This is acceptable; therefore Sub-question 11 is resolved. However, the revised response did not update the Required Action Notes for Actions E and F and associated Bases discussions; rather it pointed to the applicant's response (ML16295A249) to RAI 498-8595, Question 16-153, Sub-question 3, which is resolved as described below.

In RAI 295-8263, Question 16-112 (ML15314A020), in Sub-question 2, the staff requested that the applicant revise the first two paragraphs on page B 3.3.5-5 in Subsection B 3.3.5 Background section, for clarity and consistency with the ESF logic design. In its response (ML16093A021) the applicant stated:

> The local coincidence logic (LCL) and initiation logic are sequentially located in the LCL processor. The LCL performs the 2-out-of-4 logic and then the initiation logic receiving the LCL outputs performs the "OR" logic to generate the ESF actuation signal to the ESF-CCS actuation logic. Therefore, the first two paragraphs on page B 3.3.5-5 will be changed as follows:
>
>> The actuation logic in each channel of ESF-CCS takes part in actuating the equipment of the corresponding ESF train. Each ESFAS Function has individual actuation logic in each channel of the ESF-CCS.
>>
>> The initiation logic performs the logical "OR" of LCL outputs for each ESFAS Function, to generate the ESF actuation signal to the ESF-CCS actuation logic.

The staff finds that the revised paragraphs clearly describe the ESF logic design to the appropriate level of detail. Therefore, RAI 295-8263, Question 16-112, Sub-question 2 is resolved.

In RAI 295-8263, Question 16-112 (ML15314A020), in Sub-question 3a, the staff requested that the applicant confirm the following description of the LCL [processor] for coincidence logic, the group controller (GC) for initiation logic, and the loop controller (LC) for actuation logic; the actuation logic is apparently considered by Table 3.3.6-1 to include the ESFAS Division's component control logic. (Note that the terms channel and division are treated as synonyms.)

The staff understands that, for each channel (Division A, B, C, or D) of an ESFAS Function, the Engineered Safety Features Component Control System (ESF-CCS) includes:

- Two redundant Group Controllers (GC1 and GC2) that independently perform the "initiation logic" function—the "selective 2-out-of-4 logic" processing of the coincidence logic output signals [that are] received from the Local Coincidence Logic (LCL) processors in all four Plant Protection System (PPS) channels. For example, for ESFAS Division A, the coincidence logic trip signals received from the four PPS channels are labeled A1, B1, C1, and D1, and for ESFAS Division B, they are labeled A2, B2, C2, and D2. The selective 2-out-of-4 logic in Division A is "A1 or C1 AND B1 or D1"; and in Division B, it is "A2 or C2 AND B2 or D2."

- A Loop Controller (LC), with a primary and a backup processor module (PM1 and PM2), that processes the GC1 and GC2 ESF actuation signals, respectively, with the ESF component control logic to generate and send component control signals to the component interface module (CIM) of each actuated device in the respective ESF train.

In its initial response (ML16093A021) to Question 16-112, regarding Sub-question 3a, the applicant stated:

> Two redundant Group Controllers (GC1 and GC2) located in each ESF-CCS cabinet independently perform the "actuation logic" function that processes the "selective 2-out-of-4 logic" using the initiation logic output signals from the LCL processors in all four PPS channels. The description pertaining to the Loop Controller (LC) is correct. The additional detailed information regarding the ESF-CCS is described in DCD Tier 2, Section 7.3, "Engineered Safety Features Systems."

The staff finds that the provided clarification of the role of the Group Controllers as performing the "actuation logic" function that applies selective 2-out-of-4 logic to the "initiation logic" signals from the output signals of the LCL processor, and confirmation that the role of the Loop Controllers is correctly described, together resolve RAI 295-8263, Question 16-112, Sub-question 3a.

In RAI 295-8263, Question 16-112 (ML15314A020), in Sub-question 3b, the staff stated:

> On page B 3.3.5-5, the third paragraph uses the phrase "serial data link for group and loop controllers." A word search of DCD Chapter 16 found no other instances of the use of the terms "group controller(s)" and "loop controller(s)."

The staff requested that the applicant describe the functions and purposes of the equipment listed in the subject paragraph by expanding the subject Bases paragraph, which confusingly states, "The ESF-CCS comprises power supply, manual switch, latching logic and serial data link for group and loop controllers."

In its initial response (ML16093A021) to Question 16-112, Sub-question 3b, the applicant stated:

> Since the detailed ESF-CCS configuration is described in DCD Tier 2, Section 7.3 and is not directly related to the safety functions covered in Technical Specification, the third paragraph will be deleted.

The staff accepts removal of this paragraph from the Background section of the Bases for Subsection 3.3.5, and considers Sub-question 3b resolved. However, such information would be more appropriately located in the Background section of the Bases for Subsection 3.3.6. Since RAI 295-8263, Question 16-117 addresses the effects of power supply failures in two divisions or channels of the PPS, and the subject information includes the ESF-CCS power supply, inclusion of this information is discussed further in the evaluation of Subsection 3.3.6.

In RAI 295-8263, Question 16-112 (ML15314A020), in Sub-question 4, the staff requested that the applicant revise the Background section of the Bases for Subsection 3.3.5 (or 3.3.6) to provide additional discussion describing ESFAS Function sub groups, because the fourth paragraph on page B 3.3.5-5 is confusing; it states:

> Each ESFAS Function has sub groups and each sub group is in charge of one or more ESFAS Functions. The initiation and actuation logics to the sub groups are identified in LCO 3.3.6.

In addition, the "ESFAS function sub groups" do not appear to be listed or defined in any kind of detail anywhere in the DCD, the Safety I&C TeR, or the Bases for GTS Subsection 3.3.6. In its initial response (ML16093A021) to RAI 295-8263, Question 16-112, Sub-question 4, the applicant stated:

> The fourth paragraph on page B 3.3.5-5 will be revised to be consistent with the information stated in Section 7.3.2.5 of DCD Tier 2, and Section 4.4.2 of the Safety I&C TeR as follows:
>
> > Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations. The initiation and actuation logics to the subgroups are addressed in LCO 3.3.6.

Although the proposed revised paragraph adequately explains the role of the ESFAS sub groups, it omits details about the ESF-CCS channels and actuated equipment associated with each subgroup for each ESFAS Function. The staff needs this information to confirm that the ESF Logic testing will not adversely affect plant operations. Pending verification that Subsection B 3.3.6 Background section or DCD Tier 2, Section 7.3.2.5 includes such details, RAI 295-8263, Question 16-112, Sub-question 4, was tracked as an open item. In its supplemental response (ML17233A386) to Sub-question 4 the applicant stated;

> Actuation Logic Testing required by SR 3.3.6.1 is performed to test the selective 2/4 logic in the GC. This test is performed for one channel, one GC, one ESFAS function at a time. The output of the GC under Actuation Logic Testing is blocked for the ESFAS function to ensure that the components are not affected by the testing. The testing block is removed when a valid ESFAS signal is received during testing even if it is under testing. Therefore, the ESF Actuation Logic Testing does not adversely affect plant operations.

> The purpose of individual subgroup test required by SR 3.3.6.2 [is] to verify the operability of the component control logic and component. This test is performed for, one channel, one GC, and one subgroup at a time. The individual subgroup test does not cause system level ESFAS actuation.

This response clearly explains how the actuation logic testing of SR 3.3.6.1 and the testing of component control logic and actuated devices by sub groups of SR 3.3.6.2 will not adversely affect plant operation. In addition, the applicant revised the Background section of Subsection B 3.3.6 to include this explanation; this Bases change is discussed in the evaluation of RAI 295-8263, Question 16-115, under the evaluation of GTS Subsection 3.3.6 below. Therefore, RAI 295-8263, Question 16-112, Sub-question 4, is resolved.

The staff notes that sub group testing is the subject of another issue concerning surveillance column Note 2 of SR 3.3.6.2 ("Subgroup of Actuation Logic channel A, C and B, D shall be tested on a staggered basis."); this issue is the subject of RAI 295-8263, Question 16-115 (ML15314A020), Sub-question 2 and is related to Sub-questions 1 and 3 of Question 16-115. The applicant's response to these sub-questions is addressed in the evaluation of GTS Subsection 3.3.6.

In RAI 295-8263, Question 16-112 (ML15314A020), in Sub-questions 5 and 6, the staff requested that the applicant revise the Background section of the Bases for Subsection 3.3.5, fifth and seventh paragraphs on page B 3.3.5-5. In its response, the applicant revised the paragraphs to more clearly and accurately describe the differences in roles and effects of the "all-bypass function" and the "trip channel bypass," and how bypassing more than one ESFAS channel at a time is prevented; and the effects of an enabled automatic operating bypass function. The revised paragraphs, with staff suggested corrections shown in italics with gray highlight, state:

> ...The all-bypass ~~All bypass~~ function for bypassing all parameters in ~~the~~ an ESFAS channel is interlocked in the LCL algorithm to prevent simultaneous bypass of more than one channel. The all-bypass function interlock is implemented ~~based on~~ with an analog circuit ~~through~~ and hardwired cable between the LCLs in all channels. The purpose of *the* all-bypass function is to support testing and maintenance of the BP whereas the trip channel bypass is used ~~against~~ in case of sensor failure.
>
> ~~Operating bypass protects the output of trip and alarm signals from bistable processor.~~ An enabled operating bypass function blocks the output of trip and alarm signals from the bistable processor to the LCL, IPS, and QIAS-N. The Pressurizer Pressure – Low input to the SIAS shares an operating bypass with the Pressurizer Pressure – Low reactor trip.

These changes are acceptable because they provide the needed clarification. The staff confirmed that these changes, including the suggested edits, are incorporated in the Background section of Subsection B 3.3.5 of Revision 2 of the DC application. Therefore, RAI 295-8263, Question 16-112, Sub-questions 5 and 6 are resolved.

In RAI 498-8595, Question 16-153 (ML16182A332), in Sub-question 3, the staff requested that the applicant provide further justification for the Mode 3 and Mode 4 applicability of various ESFAS instrument Functions, as stated in Table 3.3.5-1 and Table 3.3.6-1, compared to STS ESFAS instrument Functions. In its initial response (ML16295A249) the applicant extended the applicability of all Functions in Table 3.3.5-1 to include Mode 4 and the applicability of all coincidence logic and initiation logic Functions in Table 3.3.6-1 to also include Mode 4. Therefore, RAI 498-8595, Question 16-153, Sub-question 3, is resolved.

The staff reviewed Subsection 3.3.5 and Subsection B 3.3.5 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the specified RPS instrumentation reactor trip Functions, so that in the event an accident occurs in Mode 1, 2, 3, or 4, and monitored process variables or conditions satisfy specified trip setpoints, the affected functions will generate trip signals to the ESF logic, which if satisfied, will cause automatic actuation of safety-related equipment, as assumed in the transient and accident analyses. The trip setpoints are determined in accordance with the NRC approved setpoint methodology, which is specified in Subsection 5.5.19, “Setpoint Control Program,” and will ensure that each trip function will actuate before exceeding the analytical limit for the trip setting assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.3.5 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.3.5. The staff also verified that Subsections 3.3.5 and B 3.3.5 are consistent with the guidance in CE STS Subsections 3.3.5B and B 3.3.5B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.5 and Subsection B 3.3.5 are acceptable.

Subsection 3.3.6 ESFAS Logic and Manual Trip

The Engineered Safety Features (ESF) Actuation System (ESFAS) initiates necessary safety systems, based upon the values of selected unit parameters, to protect against violating core design limits and the RCS pressure boundary during anticipated operational occurrences (AOOs) and ensures acceptable consequences during accidents.

The ESFAS consists of four channels of sensors and associated auxiliary process cabinets – safety (APC-S) (measurement channels and bistable logic processor channels), the ESFAS initiation portion of the Plant Protection System (PPS) cabinets and the ESF Component Control System (ESF-CCS). The ESFAS logic, consisting of coincidence logic, initiation logic, and actuation logic, employs a scheme that provides an ESF actuation of two or four divisions of actuated components (depending upon the actuated system) when bistable processors, for the same input parameter, trip in any two of the four measurement channels. This is called a two-out-of-four trip logic.

In each PPS channel (or equivalently, PPS division), function-specific bistable logic (BL) modules in redundant bistable processor (BP) racks receive inputs from (a) sensor analog signal transmitters for process parameters (such as pressurizer and containment pressure, differential pressure for level and flow measurements, and temperatures) by way of the APC-S, (b) the Radiation Monitoring System, which turns analog signals from area radiation monitors into digital output signals, (c) the Excore Neutron Flux Monitoring System (ENFMS) analog output of core power, and (d) Core Protection Calculator System (CPCS) digital output signals for LPD – High and DNBR – Low partial reactor trip signals.

When a digitized input signal for a given instrument function matches the nominal trip setpoint in the function’s bistable logic processor memory, each redundant BP sends a partial trip signal to redundant Local Coincidence Logic (LCL) racks in the PPS cabinets of all four divisions.

Whenever two of four partial trip signals for a given instrument function are concurrently received by an LCL channel, the LCL outputs a coincidence signal to all four divisions of ESF-CCS group controllers (GCs), where 2-out-of-4 selective logic is performed (Channel A or C, and Channel B or D). In each ESF-CCS division, if the GC logic selective logic is satisfied, an initiation signal is sent to the component control logic in the Loop Controller (LC) for that division of actuated equipment, which, based on the system-level priority logic state, sends an actuation signal to the component interface module (CIM) for each actuated component, and based on the component level priority logic state in the CIM, a signal is sent to start or stop a pump, open or close valve(s), vary valve position to modulate auxiliary feedwater flow, or start the division’s emergency diesel generator (EDG).

The following table lists the APR1400 ESFAS logic and manual trip Functions and equivalent STS ESFAS logic and manual trip Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.6	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.6
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.6 ESFAS Logic and Manual Trip	3.3.6 ESFAS Logic and Manual Trip
1. Safety Injection Actuation Signal a. Coincidence Logic ....1,2,3,4 b. Initiation Logic....................................1,2,3,4 c. Actuation Logic ....1,2,3,4 d. Manual Trip..1,2,3,4	1. Safety Injection Actuation Signal a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3,4 c. Actuation Logic .... 1,2,3,4 d. Manual Trip 1,2,3,4
2. Containment Spray Actuation Signal a. Coincidence Logic ....1,2,3,4 b. Initiation Logic....................................1,2,3,4 c. Actuation Logic ....1,2,3,4 d. Manual Trip..1,2,3,4	5. Containment Spray Actuation Signal[b] a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3,4 c. Actuation Logic .... 1,2,3,4 d. Manual Trip 1,2,3,4
3. Containment Isolation Actuation Signal a. Coincidence Logic ....1,2,3,4 b. Initiation Logic....................................1,2,3,4 c. Actuation Logic ....1,2,3,4 d. Manual Trip..1,2,3,4	2. Containment Isolation Actuation Signal a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3,4 c. Actuation Logic .... 1,2,3,4 d. Manual Trip 1,2,3,4
—	3. Containment Cooling Actuation Signal[a] a. Initiation Logic .... 1,2,3,4 b. Actuation Logic .... 1,2,3,4 c. Manual Trip 1,2,3,4
—	4. Recirculation Actuation Signal a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3,4 c. Actuation Logic .... 1,2,3,4 d. Manual Trip 1,2,3,4
4. Main Steam Isolation Signal a. Coincidence Logic 1,2,3,4	6. Main Steam Isolation Signal a. Matrix Logic.. 1,2,3

APR1400 Generic TS Section 3.3 Instrumentation, Subsection 3.3.6	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation, Subsection 3.3.6
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
b. Initiation Logic ....1,2,3,4 c. Actuation Logic ....1,2,3,4 d. Manual Trip 1,2,3,4	b. Initiation Logic .... 1,2,3 c. Actuation Logic .... 1,2,3 d. Manual Trip 1,2,3
5. AFAS-1 a. Coincidence Logic .... 1,2,3,4[a] b. Initiation Logic .... 1,2,3,4[a] c. Actuation Logic .... 1,2,3,4[a] d. Manual Trip .... 1,2,3,4[a]	7. EFAS-1 a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3 c. Actuation Logic .... 1,2,3 d. Manual Trip 1,2,3
6. AFAS-2 a. Coincidence Logic .... 1,2,3,4[a] b. Initiation Logic .... 1,2,3,4[a] c. Actuation Logic .... 1,2,3,4[a] d. Manual Trip .... 1,2,3,4[a]	8. EFAS-2 a. Matrix Logic.. 1,2,3 b. Initiation Logic .... 1,2,3 c. Actuation Logic .... 1,2,3 d. Manual Trip 1,2,3
7. Diverse Manual ESF Actuation Signal a. Safety Injection ....1,2,3,4 b. Containment Spray ....1,2,3,4 c. Auxiliary Feedwater (SG #1)............... 1,2,3,4[a] d. Auxiliary Feedwater (SG #2)............... 1,2,3,4[a] e. Main Steam Isolation per MSIV ....1,2,3,4 f. Containment Isolation 1,2,3,4	—
Footnote: (a) When a steam generator is relied upon for heat removal.	Footnotes: (a) Automatic SIAS also initiates CCAS. (b) Automatic SIAS also required for automatic CSAS initiation.

The APR1400 design does not have a separate dedicated safety grade ventilation fan and cooling coil based system to cool the containment atmosphere post accident; rather this cooling function is accomplished by the APR1400 containment spray system (CSS). Accordingly, the GTS contain no LCO equivalent to Subsection 3.6.6B, “Containment Spray and Cooling Systems (Atmospheric and Dual) (Credit not taken for iodine removal by the Containment Spray System),” and instrument and actuation logic functions equivalent to STS Subsection 3.3.6B, Function 3, “Containment Cooling Actuation Signal (CCAS) on an SIAS signal.”

The APR1400 design does not need the safety injection system to automatically or manually switch over from drawing borated makeup water from the outside-containment refueling water tank (RWT) to drawing borated and pH controlled water from the containment sump to initiate the recirculation mode of safety injection system operation. This is because the APR1400 has an In-containment Refueling Water Storage Tank (IRWST) that collects most of the injected water, which has spilled from the RCS pipe break during a LOCA, and also most of the borated water discharged into containment by the containment spray system. This return water flows to the IRWST by way of the containment sumps that drain to the containment holdup tanks, which direct the borated and (now) pH controlled water into the IRWST, the normal and emergency water source for both the safety injection system and containment spray system. Containment heat removal is accomplished by the automatic alignment of the shutdown cooling system heat exchangers to cool the water taken from the IRWST by the CSS before the water is sprayed back into containment. Accordingly, the GTS contain no instrument and actuation logic functions equivalent to STS Subsection 3.3.5, Function 5a, “Recirculation Actuation Signal on Refueling Water Storage Tank Level – Low,” and STS Subsection 3.3.6B, Function 5, “Recirculation Actuation Signal.”

Although GTS Subsection 3.3.6 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.6 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.6.

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	SR 3.3.6.2 - surveillance column Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.6 and B 3.3.6	CU	16-137
16-111.11	295-8263 ML15314A020 Responses: ML16093A021 ML16268A005	3.3.6 - Added Mode 4 to Applicability of Table 3.3.6-1 Functions 3a and 3b	CC	See 16-153.3
16-112.1	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	Used “coincidence logic state” on Pages B 3.3.1-8, B 3.3.4-3, B 3.3.5-3, and B 3.3.6-2	CC	
16-114.1	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	3.3.6 Applicability - Justify omitting Mode 4 for Functions 3a (CIAS coincidence logic) and 3b (CIAS initiation logic)	CU	16-153
16-114.2	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	3.3.6 Actions table – Corrected phrasing and placement of Notes for Required Actions of Conditions E and F; revised Condition E to reference Conditions A, B, and C; and	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Condition F to reference Conditions A, B, C, and D.		
16-114.3a	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	3.3.6 LCO statement – revised to state: “The ESFAS Coincidence Logic, Initiation Logic, Actuation Logic, Manual Trip, and Diverse Manual ESF Actuation channels required for each Function in Table 3.3.6-1 shall be OPERABLE.”; also revised Table 3.3.6-1 to include a column to list the number of required channels for each ESF Logic and Manual Trip Function, and for each Diverse Manual ESF Actuation Function	CC	
16-114.3b	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	B 3.3.6 Actions section – Revised last paragraph of Bases for Required Action D.1 to state: “The associated Completion Time is reasonable based on operating experience for repair and restoration of this type of diverse manual ESF equipment. In addition, it is assumed that the probability of multiple failures occurring in the automatic ESFAS actuation logic and other manual controls within 72 hours is small. If the inoperable Diverse Manual ESF Actuation channel is not restored to OPERABLE status within 72 hours, Condition F is entered.”	CC	
16-114.3c	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	3.3.6 Actions table – Revised Condition D statement to state: “One or more Diverse Manual ESF Actuation Functions with one channel inoperable.”; and Required	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Action D.1 to state: "Restore inoperable channel to OPERABLE status."; and the Actions table Note to state, "Separate Condition entry is allowed for each ESFAS Function and for each Diverse Manual ESF Actuation Function."		
16-114.3d	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	B 3.3.6 Actions section – Justified 72 hour Completion Time for one inoperable channel of Diverse Manual ESF Actuation Function 7e (Main Steam Isolation, just one switch channel per valve) and Function 7f (Containment Isolation, only one switch provided)	CC	
16-114.4	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	B 3.3.6 Actions section – Revised first sentence of Bases for E.1, E.2, and E.3 to state: "If any Required Action~~s~~ and associated Completion Time of Condition A, B, C, or D cannot be met, ..."; – Added sentences describing the Note to Required Action E.2; and the Note to Required Action E.3.	CC	
16-114.5	295-8263 ML15314A020 Responses: ML16093A021 ML17191B240	3.3.6 SR table – Revised surveillance column Note for SR 3.3.6.1 as indicated: "Testing of Actuation Logic shall include the verification of proper operation of each actuation circuit ~~signal~~." for consistency with DCD Tier 2, Section 7.3; – Revised surveillance column Notes for SR 3.3.6.2 as indicated: "-------------NOTES------------ 1. Components exempt from testing during operation	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		shall be tested once every 18 months (MODE 6) or in MODE 5 if not tested ~~until~~ within the previous 62 days. 2. The pair of Actuation Logic subgroup channels A and C and the pair of Actuation Logic subgroup channels B and D shall be tested on a staggered basis. ------------------------------------”		
16-115.1	295-8263 ML15314A020 Responses: ML16134A009 ML17233A386	B 3.3.6 SR section – Revised Bases for SR 3.3.6.2 by adding more specific information about the design of ESFAS Actuation Logic subgroups and trip legs	CC	
16-115.2	295-8263 ML15314A020 Response: ML16134A009	Submitted a listing of safety components with certain attributes, but did not include each item’s ESF Actuation sub group designation, as requested.	CR	See Sub-question 16-122.3d
16-115.3	295-8263 ML15314A020 Response: ML16134A009	B 3.3.6 Background section on page B 3.3.6-3 – Added discussion under heading “ESF Actuation Logic” explaining meaning of a “trip leg” in the ESF Initiation Logic	CC	
16-115.4a	295-8263 ML15314A020 Response: ML16134A009	B 3.3.5 and B 3.3.6 Back-ground section – Used initial upper case letters for “Reactor Coolant System”	CC	
16-115.4b	295-8263 ML15314A020 Response: ML16134A009	B 3.3.5 and B 3.3.6 Back-ground section – On pages B 3.3.5-1 and B 3.3.6-1, applied STS ordered list format convention to list of ESFAS functions	CC	
16-115.4c	295-8263 ML15314A020	B 3.3.5 and B 3.3.6 Back-ground section, fourth	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16134A009	paragraph on pages B 3.3.5-1 and B 3.3.6-1 – Revised for clarity and for acronym definition and usage consistency		
16-115.4d	295-8263 ML15314A020 Response: ML16134A009	Made editorial improvements to pages B 3.3.5-1 & 2, and page B 3.3.6-2	CC	
16-115.4e	295-8263 ML15314A020 Response: ML16134A009	On pages B 3.3.5-2 & 3 – changed "Bistable Logics" to "Bistable Logic Processors"	CC	
16-115.4f	295-8263 ML15314A020 Response: ML16134A009	On page B 3.3.6-2 and page B 3.3.5-4 – Made editorial improvements for global consistency of GTS Section B 3.3 Subsection Background sections	CC	
16-115.4g	295-8263 ML15314A020 Response: ML16134A009	B 3.3.6 Background section on pages B 3.3.6-2 and -3, for clarity, revised paragraphs under the heading "Coincidence Logic"	CC	
16-115.4h	295-8263 ML15314A020 Response: ML16134A009	B 3.3.6 Background section on page B 3.3.6-3, for clarity, revised paragraph under the heading "Initiation Logic"; paragraphs under the heading "Actuation Logic"; and paragraph under the heading "Manual Trip"	CC	
16-115.5a 16-115.5b 16-115.5c 16-115.5d	295-8263 ML15314A020 Response: ML16134A009	B 3.3.6 – Revised Bases to include same level of detail that was included in CE System 80+ generic TS Subsection B 3.3.6 for Function 7, Diverse Manual ESF Actuation Signal: Discussed Function 7 in (a) Background section; and discussed Function 7 interface to ESF components	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		in (b) ASA section, (c) LCO section, and (d) Applicability section.		
16-115.6	295-8263 ML15314A020 Response: ML16134A009	Explained why Diverse Manual ESF Actuation Signal functions are not specified in a separate LCO subsection.	CR	
16-116	295-8263 ML15314A020 Responses: ML16047A034 ML17236A388	Explained how Priority Logic is within the scope of ESF Actuation Logic specified by Table 3.3.6-1 Functions 1c, 2c, 3c, 4c, 5c, and 6c	CC	
16-117.1	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.6 – explained how loss of (vital ac) electrical power to two PPS divisions initiates SIAS, CSAS, CIAS, MSIS, and AFAS	CC	
16-117.2	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.6 - explained how loss of (vital ac) electrical power to two PPS divisions affects an enabled operating bypass	CC	
16-117.3	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.6 Actions section, and DCD Tier 2, Chapters 7 and 8 – revised with explanation of how a loss of (vital ac) electrical power to two PPS divisions initiates SIAS, CSAS, CIAS, MSIS, and AFAS	CC	
16-117.4	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.6 and B 3.3.7, Applicable Safety Analyses section – revised to explain that SIAS, CSAS, and AFAS initiate EDG start	CC	
16-117.5	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.1 Background section and B 3.3.5 Background section – added description of the effect on an enabled operating bypass if the associated PPS division loses ac power	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-119	295-8263 ML15314A020 Response: ML16093A021	B 3.3.6 Applicable Safety Analyses section – clarified which events are mitigated by AFAS	CC	
16-120	295-8263 ML15314A020 Response: ML16093A021	B 3.3.6 LCO section – corrected error in the stated required number of channels of coincidence logic for AFAS-2 from six to four	CC	
16-121	295-8263 ML15314A020 Response: ML16093A021	B 3.3.6 Applicability section - resolved the apparent conflicts in the Bases regarding which automatic ESFAS Logic functions are required to be operable in Mode 4. The applicable Modes in Table 3.3.6-1 for CIAS and AFAS Coincidence Logic and Initiation Logic functions are changed to include Mode 4, consistent with CIAS and AFAS Actuation Logic and Manual Trip functions, which are required to be operable in Mode 4; explained why CIAS and AFAS Actuation Logic Functions must be operable to support operability of CIAS and AFAS Manual Trip Functions in Mode 4.	CR	
16-122.1	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Subsections B 3.3.1, B 3.3.4, B 3.3.5, and B 3.3.6; first paragraph of SR Section: Clarified that the “interface and test processor (ITP)” is needed to perform Channel Functional Test in Bases of SR 3.3.6.1.	CC	
16-122.2	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Subsection B 3.3.5, SR section, revised the Bases for SR 3.3.5.2 to clarify the Channel Functional Test of ESFAS Functions including	CC	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		overlap of tests for sensor instrumentation, bistable logic, coincidence logic, initiation logic, actuation logic, and actuated device		
16-122.3a	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	B 3.3.6 SR section – Explained meaning of last sentence of sixth paragraph of Bases for SR 3.3.6.1 for Actuation Logic testing; also corrected the six paragraphs in Bases for SR 3.3.6.1 which had been incorrectly revised based on an incorrectly transcribed RAI question markup.	CC	See Sub-question 16-122.3f
16-122.3b	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Explained that the LCL, initiation logic, and actuation logic tests are described in the B 3.3.6 SR section discussion of SR 3.3.6.1 as being performed sequentially, using overlapping tests: "The Channel Functional Test is part of an overlapping test sequence similar to that employed in the RPS. This sequence, consisting of SR~~s~~ 3.3.5.2, SR 3.3.6.1, and SR 3.3.6.2 tests the entire ESFAS from sensor input to the bistable logic processor ~~input~~ through the automatic ESF actuation logic (actuational) output of ~~the individual~~ each subgroup."	CC	ESFAS test overlap is related to scope of Question 16-137.
16-122.3c	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	Clarified B 3.3.6 Background section description of ESFAS Actuation Logic	CC	
16-122.3d	295-8263 ML15314A020	B 3.3.6 – Provided a listing of all component groups,	CR	

Subsection 3.3.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML16134A009 ML17241A118	subgroups, which ESF-CCS ESFAS Actuation Logic Division is associated with, the components in each subgroup, and testing MODE constraints; declined to include these details in Subsection B 3.3.6.		
16-122.3e	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	B 3.3.6 SR section – Revised to clarify Bases for SR 3.3.6.2 Frequency Note 2; also revised Note 2 to say "The pair of Actuation Logic subgroup channels A and C and the pair of Actuation Logic subgroup channels B and D shall be tested on a staggered basis."	CC	
16-122.3f	295-8263 ML15314A020 Responses: ML16134A009 ML17241A118	B 3.3.6 SR section, clarified that SR 3.3.6.1 and SR 3.3.6.2 *do not apply* to Function 7, Diverse Manual ESF Actuation Signal; but SR 3.3.6.3 does apply.	CC	
16-149.2J	481-8546 ML16133A271 Response: ML16312A528	3.3.6 – Justified not requiring Mode 5 and Mode 6 Applicability for Functions 1d, SIAS Manual Trip, and 7a, SI Diverse Manual ESF Actuation to support LCO 3.5.3 SIS train operability requirements with the unit in a low RCS water level (reduced inventory) condition	CR	
16-153.3	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Added Mode 4 to all Subsystem 3.3.6 ESFAS Actuation Logic Functions	CC	
16-153.3c → 3g	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	3.3.6 – See RAI question list in Subsection 3.3.5 evaluation	CR	

Refer to the beginning of Section 16.4.8 for discussion and disposition of RAI 470-8552, Question 16-137.

SR 3.3.6.2 clarification

SR 3.3.6.2 requires performing a verification of the operability of "subgroup for Actuation signal of each Actuation Logic channel" with a Frequency of "31 days on a STAGGERED TEST BASIS." Surveillance column Note 2 states, "Subgroup of Actuation Logic channel A, C and B, D shall be tested on a staggered basis." The staff found that these requirements needed clarification observing that neither DCD Section 7.3 nor the associated Bases for Subsection 3.3.6 listed the subgroups of Actuation Logic, or stated the ESFAS Actuation Logic channels (or divisions) and actuated components within each subgroup. In RAI 295-8263 (ML15314A020), Questions 16-114, 16-115, and 16-117, the staff requested that the applicant provide the desired clarification; the applicant made the requested changes to Subsection 3.3.6 as follows.

- In its response (ML16093A021) to RAI 295-8263, Question 16-114, Sub-question 5, the applicant revised surveillance column Note 1 for SR 3.3.6.2 to state "Components exempt from testing during operation shall be tested once every 18 months (MODE 6) or in MODE 5 if not tested ~~until~~ within the previous 62 days." The staff finds this acceptable.

- In its response (ML16134A009) to RAI 295-8263, Question 16-115, Sub-question 1, the applicant included additional discussion in the Bases for SR 3.3.6.2 regarding the ESF-CCS actuation logic design, consistent with the descriptions in TeR APR1400-Z-J-NR-14001-P, "Safety I&C System," Revision 0. The applicant explained the apparent interchangeable use of the terms division and channel when referring to the portion of the ESFAS Actuation Logic receiving the output of the local coincidence logic:

> In accordance with the IEEE Std. 603-1991, the channel loses its identity where single protective action signals are combined. Therefore, TeR APR1400-Z-J-NR-14001-P, Rev. 0 uses the word "division" for the portion of the circuit from the local coincidence logic to the actuation logic. This approach is consistent with DCD Tier 2, Chapter 7. However, generic TS LCOs 3.3.4 and 3.3.6 use the word "channel" instead of "division" for the same portion of the circuit; from the local coincidence logic to the actuation logic, in accordance with the definitions of channel check, channel functional test, and channel calibration stated in Section 1.1 of NUREG 1432. As a result, the words "channel" and "division" are interchangeable regarding the portion from the local coincidence logic to the actuation logic.

Using either term for the same portion of the Actuation Logic circuit depending upon whether the discussion is in the FSAR or in the generic TS is acceptable provided the

Bases for each affected Subsection in Section 3.3 includes a statement about the interchangeability of channel and division for the initiation logic and the actuation logic. Pending receipt of a DCD Section 16.3.3 update, which includes such statements in the Bases for all affected Subsections, RAI 295-8263, Question 16-115, Sub-question 1 was tracked as an open item. In its supplemental response to Sub-question 1 (ML17233A386), the applicant updated the Background section of the Bases for Subsection 3.3.6 by adding a statement about the interchangeability of channel and division:

> In accordance with the IEEE Std. 603-1991, the channel loses its identity where single protective action signals are combined. Technical Specifications and Bases use the word “channel" or "division” for the portion of the circuit from the local coincidence logic to the actuation logic. The words “channel” and “division” are interchangeable regarding the portion from the local coincidence logic to the actuation logic.

Adding this statement resolves Sub-question 1 of Question 16-115 of RAI 295-8263.

- In order for the staff to verify the TeR quotations in RAI 295-8263, Question 16-115, Sub-question 1, the staff requested, in Sub-question 2, that the applicant provide for each ESFAS subgroup (“subgroup for Actuation signal of each Actuation Logic channel”), a list of components (motor, air, and solenoid operated valves, pumps, dampers, and fans) by equipment designator and name, for all six NSSS ESFAS Functions, and all three BOP ESFAS Functions. For each component indicate (a) the supporting electrical power division (also indicate whether dc or ac power), (b) the associated safety train (A, B, C, or D), and the associated ESFAS Actuation Logic division. For each containment penetration flow path, indicate which isolation valve is inside and which isolation valve is outside containment. Also indicate the same information, where applicable, for the pressurizer [pilot] operated safety relief valves, the steam generator atmospheric steam dump valves and block valves, the CVCS isolation valves, the SCS valves, the steam generator blowdown system isolation valves, and the RCS leak detection system instrumentation, and the post accident monitoring instrumentation (AMI) for Type A, B, and C parameters.

  In Attachment 2 of its response (ML16134A009) to Question 16-115, Sub-question 2, the applicant provided a list of all BOP and NSSS components in the ESF-CCS ESFAS Actuation Logic Division Functions for the groups and subgroups. Pending the staff completing its review of this list, RAI 295-8263, Question 16-115, Sub-question 2, was tracked as an open item. Based on the information about component sub groups provided in the response, the staff determined that the testing required by SR 3.3.6.2 will not adversely interfere with safe plant operation. Therefore, RAI 295-8263, Question 16-115, Sub-question 2, is resolved.

- In RAI 295-8263, Question 16-115, Sub-question 3, the applicant was requested to discuss what is meant by an ESFAS “trip leg” in the Background section of the Bases on page B 3.3.5-4 and page B 3.3.6-3. In its response (ML16134A009), the applicant stated:

  > The Actuation Logic in the ESF-CCS Group Controller is composed of selective two-out-of-four logic. The ESFAS “trip leg” which represents half of a selective two-out-of-four logic function pertains to one portion of the “logical OR” combination of PPS channel A or C and PPS channel B or D. Therefore,

the following paragraph will be added under the heading "Actuation Logic" in the "Background" section of the Bases on page B 3.3.6-3.

> A trip leg is defined as the "logical or" combination of channel states ~~*which*~~ *and* represent*s* half of a selective two-out-of-four logic function. When both trip leg*s* of a selective two-out-of-four logic function assume a true state, the output of the selective two-out-of-four logic function assumes a true state (e.g., in a selective two-out-of-four logic {(A "or" C) "and" (B "or" D) = N}; the term (A "or" C) is a trip leg, the term (B "or" D) is a trip leg, and N is the output).

The staff finds the proposed addition provides the requested description, and is therefore acceptable. However, pending incorporation of the edits denoted by italics and gray highlight, Question 16-115, Sub-question 3, was tracked as an open item. In its supplemental response (ML17233A386) the applicant incorporated the requested edits in Subsection B 3.3.6, which resolved Question 16-115, Sub-question 3.

- In RAI 295-8263 (ML15314A020), Question 16-117, the staff stated:

> DCD Tier 2, Section 7.3.1.3 Actuation Logic, below the heading "ESFAS Function" beginning on page 7.3-5, makes the following statements:
>
> > The SIAS is also initiated by a loss of power to two PPS divisions. The SIAS also actuates the EDG.
> >
> > The CSAS is also initiated by a loss of power to two PPS divisions.
> >
> > The CIAS is also initiated by a loss of power to two PPS divisions. The MSIS is also initiated by a loss of power to two PPS divisions.
> >
> > The AFAS-1 or AFAS-2 is also initiated by a loss of power to two PPS divisions.
>
> ESFAS Functional Logic, as depicted in DCD Figure 7.3-4 SIAS, Figure 7.3-5 CSAS, Figure 7.3-6 CIAS, Figure 7.3-7 MSIS, and Figure 7.3-8 AFAS, does not appear to illustrate the effect of a loss of vital ac power to two PPS divisions on the coincidence logic, initiation logic, and actuation logic for these EFSAS Functions. In addition to an SIAS coincidence logic output signal, the EDG of the associated Class 1E electrical safety train also gets a start signal from the CSAS, AFAS-1, and AFAS-2 coincidence logic output signals, according to Figure 7.3-21, EDG Loading Sequencer – Control Logic Diagram.

In RAI 295-8263, Question 16-117, Sub-question 1, the staff requested that the applicant "describe how loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment." In its response (ML16093A021) to Question 16-117, Sub-question 1, regarding the loss of (vital ac) electrical power to two PPS divisions, the applicant stated:

(1) Each ESF-CCS division receives an NSSS ESF initiation signal from all four divisions of the PPS and generates ESF actuation signals by means of the selective 2-out-of-4 coincidence logic. The loss of (vital ac) electrical power to two PPS divisions causes the inputs from both [of these] PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes [each of] the [two] failed input signals as [an] actuated state in the group controllers (GCs). Accordingly, the selective 2-out-of 4 coincidence logic in the ESF-CCS GC generates the ESF actuation signals to all ESF trains of equipment.

The staff finds that this response clearly explains the effect of a loss of electrical power to two PPS divisions. Therefore, Sub-question 1 is resolved.

In RAI 295-8263, Question 16-117, Sub-question 2, the staff requested that the applicant "describe how loss of (vital ac) electrical power to two PPS divisions would affect an enabled operating bypass, including when the operating bypass is in a deenergized PPS division, and when it is in an unaffected PPS division." In its response (ML16093A021) to Question 16-117, Sub-question 2, regarding the loss of (vital ac) electrical power to two PPS divisions on an enabled operating bypass, the applicant stated, with staff interpretations provided in italics in brackets:

(2) The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment due to the ESF-CCS receiving two failed state NSSS ESF initiation signals from the two PPS divisions. At that time, the enabled operating bypass in the deenergized PPS division returns to normal (disabled). *[This results in a failed state NSSS ESF initiation signal from this deenergized PPS division.]* An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. *[No NSSS ESF initiation signal is provided by this unaffected PPS division.]* In both cases, the plant will be in a safe condition since it will have tripped *[the ESF equipment will have actuated]* due to deenergization of one *[Does applicant mean to say "two"?]* PPS division level output.

The staff interprets the above discussion as concluding that ESF system actuation will occur upon loss of electrical power to two PPS divisions regardless of whether a PPS instrument channel operating bypass was enabled on (i) a deenergized PPS division or (ii) an unaffected PPS division. Completion of the staff's evaluation of this response, RAI 295-8263, Question 16-117, Sub-question 2, was tracked as an open item. In its supplemental response (ML17233A386) the applicant clarified its response as follows (emphasis of replacement text added):

(2) The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions

generates ESF *initiation signals provided to each division of GC in the ESF-CCS*. At that time, an enabled operating bypass in *a* deenergized PPS division returns to the normal *state* (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since the *deenergization of two PPS divisions causes the ESF equipment to be actuated if the selective 2/4 coincidence logic in the ESF-CCS GC is met.*

The staff finds that this response clearly explains how a loss of electrical power to two PPS divisions would affect an enabled operating bypass, including when the operating bypass is in a deenergized PPS division, and when it is in an unaffected PPS division. Therefore, RAI 295-8263, Question 16-117, Sub-question 2, is resolved.

In RAI 295-8263, Question 16-117, Sub-question 3, the staff requested that the applicant "revise the Bases for generic TS subsection 3.3.6 ESFAS Logic and Manual Trip, and DCD Tier 2, Chapters 7 and 8, to explain how a loss of (vital ac) electrical power to two PPS divisions generates ESF actuation signals to all ESF trains of equipment, in terms of the ESFAS Functional Logic design." In its response (ML16093A021) to Question 16-117, Sub-question 3, regarding the loss of (vital ac) electrical power to two PPS divisions, the applicant stated:

(3) The statements regarding the generation of ESF actuation signals to all ESF trains of equipment on a loss of (vital ac) electrical power to two PPS divisions will be inserted into the Bases for TS 3.3.6, Actions Section for B.1 and B.2 and also in DCD Section 7.3. The statements are not related to Chapter 8.

The staff reviewed the following information which the applicant proposed to insert into DCD Tier 2, Section 7.3; the markup shows staff suggested edits:

> The loss of (vital ac) electrical power to two PPS divisions causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated states in the GCs. Accordingly, if the selective 2-out-of-4 coincidence logic in the ESF-CCS GC is met, the ESF-CCS GC generates the ESF actuation signals to ~~all ESF trains of equipment~~ the component control logic in the LC.

The staff also reviewed the following information which the applicant proposed to insert into the Actions section of Subsection B 3.3.6 regarding Required Actions B.1 and B.2 for the failure of both *initiation* logic channels affecting the same trip leg (between the second and third paragraphs of the Bases for Action B); the markup shows staff suggested edits:

> The failure of vital electrical power to two PPS divisions which exclude*s* the same trip leg of the selective 2-out-of-4 actuation logic causes the inputs from both PPS divisions to go to a failed (i.e., safe) state. The ESF-CCS recognizes the failed input signals as actuated states in the actuation logic. Therefore, a loss of vital electrical power to two PPS divisions generates ESF actuation

> signals to ~~all ESF trains of equipment~~ the component control logic in the LC when the selective 2-out-of-4 coincidence logic in the ESF-CCS GC is met.

Pending completion of the staff's evaluation of this response, RAI 295-8263, Question 16-117, Sub-question 3, was tracked as an open item. In its supplemental response (ML17233A386), the applicant incorporated the suggested edits in the above passages for improved clarity. The staff concludes that the response provided the requested explanation. Therefore, RAI 295-8263, Question 16-117, Sub-question 3, is resolved.

In RAI 295-8263, Question 16-117, Sub-question 4, the staff requested that the applicant "revise the Bases for generic TS Subsection 3.3.6, 'ESFAS Logic and Manual Trip,' and Subsection 3.3.7, 'EDG ─ LOVS,' to clarify how SIAS, CSAS, and AFAS signals initiate an EDG start, and that this actuation logic is required by LCO 3.3.6 and tested by a Channel Functional Test surveillance." In its response (ML16093A021) to Question 16-117, Sub-question 4, regarding how SIAS, CSAS, and AFAS signals initiate an EDG start, the applicant stated:

> (4) The statements to clarify how SIAS, CSAS, and AFAS signals initiate an EDG start will be inserted into the Bases for TS 3.3.6 and 3.3.7, including that it is tested by a Channel Functional Test in SR 3.3.6.2.

The staff reviewed the information which the applicant proposed to insert into Subsection B 3.3.6 ASA section and also the Subsection B 3.3.7 ASA section, to point out that SIAS, CSAS, and AFAS each initiate an EDG start, and Subsection B 3.3.6 SR section to clarify that SR 3.3.6.2 Channel Function Test also verifies that SIAS, CSAS, and AFAS each initiate an EDG start. The surveillance information, inserted into the Bases for SR 3.3.6.1, needs correction as indicated by the following markup:

> A CHANNEL FUNCTION TEST ~~performs to verify~~ also verifies that an EDG start is separately actuated by SIAS, CSAS, and AFAS signals.

Pending completion of the staff's evaluation of this response, and correction of the proposed addition to the Bases for SR 3.3.6.1, RAI 295-8263, Question 16-117, Sub-question 4, was tracked as an open item. In its supplemental response (ML17233A386) the applicant incorporated the suggested edits in the above passages for improved clarity. The staff finds that the added passages to the ASA section of the Bases for Subsections 3.3.6 and 3.3.7, and the Bases for SR 3.3.6.1 clarify that SIAS, CSAS, and AFAS signals initiate an EDG start. Therefore, RAI 295-8263, Question 16-117, Sub-question 4, is resolved.

In RAI 295-8263, Question 16-117, Sub-question 5, the staff requested that the applicant "revise as appropriate the operating bypass discussions in the generic TS Section 3.3 Bases to clarify how an enabled operating bypass is affected when its associated PPS division loses ac electrical power." In its response (ML16093A021) to Question 16-117, Sub-question 5, regarding the effect on an enabled operating bypass by the loss of (vital ac) electrical power to its associated PPS division, the applicant stated:

(5) The statements regarding the effect of an enabled operating bypass caused by PPS division's ac electrical power will be inserted into the Background section of Bases for TS 3.3.1 RPS Instrumentation and 3.3.5 ESFAS Instrumentation.

The staff reviewed the information which the applicant proposed to insert into Subsection B 3.3.1 Background section; this information needs clarification as indicated by italics in gray highlight in the following markup (the preceding two paragraphs are stated for context):

> … In addition to the trip channel bypasses, there are also operating bypasses on select RPS trips. These bypasses are enabled manually in all four RPS channels when plant conditions do not warrant the specific trip protection. All operating bypasses are automatically removed when enabling bypass conditions are no longer satisfied.
>
> Operating bypasses are implemented in the bistable logic, so that normal trip indication is also disabled. Trips with operating bypasses include Pressurizer Pressure – Low, Logarithmic Power Level – High, and CPC (DNBR – Low and LPD – High).
>
> ~~*The*~~ *An enabled* operating bypass inhibits the trip and pre-trip outputs from trip and pre-trip algorithms in ~~*a*~~ *the associated* bistable processor. ~~*An enabled operating bypass is removed since the*~~ *A loss* of vital electrical power to a PPS division *removes an enabled operating bypass, since this* deenergizes the bistable processor.

The applicant incorporated the above indicated clarifications to Subsection B 3.3.1 in its supplemental response (ML17233A386) to Question 16-117, Sub question 5. The staff also reviewed the information that the applicant had proposed to insert into the Background section of Subsection B 3.3.5. Since the staff noted that this information also needed clarification, the applicant provided the following revised paragraph in the aforementioned supplemental response:

> The operating bypass inhibits the trip and pre-trip outputs from the trip and pre-trip algorithms in the bistable processor. The loss of (vital ac) electrical power to two PPS divisions generates ESF initiation signals, which are provided to the ESF-CCS GC in each division. At that time, an enabled operating bypass in a deenergized PPS division returns to the normal state (disabled). An enabled operating bypass in an unaffected PPS division (power remains) will stay in the bypassed state. In both cases, the plant will be in a safe condition since deenergization of two PPS divisions causes the ESF equipment to be actuated if the selective 2/4 coincidence logic in the ESF-CCS GC is met.

Pending the supplemental response to incorporate the suggested clarifications, RAI 295-8263, Question 16-117, Sub-question 5, was tracked as an open item. Finding that the supplemental response provided the needed changes to Subsections B 3.3.1 and B 3.3.5, the staff concludes that Sub-question 5 is resolved.

<u>Whether the Scope of Actuation Logic includes the Priority Logic in the ESF-CCS Loop Controller (LC) and the Priority Logic in the Component Interface Module (CIM)</u>

The staff issued RAI 295-8263 (ML15314A020), Question 16-116, requesting that the applicant describe how the priority logic, which is implemented in the ESF-CCS LC and the priority logic, which is implemented in the CIM, is considered to be within the scope of the ESFAS Actuation Logic Functions specified by LCO 3.3.6, Table 3.3.6-1, Functions 1c, 2c, 3c, 4c, 5c, and 6c. In its response (ML16047A034) to Question 16-118 the applicant described the design of the two kinds of priority logic for the ESF-CCS LC and CIM. In summary:

- The LC provides the prioritization logic between (automatic) system-level ESFAS signals, which come from the PPS and the ESF-CCS GC, and component-level control signals, which come from ESCM and MI switches. The system-level ESFAS signals have priority over the component-level control signals.

- The manual ESFAS switches generate system-level ESFAS manual actuation signals (by way of the control panel multiplexer (CPM) and ESF-CCS GC) that have priority over the component-level control signals from the ESCM and MI switches, using the priority logic in the LC.

- The CIM prioritizes the control signals from the (A) ESF-CCS LC, (B) diverse protection system (DPS), and (C) diverse manual actuation (DMA) switches. Of signals A and B, the one that causes the associated component to go to its safety state is the higher priority signal (state based priority). Regardless of signals A and B, signal C has the higher priority. Since the DMA functions initiate system-level actuation of all ESF trains, the DMA switch generated signals have system-level priority.

The response included a logic diagram of the CIM input signals to illustrate how any signals from the ESF-CCS LC, DPS and DMA switches to achieve the required safety functions can be activated under anticipated operational occurrences (AOOs), accident conditions, and common-cause failure (CCF) conditions of the PPS or the ESF-CCS.

The staff finds that the above description of the ESFAS priority logic, while concise and informative, did not state which LCO operability and surveillance requirements ensure the priority logic performs as designed. Pending receipt of this information, RAI 295-8263, Question 16-116 was tracked as an open item. In its revised response (ML17236A388) to Question 16-116, the applicant inserted the following paragraphs at the end of the Actuation Logic discussion in the Background section of Subsection B 3.3.6 “to ensure the priority logic performs as designed”:

> The actuation logic includes the priority logic in the ESF-CCS loop controller (LC) and the priority logic in the component interface module (CIM). The LC provides the prioritization logic between system-level ESFAS signals and component-level control signals. The system-level ESFAS signals have priority over the component-level control signals.
>
> The manual ESFAS switches generate system-level ESFAS manual actuation signals that have priority over the component-level control signals, using the priority logic in the LC.

The CIM prioritizes the control signals from the (A) ESF-CCS LC, (B) diverse protection system (DPS), and (C) diverse manual actuation (DMA) switches. Of signals A and B, the one that causes the associated component to go to its safety state is the higher priority signal (state based priority). Regardless of signals A and B, signal C has the highest priority. Since the DMA functions initiate system-level actuation of all ESF trains, the DMA switch generated signals have system-level priority.

In addition, the response appended the following sentence to the end of the paragraph below the heading “ESFAS Logic” in the Background section of Subsection B 3.3.6:

The actuation logic includes the priority logic.

The staff finds that the addition of this information to Subsection B 3.3.6 makes clear the priority logic is considered as part of the actuation logic and is subject to the actuation logic’s operability, action, and surveillance requirements. Therefore, RAI 295-8263, Question 16-116, is resolved.

In RAI 295-8263 (ML15314A020), Question 16-122, Sub-question 3a, the staff requested that the applicant clarify the last sentence of the sixth paragraph of the Bases for SR 3.3.6.1. In its response (ML16134A009) to Question 16-122, Sub-question 3a, the applicant revised the subject sentence as indicated (with one apparent omission of the existing word “by”). In its revised response (ML17241A118) to Sub-question 3a, the applicant corrected the omission, and changed “two-out-of-four” to “selective 2-out-of-4” for consistency, as indicated:

Actuation Logic Testing

Actuation logic testing ~~is tested to verify the operability of~~ verifies the OPERABILITY of the ~~two-out-of-four~~ selective 2-out-of-4 actuation logic after the completion of initiation logic (trip path) testing. This test is performed only for one channel and one actuation logic at a time *by* periodic automatic test.

In its response to Sub-question 3a, the applicant also elected to revise the six paragraphs in the Bases for SR 3.3.6.1; but the proposed changes could not be accepted because they apparently implemented inadvertent transcription errors in RAI Letter No. 295. In its revised response (ML17241A118) to Question 16-122, Sub-question 3a, the applicant revised the six paragraphs as intended. The actual staff-suggested changes to the Bases of SR 3.3.6.1 of Revision 0 of GTS Subsection B 3.3.6 SR section, are as indicated:

SR 3.3.6.1

A CHANNEL FUNCTIONAL TEST is performed ~~every 31 days~~ to ensure the entire channel will perform its intended function when needed. The ~~operability~~ OPERABILITY of ~~the~~ each ESFAS Logic channel~~,~~ and ESFAS Manual Trip channel~~, and Diverse Manual ESF Actuation channel~~ is verified ~~by the operator every 31 days at least to meet the surveillance requirement~~ on a 31 day interval with applicable extensions. This Frequency is based on operating experience which shows that automatic ESF actuation logic channels~~,~~ and ESF manual trip channels~~, and diverse manual ESF actuation channels~~ usually pass the CHANNEL FUNCTIONAL TEST when performed on a 31 day Frequency.

The CHANNEL FUNCTIONAL TEST is part of an overlapping test sequence similar to that employed in the RPS. This sequence, consisting of SR~~s~~ 3.3.5.2, SR 3.3.6.1, and SR 3.3.6.2 tests the entire ESFAS from sensor input to the bistable logic processor ~~input~~ through the automatic ESF actuation logic (actuational) output of each ~~the actuation of the individual~~ subgroup. These overlapping tests are described in Reference 1. SR~~s~~ 3.3.5.2 and SR 3.3.6.1 are normally performed together and in conjunction with ESFAS testing. When the actuational output signal ~~of each~~ for a subgroup is generated, SR 3.3.6.2 verifies that ~~actuation ability of~~ ESF components associated ~~actuation signal of the associated~~ with ~~each~~ the subgroup are capable of being actuated by the ESF-CCS.

These tests verify that the ESFAS is capable of performing its intended function, from sensor input to the bistable logic processor ~~input~~ through to the actuated components. SR 3.3.5.2 is addressed in LCO 3.3.5. SR 3.3.6.1 includes LCL testing, initiation logic (trip path) testing, and actuation logic testing. This CHANNEL FUNCTIONAL TEST also verifies that an EDG start is separately actuated by SIAS, CSAS, and AFAS signals.

Local Coincidence Logic Testing

LCL testing ~~is tested to verify~~ verifies the ~~operability~~ OPERABILITY of the 2-out-of-4 coincidence logic and trip channel bypass logic.

Initiation Logic (Trip Path) Testing

Testing of initiation logic, ~~Initiation logic testing is for~~ ~~Initiation Logic~~ which consists of logical “OR” ~~*(selective 2-out-of-4 logic),*~~ ~~and~~ is performed after the completion of LCL testing. This testing ~~implements the~~ exercises only one ~~Initiation~~ initiation logic ~~of one~~ channel at a time, which affects only one trip path.

Actuation Logic Testing

Actuation logic testing ~~is tested to verify~~ verifies the ~~operability~~ OPERABILITY of the ~~two-out-of-four~~ selective 2-out-of-4 actuation logic after the completion of initiation logic (trip path) testing. This test is performed only for one channel and one actuation logic at a time by periodic automatic test.

In addition to the transcription error, the staff had incorrectly interpreted that SR 3.3.6.1 applies to Function 7, Diverse Manual ESF Actuation; accordingly, using double line-out and double underline, this reference has been marked for deletion from the staff’s originally suggested changes in the first paragraph above. Pending verification of the adequacy of the applicant’s proposed changes to the six paragraphs of the Bases for SR 3.3.6.1, the response to RAI 295-8263, Question 16-122, Sub-question 3a, was tracked as an open item. Based on the changes proposed in the revised response (ML17241A118) to Question 16-122, Sub-question 3a, matching the requested changes, the clarification of the last sentence of the sixth paragraph, and the correction of the inapplicability of SR 3.3.6.1 to the Diverse Manual

ESF Actuation Function, the staff concludes the response clearly describes the basis for SR 3.3.6.1. Therefore Sub-question 3a of Question 16-122 is resolved.

In RAI 295-8263 (ML15314A020), Question 16-122, Sub-question 3b, the staff requested that the applicant improve the clarity of the Subsection B 3.3.6, SR section, description of the Channel Functional Test, SR 3.3.6.1. In its response (ML16134A009) the applicant provided conflicting quotations of the first sentence of the second paragraph. The following indicated changes reflect this sentence as stated on page 7 compared to this sentence as quoted on page 8 of the response letter's Enclosure for Question 16-122; the markup of page B 3.3.6-14 (Attachment 1, pages 6 and7) matches the indicated changes.

> The Channel Functional Test is part of an overlapping test sequence similar to that employed in the RPS. This sequence, consisting of SRs 3.3.5.2, 3.3.6.1, and 3.3.6.2 tests the entire ESFAS from sensor input to the bistable logic processor ~~input~~ through the automatic ESF actuation logic (actuational) output of ~~the individual~~ each subgroup.

Pending clarification of this inconsistency, RAI 295-8263, Question 16-122, Sub-question 3b, was tracked as an open item. In the revised response (ML17241A118) to Question 16-122, Sub-question 3a, the applicant revised the second paragraph, as stated previously, according to the staff's suggestion. Therefore, Sub-question 3b of Question 16-122 is resolved.

In RAI 295-8263 (ML15314A020), Question 16-122, Sub-question 3c, the staff requested that the applicant improve the clarity of the Subsection B 3.3.6 descriptions of the ESFAS Actuation Logic. In its response (ML16134A009) the applicant stated:

> LCO 3.3.5 covers the sensor, the APC-S, and the Bistable logic processor in the PPS. LCO 3.3.6 covers the PPS local coincidence logic (LCL), the PPS initiation logic ("OR" logic), the ESF-CCS Group Controller (GC), the ESF-CCS Loop Controller (LC), and the Component Interface Module (CIM). *The initiation logic following the LCL in the PPS is not a selective 2/4 logic, but a logical "OR" and its output signal is transmitted to the ESF-CCS GC.*

The last statement (italics added) appears to conflict with the discussion of initiation logic (trip path) testing in the SR section of the Bases for Subsection 3.3.6, as revised by the response to Sub-question 3a. Pending resolution of this conflict, RAI 295-8263, Question 16-122, Sub-question 3c, was tracked as an open item. In its revised response (ML17241A118) to Question 16-122, Sub-question 3c, the applicant did not change the previous statement, but corrected the fifth paragraph concerning initiation logic, as indicated under the discussion of Sub-question 3a of Question 16-122, thereby clearing the apparent conflict. Therefore, Sub-question 3c of Question 16-122 is resolved.

In RAI 295-8263 (ML15314A020), Question 16-122, Sub-question 3d, the staff requested that the applicant list all component groups, subgroups, and the ESF-CCS ESFAS Actuation Logic Division associated with the components in each subgroup, and which subgroups cannot be tested during power operation of the unit, and "must be tested in accordance with the Note to SR 3.3.6.2." In its response (ML16134A009) to Question 16-122, Sub-question 3d, the applicant stated, "A list of all components in the ESF-CCS ESFAS Actuation Logic Division Functions for the groups and subgroups is attached." However, the staff could not determine how to select the set of components within any particular subgroup based on the component subgroup designator in the last column of the table (labeled "Subgrouping"). Pending clarification of how to interpret the subgroup designators, RAI 295-8263, Question 16-122, Sub-question 3d, was tracked as an open item. Subsequently, the staff determined how the table indicates components within each sub group for testing per SR 3.3.6.2, and which sub group components cannot be tested during power operation. Therefore, Sub-question 3d of Question 16-122 is resolved.

In RAI 295-8263 (ML15314A020), Question 16-122, Sub-question 3e, the staff requested that the applicant explain the meaning of a sentence in the Bases for the Frequency of SR 3.3.6.2, which stated:

> The 31 day Frequency on a staggered test basis complies with the operating experience and ensures the problems of individual logic signal can be detected within this time frame.

In its response (ML16134A009) to Question 16-122, Sub-question 3e, the applicant offered the following explanation:

> The subgroup of Actuation Logic channels A and C are tested during the interval of the 31 day Frequency and then the remaining channels B and D are tested during the next interval of 31 day Frequency. Therefore, all channels are tested during the 62 day Frequency interval.

Although this explanation makes clear the apparently intended meaning of the subject paragraph, the staff finds that the paragraph itself needs to be revised because the meaning of the phrase "staggered test basis complies with the operating experience" is unclear. In addition, surveillance column Note 2 to SR 3.3.6.2 needs to be stated more clearly; there is no equivalent Note in STS SR 3.3.6.2; the Note states:

> 2. Subgroup of Actuation Logic channel A, C and B, D shall be tested on a staggered basis.

The staff also observes that the first sentence of the Bases for SR 3.3.6.2 is not adequate to explain the ESF Actuation design, which does not use sub group "relays"; this sentence was taken from the STS Bases with the changes indicated:

> Individual ~~ESFAS~~ subgroups ~~relays~~ must also be tested, one at a time, to verify the individual ESFAS components will actuate when required.

Pending resolution of the above issues, RAI 295-8263, Question 16-122, Sub-question 3e, was tracked as an open item. In its revised response (ML17241A118) to Question 16-122, Sub-question 3e, the applicant revised surveillance column Note 2 to SR 3.3.6.2 to state:

> 2. The pair of Actuation Logic subgroup channels A and C and the pair of Actuation Logic subgroup channels B and D shall be tested on a staggered basis.

In addition, the Bases for Note 2 was revised to state:

> In accordance with Note 2 to this SR, the pair of Actuation Logic subgroup channels A and C are tested during the first interval of the staggered 31 day Frequency, and the pair of Actuation Logic subgroup

channels B and D are tested during the second interval of the staggered 31 day Frequency. Therefore, each pair of Actuation Logic subgroup channels is tested during an interval of 62 days, plus applicable extensions.

The staff concludes that the revised note and its rationale are acceptable because how the staggered testing is divided between the two pairs of sub groups is clear. The revised response also adequately clarified the meaning of the first sentence of the Bases for SR 3.3.6.2 by adding additional discussion, as follows:

> Individual subgroups must also be tested, one at a time, to verify the individual ESFAS components will actuate when required.
>
> Each ESFAS Function has an associated group of outputs. Each group of outputs is divided into subgroups. Outputs within a subgroup are tested concurrently and are selectively arranged so that concurrent actuation does not adversely affect plant operations.

Although the meaning of the phrase "staggered test basis complies with the operating experience" remains unclear, the actual reason for the 31 day Frequency on a staggered test basis, which is to ensure individual logic signal problems can be detected within this time frame, is clear.

Based on the above discussion of changes to SR 3.3.6.2 and its Bases, RAI 295-8263, Question 16-122, Sub-question 3e, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2J, the staff asked whether two manual SIS actuation Function divisions (or channels) need to be operable to support the two required SIS trains in MODES 5 and 6. This is Function 1.d, SIAS Manual Trip of Table 3.3.6-1. [An OPERABLE SIS train may also need the support of] Function 7.a, Diverse Manual ESF Actuation. In its response (ML16312A528) to Question 16-149, Sub-question 2J, the applicant stated:

> [Generic] TS LCO 3.3.6 requires the SIAS manual trip function to be OPERABLE in MODES 1, 2, 3, and 4. The APPLICABILITY of [generic] TS B 3.3.6 states that the SIAS manual actuation is simplified by the use of the manual trip push buttons because of the large number of components actuated by this function. This means LCO 3.3.6 addresses only system level manual trip function. The APPLICABILITY also states that the systems initiated by ESFAS are either reconfigured or disabled for shutdown cooling operation in MODES 5 and 6, and accidents in these MODES are slow to develop and would be mitigated by manual operation of individual components. This indicates that the component level manual SIS actuation is performed in MODES 5 and 6 if required. Regarding the SIAS manual trip, the General TS approach complies with STS LCO 3.3.6 and B 3.3.6.
>
> The diverse manual actuation is required to be OPERABLE in the same MODE as the manual trip function since the purpose of the diverse manual actuation is to cope with the common cause failure of the ESF-CCS.
>
> Therefore, the manual SIS actuation function in MODES 5 and 6 can be performed by the component level SIS actuation in accordance with the

APPLICABILITY of [generic] TS B 3.3.6, which is the same approach as Standard TS B 3.3.6 (Rev. 4.0).

The staff finds this response acceptable because it explains why two manual SIS actuation Function divisions (or channels) do not need to be operable to support the two required SIS trains in Modes 5 and 6. Therefore, RAI 481-8546, Question 16-149, Sub-question 2J, is resolved.

In its revised response (ML16268A005) to RAI 295-8263, Question 16-111, Sub-question 11, the applicant stated that it is extending the applicability of the CIAS related instrument Functions and CIAS related ESF coincidence logic and initiation logic Functions to include Mode 4. This change is acceptable because it increases instrument function operability requirements, which enhances safety; therefore Sub-question 11 is resolved. However, since the revised response did not include a markup of affected pages of Subsection 3.3.6, the staff anticipated such a markup would be included in the response to follow up RAI 498-8595 (ML16182A332), Question 16-153. In its initial response (ML16295A249) to RAI 498-8595, Question 16-153, regarding Sub-question 3, the applicant included a markup of Table 3.3.6-1 that applied Mode 4 to the Applicability of ESFAS Coincidence and Initiation Logic Functions for CIAS and AFAS.

In RAI 498-8595 (ML16182A332), Question 16-153, in Sub-question 3, the staff had requested that the applicant provide further justification for the Mode 3 and Mode 4 applicability of various ESF Logic Functions, as stated in Table 3.3.6-1, compared to STS ESF Logic Functions. In its response (ML16295A249) to Question 16-153, regarding Sub-question 3, the applicant also extended the applicability of all Functions in Table 3.3.5-1 to include Mode 4. However, the applicant also

- applied Table 3.3.5-1 Footnote (b) to the new Mode 4 Applicability of the MSIS and AFAS instrument Functions, which seems out of place for AFAS because Footnote (b) only addresses MSIS instrument Functions; and

- added new Footnote (d) to Table 3.3.5-1, and applied it to the Mode 4 Applicability of the MSIS instrument Functions. Footnote (d) states "When a steam generator is relied upon *for* heat removal."

The staff agrees with applying Footnote (d) to the Mode 4 Applicability of the MSIS instrument Functions, but believes it also should be applied to the Mode 4 Applicability of the AFAS instrument Functions. Pending resolution of the application of Footnotes (b) and (d) to the Mode 4 Applicability of Table 3.3.5-1 Functions 5a and 6a for AFAS on SG Level – Low, RAI 498-8595, Question 16-153, Sub-question 3, was tracked as an open item. In its supplemental response (ML17233A389) to Question 16-153, regarding Sub-question 3, the applicant stated in would revise the response to RAI 295-8263, Question 16-111, Sub-question 11, for the following reasons (edited by the staff for clarity):

> Mode 4 shall be included in the Applicability for the Containment Isolation Actuation Signal (CIAS) Specification like it is in the Safety Injection Actuation Signal (SIAS) Specification, based on the following DCD descriptions and detailed design concepts:
>
> (1) DCD, Tier 2, Subsection 6.3.2.5.4 (Page 6.3-23) indicates that the Safety Injection System (SIS) is required to mitigate the consequences of a LOCA that is initiated when the reactor is in any operational condition, or mode, from

hot shutdown [Mode 4] to full power operation [Mode 1]. Therefore, SIAS operability is required in Modes 1, 2, 3, and 4.

(2) The SIS shall be used to keep the core subcooled in response to a large break LOCA in which the Shutdown Cooling System (SCS) cannot be used.

(3) After a LOCA and SIS actuation, containment isolation is also required for preventing the release of radioactive material out of containment.

(4) Detailed design requirements show that one of the sensed inputs for SIAS is a low pressurizer pressure signal, provided by four pressure sensor channels, P-102A thru 102D, which have a manual bypass permissive setpoint on decreasing pressure of ≤ 400 psia. The design requirements for CIAS are the same because CIAS uses the same sensor inputs used by SIAS. Therefore, the applicable operational modes specified for CIAS shall be the same as specified for SIAS. That is, CIAS operability is also required in Modes 1, 2, 3, and 4.

(5) DCD Section 3.6.3 (Page 3.6.3-1) indicates that the applicable operational modes specified for containment isolation valve operability for automatic actuation should be Modes 1, 2, 3, and 4.

(6) Therefore, Mode 4 will be added to the Applicability of Function 3b, CIAS on a low pressurizer pressure signal, in Specification 3.3.5, and Function 3, CIAS Coincidence, Initiation, and Actuation Logic and Manual Trip, in Specification 3.3.6. Conforming changes to the associated Bases will also be made.

In addition, the Main Steam Isolation Signal (MSIS) and the Auxiliary Feedwater Actuation Signal (AFAS) shall be operable in Mode 4 because the main steam and auxiliary feedwater systems are designed for RCS heat removal from the hot standby condition (Mode 3) to the SCS entry conditions in Mode 4 (i.e., ≤ 350°F and ≤ 450 psia). Therefore, Mode 4 will also be added to the Applicability of Function 4a, MSIS on a low SG pressure signal, and Function 4b, MSIS on a high narrow range containment pressure signal; and Functions 5a and 6a, AFAS on a low wide range SG level signal in Specification 3.3.5 and associated Bases; and Function 4, MSIS Coincidence, Initiation, and Actuation Logic and Manual Trip, and Functions 5 and 6, AFAS Coincidence, Initiation, and Actuation Logic and Manual Trip in Specification 3.3.6 and associated Bases.

Since requiring operability of SIAS, CIAS, MSIS, and AFAS instrumentation, ESFAS logic, and manual trip Functions in Mode 4 is consistent with the APR1400 design and is a safety improvement over the STS, these changes are acceptable. In addition, Footnote (b) is removed and Footnote (d) is applied to the Mode 4 Applicability of Table 3.3.5-1 Functions 5a and 6a for AFAS on a low SG level signal. And footnote (d) is revised to state “When a steam generator is relied upon for heat removal.” Therefore, the staff concludes that RAI 498-8595, Question 16-153, Sub-question 3, and RAI 295-8263, Question 16-111, Sub-question 11, are resolved. In Revision 3 of DCA part 4, in Table 3.3.6-1, the Mode 4 Applicability of ESFAS Functions 5a, 5b, 5c, 6a, 6b, and 6c, Manual Functions 5d and 6d, and Diverse Manual Functions 7c and 7d was revised with Footnote (a) “When a steam generator is relied upon for heat removal.” This change was necessary to achieve consistency for the Mode 4 Applicability of the auxiliary feedwater (AFW) system of Subsection 3.7.5 and the supporting AFAS instrumentation Functions of Subsection 3.3.5, and the AFAS Actuation Logic, AFW Manual Trip, and AFW Diverse Manual Trip Functions of Subsection 3.3.6.

The staff reviewed Subsection 3.3.6 and Subsection B 3.3.6 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the ESFAS coincidence logic, initiation logic, and actuation logic, so that in the event an accident occurs in Mode 1, 2, 3, or 4, upon receipt of a valid trip signal from at least two channels of at least one ESFAS instrumentation Function, the ESFAS logic will cause the safety related equipment to actuate, as assumed in the transient and accident analyses. Similarly, the operability of the Manual Trip for each of the ESFAS Functions of SIAS, CSAS, CIAS, MSIS, and AFAS is ensured so that the control room operator can initiate safety injection, containment spray, containment isolation, main steam isolation, or auxiliary feedwater upon failure of one or more associated components to actuate automatically on a valid actuation signal. Subsection 3.3.6 also ensures the operability of the diverse manual ESF actuation signal for each of these ESFAS Functions, in case a common cause ESFAS software failure defeats any of the safety-related ESFAS Functions, so that the control room operator can actuate the affected ESF system. Accordingly, the staff concludes that Subsection 3.3.6 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.6 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.3.6. The staff also verified that Subsections 3.3.6 and B 3.3.6 are consistent with the guidance in CE STS Subsections 3.3.6B and B 3.3.6B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.6 and Subsection B 3.3.6 are acceptable.

Subsection 3.3.7 Emergency Diesel Generator (EDG) – Loss of Voltage Start (LOVS)

Subsection 3.3.7 includes instrumentation requirements for automatically starting emergency diesel generators (EDGs) when an undervoltage or loss of voltage condition is sensed on the associated Class 1E 4160 Vac bus. The loss of voltage start (LOVS) instrumentation for each of the four EDGs is independent. There are four undervoltage sensor channels in a two-out-of-four trip logic for each train of the 4160 Vac power supply. The LOVS function is required for engineered safety features (ESF) systems to function in any accident with a loss of offsite power. Loss of the LOVS Function could result in the delay of safety system initiation when required. This could lead to unacceptable consequences during accidents.

The following table lists the APR1400 ESFAS EDG-LOVS Functions and equivalent STS ESFAS DG-LOVS Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.7 Emergency Diesel Generator – Loss of Voltage Start (EDG-LOVS)	3.3.7B Diesel Generator – Loss of Voltage Start (DG-LOVS)
LCO 3.3.7 Loss of Voltage .... Modes 1, 2, 3, and 4,	LCO 3.3.7B Loss of Voltage .... Modes 1, 2, 3, and 4,

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
When associated EDG is required to be Operable by LCO 3.8.2, “AC Sources – Shutdown.”	When associated DG is required to be Operable by LCO 3.8.2, “AC Sources – Shutdown.”
LCO 3.3.7 Degraded Voltage .... Modes 1, 2, 3, and 4, When associated EDG is required to be Operable by LCO 3.8.2, “AC Sources – Shutdown.”	LCO 3.3.7B Degraded Voltage .... Modes 1, 2, 3, and 4, When associated DG is required to be Operable by LCO 3.8.2, “AC Sources – Shutdown.”

Although GTS Subsection 3.3.7 closely follows the STS in format and content, the staff noted differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.7 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.7.

Subsection 3.3.7 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-52	162-8055 ML15235A003 Response: ML15301A207	3.3.7 Applicability statement – corrected format	CC	
16-89	239-8076 ML15282A602 Response: ML16028A482	3.3 – surveillance scope and terminology inconsistent with DCD Sections 7.2 and 7.3; GTS 3.3.7 and B 3.3.7	CU	16-137
16-117.4	295-8263 ML15314A020 Responses: ML16093A021 ML17233A386	B 3.3.6 and B 3.3.7 – revised to explain how SIAS, CSAS, and AFAS initiate EDG start	CC	

Status Codes:

CU	Closed Unresolved (has follow up question)	RC	Resolved Confirmatory
CR	Closed Resolved with no DCD changes	CC	Closed Confirmed

The staff identified content from STS Subsection B 3.3.7 that did not belong, as written, in GTS Subsection B 3.3.7 because of differences in design of the Class 1E onsite AC sources, the Class 1E AC power distribution system, and the LOVS function between the standard CE digital plant and the APR1400. Correction of these inaccuracies in Subsection B 3.3.7 were addressed as part of the response to RAI 470-8552, Question 16-137, which is resolved as described in the beginning of Section 16.4.8.

Also, changes to the Bases for Subsections 3.3.1, 3.3.2, and 3.3.5, particularly concerning identification of the nominal trip setpoint (NTSP) as the LSSS, which were made in response to RAI 295-8263, Question 16-110, may need to be made to similar content, in the Bases for

Subsection 3.3.7. The staff considers such revisions to the Bases of this and other Section 3.3 subsections, to be within the scope of Question 16-110. Pending receipt of a revised response that includes such Bases changes, RAI 295-8263, Question 16-110 was tracked as an open item. The staff reconsidered this item, and concludes that no such changes to the Bases for Subsection 3.3.7 are needed. and that the scope of Question 16-110 does not include Subsections 3.3.7 through 3.3.14. Therefore this item is closed.

The staff reviewed Subsection 3.3.7 and Subsection B 3.3.7 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the EDG-LOVS Function, so that a degraded voltage signal, or a loss of voltage signal will disconnect the normal electrical power source to the affected Class 1E 4.16 kV ESF bus, and start the associated EDG placing it in a running, no load, standby state; if an ESF signal is present, the EDG will connect to the associated ESF bus and power the actuated ESF loads as they are connected to the bus by the EDG's load sequencer. Since this automatic operation of the EDGs is necessary to ensure safety-related ESF systems actuate within the response times assumed in the accident analyses, the staff concludes that Subsection 3.3.7 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.7 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.7. The staff also verified that Subsections 3.3.7 and B 3.3.7 are consistent with the guidance in CE STS Subsections 3.3.7B and B 3.3.7B, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open items, the staff concludes that Subsection 3.3.7 and Subsection B 3.3.7 are acceptable.

Subsection 3.3.8 Containment Purge Isolation Actuation Signal (CPIAS)

Subsection 3.3.8 includes requirements on the CPIAS, which provides protection from radioactive contamination in the event an irradiated fuel assembly should be severely damaged during handling or during core alterations to support meeting LCO 3.9.3.c.2, which requires that each penetration providing direct access from the containment atmosphere to the outside atmosphere is capable of being closed by an operable Containment Purge System. It also closes the purge valves during plant operation in response to an RCS leak in Modes 1, 2, 3, and 4. In Mode 5 with RCS loops not filled and in Mode 6 with refueling water level less than 23 feet above the top of the reactor vessel (RV) flange, the CPIAS also ensures closure of the purge valves to support meeting LCO 3.6.7.c.2, which requires that each penetration providing direct access from the containment atmosphere to the outside atmosphere is exhausting through operable containment purge system air cleaning units (ACUs), and is capable of being closed by an operable Containment Purge System, to mitigate a loss of decay heat removal event.

The following table lists the APR1400 ESFAS Containment Purge Isolation (CPI) Actuation Signal (CPIAS) Functions and equivalent STS ESFAS CPI Signal (CPIS) Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.8	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.8
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.8 Containment Purge Isolation Actuation Signal (CPIAS)	3.3.8B Containment Purge Isolation Signal (CPIS)

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.8	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.8
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
LCO 3.3.8 CPI on Area Radiation Monitor – High ... Modes 1, 2, 3, and 4, Mode 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, Mode 6 when relying on LCO 3.6.7.c.2 or LCO 3.9.3.c.2.	LCO 3.3.8B CPI on Area Radiation Monitor – High .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies within containment.
LCO 3.3.8 CPIAS Manual Actuation .... Modes 1, 2, 3, and 4, Mode 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, Mode 6 when relying on LCO 3.6.7.c.2 or LCO 3.9.3.c.2.	LCO 3.3.8B CPIS Manual Actuation .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies within containment.
LCO 3.3.8 CPIAS Actuation Logic .... Modes 1, 2, 3, and 4, Mode 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, Mode 6 when relying on LCO 3.6.7.c.2 or LCO 3.9.3.c.2.	LCO 3.3.8B CPIS Actuation Logic .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies within containment.
Applicability Note: Only required when the associated containment purge or exhaust line penetration flow path is not isolated by at least one closed and de-activated automatic valve, closed manual valve, or blind flange.	Applicability Note: Only required when the penetration is not isolated by at least one closed and de-activated automatic valve, closed manual valve, or blind flange.

Although GTS Subsection 3.3.8 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.8 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.8.

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-133.1	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	LCO 3.3.8 was revised to list all Functions and actuation logic: "One CPIAS instrument division with two area radiation monitor channels, one Manual Actuation division, and one Actuation Logic division shall be OPERABLE."; B 3.3.8 – made conforming changes	CC	

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-133.2	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	3.3.8 Applicability Note – corrected placement of Note to below Applicability statement	CC	
16-133.3	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	3.3.8 Applicability Note – revised Note for clarity to state: “Only required when the associated containment purge or exhaust line penetration flow path is not isolated by at least one closed and deactivated automatic valve, closed manual valve, or blind flange.”; B 3.3.8 – made conforming changes	CC	
16-133.4	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	3.3.8 Condition A – revised to state: “CPIAS required Manual Actuation division, required Actuation Logic division, or required instrument division with one or more required ~~channels of~~ area radiation monitor~~s~~ channels inoperable in MODES 1, 2, 3, and 4.”; B 3.3.8 – made conforming changes	CC	
16-133.5	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	3.3.8 Required Action A.1 – revised to state: “Enter applicable Conditions and Required Actions ~~for affected valves~~ of LCO 3.6.3, “Containment Isolation Valves,” for containment purge isolation valves made inoperable by CPIAS instrumentation.”; B 3.3.8 – made conforming changes	CC	
16-133.6	444-8530 ML16076A028 Responses: ML16162A795	3.3.8 Condition C – revised to state: “CPIAS required Manual Actuation division, required Actuation Logic	CC	16-149 (4th response)

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16250A212	division, or required instrument division with one or more required ~~channels of~~ area radiation monitor~~s~~ channels inoperable during CORE ALTERATIONS or movement of irradiated fuel assemblies within containment, or in MODE 5 with LCO 3.6.7.c.2 not met or in MODE 6 with LCO 3.6.7.c.2 or LCO 3.9.3.c.2 not met.”; B 3.3.8 – made conforming changes		
16-133.7	444-8530 ML16076A028 Response: ML16162A795	3.3.8 Surveillance Requirements table – moved to fourth line below Actions table	CC	
16-133.8	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	Deleted DCD Rev. 0 version of SR 3.3.8.2 (7 day Channel Check) in Subsection 3.3.8, and changed Frequency of SR 3.3.8.1, Channel Check for containment upper operating area (gamma) radiation monitor channel and operating area radiation monitor channel, from 7 days to 12 hours; renumbered subsequent SRs in Subsection 3.3.8; B 3.3.8 – made conforming changes	CC	
16-133.9	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	SR 3.3.8.2 surveillance column Note – revised to match STS phrasing, as indicated: “~~This SR is applicable~~ Only required to be met in MODES 1, 2, 3, and 4 ~~only~~.”	CC	
16-133.10	444-8530 ML16076A028 Responses: ML16162A795	SR 3.3.8.3 surveillance column Note – revised to match STS phrasing and revised Applicability (see	CC	16-149 (4th response)

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16250A212	16-149), as indicated: "~~This SR is applicable~~ Only required to be met during CORE ALTERATIONS and during movement of irradiated fuel assemblies within containment, and in MODE 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, and in MODE 6 when relying on LCO 3.6.7.c.2. or LCO 3.9.3.c.2."		
16-133.11	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	SR 3.3.8.3 (as renumbered) – revised surveillance statement for consistency and clarification, as indicated: "Perform CHANNEL FUNCTIONAL TEST on each required upper operating area radiation monitor channel and required operating area radiation monitor channel in accordance with Setpoint Control Program."	CC	
16-133.12	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212 ML17233A380	SR 3.3.8.4 (as renumbered) surveillance column Note – • revised phrasing to match STS ("Surveillance ~~Requirement~~ of Actuation Logic..."); • justified use of the term "initiation circuit" in place of "initiation relay"	CC	
16-133.13	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	SR 3.3.8.4 (as renumbered) – replaced "channel" with "division" so surveillance statement says, "...CPIAS Actuation Logic division."; B 3.3.8 – made conforming changes	CC	
16-133.14	444-8530 ML16076A028	SR 3.3.8.5 (as renumbered) – revised surveillance	CC	

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML16162A795 ML16250A212	statement as indicated: "Perform CHANNEL CALIBRATION on each required [upper operating area radiation monitor channel and required operating area] containment radiation monitor channel in accordance with Setpoint Control Program."; B 3.3.8 – made conforming changes		
16-133.15	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	SR 3.3.8.6 (as renumbered) – revised surveillance statement as indicated: "Verify that the response time of each required CPIAS ~~channel~~ division is within limits."; B 3.3.8 – made conforming changes	CC	
16-133.16	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	SR 3.3.8.7 (as renumbered) – revised surveillance statement as indicated: "Perform CHANNEL FUNCTIONAL TEST on required CPIAS Manual Actuation ~~channel~~ division."; B 3.3.8 – made conforming changes	CC	
16-133.17.a.1→ 16-133.17.a.5	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 Background section – made multiple clarifying edits	CC	
16-133.17.b	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 Applicable Safety Analyses (ASA) section – made multiple clarifying edits	CC	
16-133.17.c.1	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 LCO section – made multiple clarifying edits; inserted missing period	CC	

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-133.17.d	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 Applicability section – revised last paragraph: “...when the associated containment purge or exhaust line penetration flow path is not isolated...”	CC	
16-133.17.e.1	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 Actions section – made multiple clarifying edits to first, second, and third paragraphs	CC	
16-133.17.e.2	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	Clarified Bases for Action A.1 as indicated: “The Required Action is to immediately enter the applicable Conditions and Required Actions ~~for affected valves~~ of LCO 3.6.3, “Containment Isolation Valves,”~~.~~” for containment purge isolation valves made inoperable by CPIAS instrumentation.”; clarified first sentence of Bases for Actions C.1, C.2.1, C.2.2	CC	
16-133.17.f.1	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section, DCD Rev. 0 version of SR 3.3.8.2 – Removed 7 day Channel Check Bases, which stated “SR 3.3.8.2 is the performance of a CHANNEL CHECK on the particulate and iodine channels. SR 3.3.8.2 is not applicable because there [are] no particulate and iodine channels in CPIAS.”	CC	
16-133.17.f.2	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section – revised Bases to indicate that SR 3.3.8.1 also applies to the containment operating area radiation monitors, and described that a Channel	CC	

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Check is performed with an installed check source.		
16-133.17.f.3	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section – clarified which containment area radiation monitor channels are in Channel Functional Test scope of SR 3.3.8.2 (as renumbered) (Modes 1, 2, 3, and 4), and SR 3.3.8.3 (as renumbered) (During irradiated fuel movement and Core Alterations and in MODE 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, and in MODE 6 when relying on LCO 3.6.7.c.2 or LCO 3.9.3.c.2.)	CC	16-149 (4th response)
16-133.17.f.4	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section – made conforming changes consistent with changes to surveillance column Note in renumbered SR 3.3.8.2 and SR 3.3.8.3 (see 16-133.9 and 16-133.10 above)	CC	16-149 (4th response)
16-133.17.f.5	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212 ML17233A380	B 3.3.8 SR section – Reverted to using the term “initiation circuit” in place of “initiation relay” in surveillance column Note of renumbered SR 3.3.8.4	CC	
16-133.17.f.6	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section – Changed “setting” to “settings” in new sentence of Bases for SR 3.3.8.5 (as renumbered)	CC	
16-133.17.f.7	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 SR section – revised first sentence of Bases for SR 3.3.8.6 (as renumbered) for consistency	CC	
16-133.17.f.8	444-8530 ML16076A028	B 3.3.8 SR section – revised Bases for SR 3.3.8.7 (as	CC	

Subsection 3.3.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML16162A795 ML16250A212	renumbered) to be consistent with the CPIAS Manual Actuation division design; inserted a justification for the 18 month Frequency		
16-133.17.g	444-8530 ML16076A028 Responses: ML16162A795 ML16250A212	B 3.3.8 References section – Declined to add title of FSAR Chapter 15 ("Transient and Accident Analyses") for Reference 1	CU	16-159
16-149 4th response	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634 ML17362A080	B 3.6.7 Background section ─ Revised to address GL 88-17 safety issues associated with requirements for containment closure in Modes 5 and 6; – last paragraph – removed content related to use of term "equivalent isolation method" as used in B 3.9.3 • 3.3.8 Applicability – revised to say "MODE 5 with RCS loops not filled when relying on LCO 3.6.7.c.2, MODE 6 when relying on LCO 3.6.7.c.2 or LCO 3.9.3.c.2." • 3.3.8 Condition C – revised to reflect change to Applicability, as described above (see 16-133.6) • SR 3.3.8.3 surveillance column Note – revised to reflect change to Applicability, as described above (see 16-133.10) • B 3.3.8 LCO section, Applicability section, and SR section (see 16-133.17.f.3) – made conforming changes	CC	

The staff noted that the 7 day Frequency of proposed SR 3.3.8.2 (Perform Channel Check) seemed inappropriate for the containment operating area (gamma) radiation monitor channels used by the CPIAS because STS Subsection 3.3.8B, SR 3.3.8.2, only specifies a 7 day Frequency for the Channel Check for the containment particulate and iodine radiation monitor channels used by the CPIS. The staff pointed out in RAI 444-8530 (ML16076A028), Question 16-133, Sub-questions 8 and 12, that the GTS SR 3.3.8.2 Channel Check Frequency should also be 12 hours, the same as the GTS SR 3.3.8.1 Frequency of 12 hours for the containment upper operating area (gamma) radiation monitor channels. The staff requested that the applicant change the Frequency to 12 hours and make conforming changes to Subsection B 3.3.8.

In its response (ML16162A795) to Question 16-133, Sub questions 8 and 12, the applicant proposed to delete SR 3.3.8.2 and replace the surveillance statement with the phrase "This SR is not applicable." and the Frequency with "NA"; the applicant also proposed to replace the Bases discussion with the following statement: "SR 3.3.8.2 is the performance of a CHANNEL CHECK on the particulate and iodine channels. SR 3.3.8.2 is not applicable because there [are] no particulate and iodine channels in CPIAS." In an email, dated June 27, 2016, in reply to a staff email message, which communicated concerns with these and other proposed changes related to the response to Question 16-133, the applicant indicated it would submit a revised response that will (a) remove SR 3.3.8.2 and associated Bases; (b) renumber the Surveillances SR 3.3.8.3 to SR 3.3.8.8 as SR 3.3.8.2 to SR 3.3.8.7; and (c) revise the Bases to indicate that the 12 hour Channel Check of SR 3.3.8.1 also applies to the containment operating area (gamma) radiation monitor channels. In its email message, the staff also requested that the applicant (1) revise the Background section of the Bases to describe the role of the containment particulate and iodine radiation monitors, even though they are not utilized as inputs to the CPIAS to isolate containment purge and exhaust penetration flow paths; (2) explain why LCO 3.3.8 requires both the high range and low range containment area (gamma) radiation monitors; and (3) regarding Sub-questions 12 and 17.f.5, justify use of the term "initiation relay" in place of "initiation circuit" in the surveillance column Note of SR 3.3.8.4 (as renumbered), the 18 month Channel Functional Test on required CPIAS Actuation Logic division.

In its revised response (ML16250A212) to RAI 444-8530, Question 16-133, Sub-questions 8 and 12, the applicant (a) removed SR 3.3.8.2 and associated Bases; (b) renumbered the Surveillances SR 3.3.8.3 to SR 3.3.8.8 as SR 3.3.8.2 to SR 3.3.8.7; and (c) revised the Bases to indicate that the 12 hour Channel Check of SR 3.3.8.1 also applies to the containment operating area (gamma) radiation monitor channels. These changes are acceptable because they are technically accurate. The applicant also revised the Background, LCO, and SR sections of the Bases to explain why LCO 3.3.8 requires both the high range and low range containment area (gamma) radiation monitors, but declined to insert a discussion about the role of the containment particulate and iodine radiation monitors. This is acceptable, since they do not support the CPIAS function. Regarding RAI 444-8530, Question 16-133, Sub-questions 12 and 17.f.5, the originally proposed term "initiation circuit" will be retained in the surveillance column Note of SR 3.3.8.4 (as renumbered). Finding the responses to all sub-questions (except 17g) about Subsection 3.3.8 acceptable, staff concludes that RAI 444-8530, Question 16-133 is resolved.

Including the FSAR chapter, section, or subsection title in a reference listed in the References section of a Bases subsection is considered to be within the scope of RAI 507-8587, Question 16-159, as described in the beginning of Section 16.4.8 of this report. Since the applicant's response (ML17243A310) to Question 16-159 satisfactorily addressed the concern of Sub-question 16-133.17g, the staff concludes that RAI 444-8530, Question 16-133, Sub-question 17g, is resolved.

The staff reviewed Subsection 3.3.8 and Subsection B 3.3.8 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the CPIAS Function, so that in the event an accident occurs in Mode 1, 2, 3, or 4, or during Core Alterations, or during movement of irradiated fuel assemblies in the containment, upon receipt of a valid trip signal from at least one channel of the High Area Radiation Monitor instrumentation Function, the containment purge isolation (CPI) actuation logic will close the safety related isolation dampers in the containment ventilation purge and exhaust ducts, as assumed in the transient and accident analyses. Similarly, the operability of the CPI Manual Actuation Function is ensured so that the control room operator can initiate CPI upon failure of one or more isolation dampers to close automatically on a valid actuation signal. Accordingly, the staff concludes that Subsection 3.3.8 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.8 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.8. The staff also verified that Subsections 3.3.8 and B 3.3.8 are consistent with the guidance in CE STS Subsections 3.3.8B and B 3.3.8B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff concludes that Subsection 3.3.8 and Subsection B 3.3.8 are acceptable.

Subsection 3.3.9 Control Room Emergency Ventilation Actuation Signal (CREVAS)

Subsection 3.3.9 includes requirements on the CREVAS which terminates the normal supply of outside air to the main control room (MCR), also referred to as the control room envelope (CRE) and initiates actuation of the control room emergency air cleaning unit to ensure CRE occupant radiation dose does not exceed the limits of GDC 19.

The following table lists the APR1400 ESFAS Control Room Emergency Ventilation Actuation Signal (CREVAS) Functions and equivalent STS ESFAS Control Room Isolation Signal (CRIS) Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.9	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.9
Specification / Function .... Applicable Modes	Specification / Function .... Applicable Modes
3.3.9 Control Room Emergency Ventilation Actuation Signal (CREVAS)	3.3.9B Control Room Isolation Signal (CRIS)
LCO 3.3.9 CREVAS on Main Control Room Air Intake Radiation Monitor - High .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies.	LCO 3.3.9B CRIS on Main Control Room Air Intake Radiation Monitor - High .... Modes 1, 2, 3, 4, [5, and 6], — During movement of [recently] irradiated fuel assemblies.

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.9	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.9
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
LCO 3.3.9 CREVAS Manual Actuation .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies.	LCO 3.3.9 CRIS Manual Actuation .... Modes 1, 2, 3, 4, [5, and 6], — During movement of [recently] irradiated fuel assemblies.
LCO 3.3.9 CREVAS Actuation Logic .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel assemblies.	LCO 3.3.9 CRIS Actuation Logic .... Modes 1, 2, 3, 4, [5, and 6], — During movement of [recently] irradiated fuel assemblies.

Although GTS Subsection 3.3.9 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.9 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.9.

Subsection 3.3.9 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-134.1	444-8530 ML16076A028 Response: ML16162A795	3.3.9 LCO statement – revised as indicated: “One CREVAS instrument division with one radiation monitor channel, one Manual Actuation division, and one Actuation Logic division shall be OPERABLE.”	CC	
16-134.2	444-8530 ML16076A028 Responses: ML16162A795 ML17233A383	3.3.9 Condition A – revised as indicated: “CREVAS required Manual Actuation division, required Actuation Logic division, or required instrument division with one ~~or more~~ required ~~channels of~~ radiation monitor~~s~~ channel inoperable in ~~*MODES 1, 2, 3, and 4*~~ *MODE 1, 2, 3, or 4*.”	CC	
16-134.3	444-8530 ML16076A028 Response: ML16162A795	3.3.9 Required Action A.1 – revised as indicated: “Place one control room area heating, ventilation, and air conditioning (HVAC) system train in emergency operation mode.	CC	

Subsection 3.3.9 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-134.4	444-8530 ML16076A028 Response: ML16162A795	3.3.9 Condition C – revised as indicated: "CREVAS <u>required</u> Manual Actuation <u>division</u>, <u>required</u> Actuation Logic <u>division</u>, or <u>required instrument division with</u> one ~~or more~~ required ~~channels of~~ radiation monitor~~s~~ <u>channel</u> inoperable during CORE ALTERATIONS or movement of irradiated fuel assemblies."	CC	
16-134.5	444-8530 ML16076A028 Responses: ML16162A795 ML17233A383	SR 3.3.9.3 surveillance column Note – • revised phrasing to match STS ("Surveillance ~~Requirement~~ of Actuation Logic..."); • justified use of the term "initiation circuit" in place of "initiation relay"	CC	
16-134.6	444-8530 ML16076A028 Responses: ML16162A795 ML17233A383	SR 3.3.9.3 – revise as indicated: "Perform CHANNEL FUNCTIONAL TEST on required CREVAS Actuation Logic ~~channel~~ <u>division</u>."	CC	
16-134.7	444-8530 ML16076A028 Response: ML16162A795 ML17233A383	B 3.3.9 – made conforming changes to reflect 16-134.1 to 16-134.6 changes	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Completion of the staff's evaluation of Subsection 3.3.9 and Subsection B 3.3.9 was pending resolution of RAI 444-8530, Question 16-134, Sub-questions 2, 5, 6, and 7, which were tracked as open items.

In its revised response (ML17233A383) to RAI 444-8530, Question 16-134, the applicant resolved:

- Sub-question 2 by revising Subsection 3.3.9 Condition A to be consistent with the STS to state, "CREVAS required Manual Actuation division, required Actuation Logic division, or required instrument division with one required radiation monitor channel inoperable in *MODE 1, 2, 3, or 4*."

- Sub-question 5 by revising the surveillance column Note of SR 3.3.9.3 to use the phrase “initiation circuit” in place of “initiation relay.” The response justified this by explaining that “circuit” is a more general term than relay, and can refer to relay, solid state, or digital logic devices, to accommodate a supplier’s diverse technology.

- Sub-question 6 by revising SR 3.3.9.3 to state, “Perform CHANNEL FUNCTIONAL TEST on required CREVAS Actuation Logic division.” for phrasing consistency.

- Sub-question 7 by making conforming changes to Subsection B 3.3.9 to reflect changes to Subsection 3.3.9 that resolved Sub-questions 2, 5, and 6.

Therefore, RAI 444-8530, Question 16-134 is resolved.

The staff reviewed Subsection 3.3.9 and Subsection B 3.3.9 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the CREVAS Function, so that in the event an accident occurs in Mode 1, 2, 3, or 4, or during Core Alterations, or during movement of irradiated fuel assemblies, upon receipt of a valid trip signal from at least one channel of the High Main Control Room Air Intake Radiation Monitor instrumentation Function, the CREVAS actuation logic will align the CRHS to the emergency mode of operation, which initiates the CREACS in the division of the running air handling unit of the CRSRS, as assumed in the control room occupant radiological dose consequence analysis of the accident analyses. Similarly, the operability of the CREVAS Manual Actuation Function is ensured so that the control room operator can initiate CREACS upon failure of the designated CREACS train to actuate automatically on a valid actuation signal. Accordingly, the staff concludes that Subsection 3.3.9 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.9 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.3.9. The staff also verified that Subsections 3.3.9 and B 3.3.9 are consistent with the guidance in CE STS Subsections 3.3.9B and B 3.3.9B, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.9 and Subsection B 3.3.9 are acceptable.

Subsection 3.3.10 Fuel Handling Area Emergency Ventilation Actuation Signal (FHEVAS)

Subsection 3.3.10 includes requirements on the FHEVAS which provides protection from radioactive contamination in the spent fuel pool area in the event that a spent fuel element ruptures during handling.

The following table lists the APR1400 ESFAS Fuel Handling Area Emergency Ventilation Actuation Signal (FHEVAS) Functions and equivalent STS ESFAS Fuel Handling Isolation Signal (FHIS) Functions, along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.10	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.10
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.10 Fuel Handling Area Emergency Ventilation Actuation Signal (FHEVAS)	3.3.10B Fuel Handling Isolation Signal (FHIS)

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.10	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.10
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
LCO 3.3.10 FHEVAS on Spent Fuel Pool Area Radiation - High .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel in the fuel handling area.	LCO 3.3.10B FHIS on Spent Fuel Pool Area Radiation - High.. Modes 1, 2, 3, 4, [5, and 6], — During movement of [recently] irradiated fuel in the fuel building.
LCO 3.3.10 FHEVAS Manual Actuation .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel in the fuel handling area.	LCO 3.3.10B FHIS Manual Actuation .... Modes 1, 2, 3, and 4, [5, and 6], — During movement of [recently] irradiated fuel in the fuel building.
LCO 3.3.10 FHEVAS Actuation Logic .... Modes 1, 2, 3, and 4, During CORE ALTERATIONS, During movement of irradiated fuel in the fuel handling area.	LCO 3.3.10B FHIS Actuation Logic .... Modes 1, 2, 3, and 4, [5, and 6], — During movement of [recently] irradiated fuel in the fuel building.

Although GTS Subsection 3.3.10 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.10 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.10.

Subsection 3.3.10 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-135.1	444-8530 ML16076A028 Response: ML16162A795	3.3.10 LCO statement – revise to state; “One FHEVAS instrument division with one radiation monitor channel, one Manual Actuation division, and one Actuation Logic division shall be OPERABLE.”	CC	
16-135.2	444-8530 ML16076A028 Response: ML16162A795	3.3.10 Condition A – revised as indicated to state: “Required Manual Actuation division, required Actuation Logic division, ~~Manual Actuation,~~ or required instrument division with required radiation ~~monitors channels~~ monitor channel inoperable.”	CC	
16-135.3	444-8530 ML16076A028	3.3.10 Required Action A.1 – revised as indicated to state:	CC	

Subsection 3.3.10 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16162A795	"Place one <u>OPERABLE</u> fuel handling area <u>heating, ventilation, and air conditioning (</u>HVAC<u>)</u> system train in emergency operation mode."		
16-135.4	444-8530 ML16076A028 Responses: ML16162A795 ML17235B288	SR 3.3.10.1 – Explained how the Channel Check on FHEVAS (spent fuel pool area) *required* radiation monitor channel is performed with LCO 3.3.10 only requiring one of two radiation monitor channels to be operable.	CC	
16-135.5	444-8530 ML16076A028 Responses: ML16162A795 ML17235B288	(1) SR 3.3.10.3 surveillance column Note – • revised phrasing to match STS ("Surveillance ~~Requirement~~ of Actuation Logic..."); • changed the term "initiation relay" to "initiation circuit"; (2) SR 3.3.10.3 surveillance statement – revise as indicated: "Perform CHANNEL FUNCTIONAL TEST on required FHEVAS <u>Actuation</u> Logic ~~channel~~ <u>division</u>."	CC	
16-135.6	444-8530 ML16076A028 Response: ML16162A795	SR 3.3.10.4 – revised as indicated: "Perform CHANNEL FUNCTIONAL TEST on required FHEVAS Manual Actuation ~~channel~~ <u>division</u>."	CC	
16-135.7	444-8530 ML16076A028 Response: ML16162A795	SR 3.3.10.4 – revised as indicated: "Verify that the response time of required FHEVAS ~~channel~~ <u>division</u> is within limits."	CC	
16-135.8	444-8530 ML16076A028 Responses: ML16162A795	B 3.3.10 – made conforming changes to reflect 16-135.1 to 16-135.7 changes and for	CC	

Subsection 3.3.10 Question.Sub-Question No.	NRC Letter No.– RAI No.; ADAMS Accession Nos.	Affected Generic TS or DCD Tier 2 Description	Status	Follow up Question.Sub-Question No.
	ML17235B288	consistency with B 3.3.8 and B 3.3.9		

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The staff's evaluation of Subsection 3.3.10 and Subsection B 3.3.10 was incomplete pending resolution of RAI 444-8530, Question 16-135, Sub-questions 4, 5, and 8, which were tracked as open items.

In RAI 444-8530, Question 16-135, Sub-question 4, the staff asked that the applicant explain how a Channel Check is performed on a FHEVAS radiation monitor channel, when LCO 3.3.10 requires just one of the four channels to be operable. Since the response (ML16162A795) to Question 16-135, regarding Sub-question 4, did not address the issue of how to compare indication of at least two channels for consistency, but assumed another channel would be operable while taking the required channel out of service for testing, Sub-question 4 was tracked as an open item pending a satisfactory revised response. In its revised response (ML17235B288) to Question 16-135, regarding Sub-question 4, the applicant added the following explanation to the Bases for SR 3.3.10.1.

> If only one radioactivity particulate monitor channel is required, surveillance of one radioactivity particulate monitor channel is performed by using [a] radioactive check source. The radioactive check source is generally built into the detector assembly and can be remotely activated by the operator. The radioactive check source is primarily used to check whether a particular radiation monitoring channel loop is live or functioning. When a check source is exposed to the detector on demand, if upscale measurement is indicated, the channel is assessed with channel live status by pass/fail criteria. The criteria are qualitative assessment, by observation, of channel behavior during operation.

Although this explanation would be clearer with some editorial changes, the staff found that use of the built in check source to check the status of the required radiation monitor channel is an acceptable method of performing the specified Channel Check. Therefore RAI 444-8530, Question 16-135, Sub-question 4 is resolved. The applicant's revised response to Question 16-135 also resolved:

- Sub-question 5 by revising the surveillance column Note of SR 3.3.10.3 (once per 18 month Channel Functional Test of FHEVAS Actuation Logic division, including the initiation circuit) to use the phrase "initiation circuit" in place of "initiation relay." The response justified this by explaining that "circuit" is a more general term than relay, and can refer to relay, solid state, or digital logic devices, to accommodate a supplier's diverse technology.

- Sub-question 8 by making conforming changes to Subsection B 3.3.10 to reflect changes to Subsection 3.3.10 that resolved Sub-questions 4 and 5.

The staff reviewed Subsection 3.3.10 and Subsection B 3.3.10 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the FHEVAS Function, so that in the event an accident occurs during movement of irradiated fuel [assemblies] in the fuel handling area, upon receipt of a valid trip signal from at least one channel of the FHEVAS Radiation Monitor instrumentation Function, the FHEVAS actuation logic will align the Fuel Handling Area HVAC System to the emergency mode of operation, which isolates the ventilation ducts in the fuel handling area and initiates filtered ventilation by actuating the associated air cleaning unit (ACU), as assumed in the onsite and offsite radiological dose consequence analysis of the fuel handling accident analyses. Similarly, the operability of the FHEVAS Manual Actuation Function is ensured so that the control room operator can place the Fuel Handling Area HVAC System in the emergency mode of operation upon failure of the designated fuel handling area emergency ventilation train to actuate automatically on a valid actuation signal. Accordingly, the staff concludes that Subsection 3.3.10 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.10 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.10. The staff also verified that Subsections 3.3.10 and B 3.3.10 are consistent with the guidance in CE STS Subsections 3.3.10B and B 3.3.10B, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open items, the staff concludes that Subsection 3.3.10 and Subsection B 3.3.10 are acceptable.

Subsection 3.3.11 Accident Monitoring Instrumentation (AMI)

The following table lists, for comparison and reference, the APR1400 GTS required accident monitoring instrumentation (AMI) Functions and equivalent STS required post accident monitoring (PAM) instrumentation Functions, along with the specified applicable Modes or other specified conditions. The AMI Functions consist of the Types A, B, and C variables determined using the guidance of RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," June 2006, Revision 4; while the PAM Functions consist of Type A and Category I, Types B and C, variables using the guidance of RG 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," May 1983, Revision 3. For most variables, the AMI Type A, B, and C variable category criteria correspond to the category criteria for PAM Type A variables, Category I - Type B variables, and Category I - Type C variables, respectively. However, whereas the STS selection of PAM variables was derived from a prescriptive list for pressurized light-water reactor plants in RG 1.97, Revision 3, the AMI variables selected for the APR1400 must be based on indication instrumentation needed for operators to implement the emergency operating procedures (EOPs), which are derived from the emergency operating guideline (EOG) document. The staff's review of the AMI is documented in Section 7.5 of this SER.

The following table is based on Enclosure Attachment 2 of the applicant's letter (ML16162A561) in response to RAI 38-7878, Question 7.5-1, and also on the applicant's response (ML15216A459) to RAI 38-7878, Question 7.5-2, and response (ML16153A476) to RAI 294-8302, Question 7.5-6, regarding DCD Tier 2, Table 7.5-1, "Accident Monitoring Instrumentation Variables." In its second, third, and fourth revised responses to RAI 38-7878, Question 7.5-1 (ML17271A079, ML17290B224, and ML17331B467), the applicant revised the AMI list provided in DCD Tier 2 Table 7.5-1 and generic TS Table 3.3.11-1; those changes are included in the following table.

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.11	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.11
Specification / Function (Type)...... Required Channels	Specification / Function .... Required Channels
3.3.11 Accident Monitoring Instrumentation (AMI) .....Modes 1, 2, and 3.	3.3.11 Post Accident Monitoring (PAM) Instrumentation ....Modes 1, 2, and 3.
1. Logarithmic Reactor Power (neutron flux) (A,B) 2	1. [Wide Range] Neutron Flux 2
2. Hot Leg Temperature (Wide Range) (A,B) .... 2 per loop	2. Reactor Coolant System Hot Leg Temperature – ....2 per loop
3. Cold Leg Temperature (Wide Range) (A,B) .... 2 per loop	3. Reactor Coolant System Cold Leg Temperature – ....2 per loop
4. Reactor Coolant System Pressure (C) 2	4. Reactor Coolant System Pressure (wide range)... 2
5. Reactor Vessel Level (RV Closure Head Level/RV Plenum Level) (B)... 2	5. Reactor Vessel Water Level 2
6. Reactor Cavity Level (B) 4	---
7. Containment Pressure (Wide Range) (B)........... 2	7. Containment Pressure (wide range)...................... 2
8. Containment Pressure (Extended Wide ...Range) (C) 2	---
9. Containment Isolation Valve Position (B) .... 1 (of 2) per valve (a),(b)	8. Penetration Flow Path Containment Isolation Valve Position...................2 per penetration flow path (a) (b)
10. Containment Upper Operating Area Radiation (C)... 2	9. Containment Area Radiation (high range) 2
11. Pressurizer Level (A,B) 2	10. Pressurizer Level.. 2
12. Steam Generator Level (Wide Range) (A,B)....... .... 2 per Steam Generator	11. Steam Generator Water Level (wide range) .... 2 per steam generator
13. Holdup Volume Tank Level (B) 4	---
---	12. Condensate Storage Tank Level.......................... 2
14. Core Exit Temperature – Quadrant 1 (B,C)....2 (c)	13. Core Exit Temperature - Quadrant [1].............. 2 (c)
15. Core Exit Temperature – Quadrant 2 (B,C)....2 (c)	14. Core Exit Temperature - Quadrant [2]...............2 (c)
16. Core Exit Temperature – Quadrant 3 (B,C)....2 (c)	15. Core Exit Temperature - Quadrant [3]...............2 (c)
17. Core Exit Temperature – Quadrant 4 (B,C)....2 (c)	16. Core Exit Temperature - Quadrant [4]...............2 (c)
18. Steam Generator Pressure (A,B) .... 2 per Steam Generator	---
19. RCS Saturation Margin (A,B).........................2 (d)	---
20. Core Exit Temperature (CET) Saturation Margin (A,B)...2 (e)	---
21. Reactor Vessel (RV) Upper Head Saturation Margin (B) .... 2 (f)	---
22. Pressurizer Pressure (Wide Range) (A,B) ....2 (of 4)	---
23. In-containment Refueling Water Storage Tank (IRWST) Level (B) 2	---
24. IRWST Temperature (B) 2	---
25. Containment Water Level (B) 2	6. Containment Sump Water Level (wide range)....... 2

APR1400 Generic TS Section 3.3 Instrumentation – Subsection 3.3.11	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation – Subsection 3.3.11
Specification / Function (Type)...... Required Channels	Specification / Function .... Required Channels
26. Containment Operating Area Radiation (For Fuel Handling Accident) (C) 2	---
27. Spent Fuel Pool Radiation (C) 2	---
28. Safety Injection Pump (SIP) Direct Vessel Injection (DVI) Flow Rate (B) 4	---
29. Main Steam Atmospheric Steam Dump Valve Position (B) 2	---
30. Auxiliary Feedwater Flow (B) 2	17. Emergency Feedwater Flow................................ 2
31. Hydrogen Concentration (B) 2	---
32. Containment Atmosphere Temperature (B) 2	---
33. 4.16 kV Switchgear Voltage (B) 2	---
34. DC Bus Voltage (B) 2	---
35. Instrument Power Bus Voltage (B) 2	---
Table 3.3.11-1 Footnotes: (a) Not required for isolation valves whose associated penetration is isolated by at least one closed and deactivated automatic valve, closed manual valve, blind flange, or check valve with flow through the valve secured.	Table 3.3.11-1 Footnotes: (a) Not required for isolation valves whose associated penetration is isolated by at least one closed and deactivated automatic valve, closed manual valve, blind flange, or check valve with flow through the valve secured.
(b) Only one position indication channel is required for penetration flow paths with only one installed **main** control room indication channel.	(b) Only one position indication channel is required for penetration flow paths with only one installed control room indication channel.
(c) A **measurement** channel consists of two or more core exit thermocouples.	(c) A channel consists of two or more core exit thermocouples.
(d) A measurement channel consists of Reactor Coolant Cold Leg Temperature (T-Cold) Wide Range, Reactor Coolant Hot Leg Temperature (T-Hot) Wide Range, and Pressurizer Pressure (Wide Range).	---
(e) A measurement channel consists of one or more Core Exit Temperature and Pressurizer Pressure (Wide Range).	---
(f) A measurement channel consists of Reactor Vessel Upper Head Temperature and Pressurizer Pressure (Wide Range).	---

Although GTS Subsection 3.3.11 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.11 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.11.

Subsection 3.3.11 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
7.5-1	38-7878 ML15169A320 Responses: ML16162A561 ML16292A489 ML17271A079 ML17290B224 ML17331B467	Provided the basis for the AMI variable selection in accordance with RG 1.97, Revision 4, and IEEE 497-2002.	CC	
7.5-2	38-7878 ML15169A320 Response: ML15216A459	7.5.1.1, System Description - AMI; 7.5.2.1, Design Basis Information - AMI	CU	7.5-6
7.5-6	294-8302 ML15314A019 Response: ML16153A476	Table 7.5-1, AMI Variables - Clarify why the APR1400 has no Type A variables when there are manual actions described in FSAR Tier 2, Chapter 15, Section 15.0.0.6.	CC	7.5-1
16-50	162-8055 ML15235A003 Response: ML15301A207	3.3.11 - Actions table Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-123.1a	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	Determined there should be Type A variables associated with operator termination of the limiting boron dilution event in Mode 4.	CC	7.5-1
16-123.1b	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	Determined there should be Type A variables associated with operator termination of auxiliary feedwater flow during secondary side events.	CC	7.5-1
16-123.2	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	Conformed Table 3.3.11-1 to DCD Tier 2, Table 7.5-1.	CC	7.5-1
16-123.3	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	Described AMI variable selection process used.	CR	7.5-1

Subsection 3.3.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-123.4	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	Explained term "ambiguity" in heading of last column of Table 7.5-1.	CR	
16-123.5	295-8263 ML15314A020 Response: ML16159A326 ML17331B471	SR 3.3.11.1, Table 3.3.11-1, B 3.3.11 ASA, LCO, Actions, and SR sections - editorial – do not capitalize "channel" unless it is a part of a Section 1.1 definition	CC	
16-200	509-8591 ML16214A101 Response: ML16252A511	Table 3.3.11-1 - Function table column headings: use upper case letters for prepositions (editorial)	CC	

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory
CR Closed Resolved with no DCD changes CC Closed Confirmed

The applicant's response (ML16159A326) to RAI 295-8263, Question 16-123, Sub-question 1, referred to the applicant's revised response (ML16292A489) to RAI 38-7878, Question 7.5-1. Pending resolution of RAI 38-7878, Question 7.5-1, and RAI 294-8302, Question 7.5-6 regarding the AMI selection, RAI 295-8263, Question 16-123, Sub-question 1, was tracked as an open item. In its fourth revised response (ML17331B467) to RAI 38-7878, Question 7.5-1, the applicant provided an acceptable list of AMI variables and justification for their categorization as Type A, B, C, D, or E, as defined in revised DCD, Tier 2, Section 7.5.1.1, which is consistent with the guidance of RG 1.97, Revision 4. See Section 7.5 of this report for the staff's evaluation of the applicant's AMI variable selection and responses to Questions 7.5-1 and 7.5-6. Since the staff finds that the responses to Questions 7.5-1 and 7.5-6 are acceptable, and that the Type A, B, and C AMI Functions listed in revised DCD, Tier 2, Table 7.5-1 have been incorporated in generic TS Table 3.3.11-1 and Subsection B 3.3.11, the staff concludes that RAI 295-8263, Question 16-123, Sub-question 1, is resolved. The applicant's revised response (ML17331B471) to RAI 295-8263, Question 16-123, explicitly states that "Table 3.3.11-1 will be revised from 2 to 4 in the number of 'REQUIRED MEASUREMENT CHANNELS' related to Function 28, Safety Injection Pump (SIP) Direct Vessel Injection (DVI) Flow Rate." Since this is consistent with the applicant's fourth revised response (ML17331B467) to RAI 38-7878, Question 7.5-1, and will ensure that the flow rate in each of the four safety injection DVI lines can be monitored, this change is acceptable.

Note 1 to the Actions table for Specification 3.3.11 states that "LCO 3.0.4 is not applicable." Consistent with the previous version of LCO 3.0.4, which KHNP is adopting in lieu of the current risk-informed version of LCO 3.0.4 (TSTF-359-A) that was incorporated into STS Revision 3, this Note allows increasing the unit operating mode into Mode 3 from 4, Mode 2 from 3, and Mode 1 from 2 with inoperable AMI Function channels. However, upon entering the Specification's Applicability of Modes 1, 2, and 3, all Actions Conditions that apply must be entered immediately. Since AMI only provides redundant indication of unit status during an accident, preventing mode increases with an AMI Function channel inoperable is unduly restrictive. This exception to LCO 3.0.4 is acceptable due to the passive function of the instruments, the operator's ability to monitor an accident using alternate instruments and methods, and the low probability of an event requiring these instruments.

The Specification 3.3.11 LCO statement, Applicability statement, Actions table, separate condition entry allowance for each AMI Function, and Surveillance Requirements table are consistent with those of STS 3.3.11. The AMI Function considered to be an alternate means of monitoring reactor vessel level (Function 5) corresponds to an equivalent alternate monitoring instrument Function in the STS (Function 5). This function does not require a unit shut down if not restored to operable status within the specified completion time; instead, Required Action F.1 requires immediately initiating action in accordance with Specification 5.6.5, "Accident Monitoring Report." All other AMI Functions do require a unit shut down if not restored to operable status within the specified completion times, consistent with the STS. The staff concludes that Subsection 3.3.11 is consistent with STS 3.3.11 provisions.

The staff reviewed Subsection 3.3.11 and Subsection B 3.3.11 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the AMI Functions, so that in the event an accident occurs in Mode 1, 2, or 3, control room operators will have adequate information to manually initiate credited operator actions, ascertain and monitor the condition of the unit, and monitor the operation of ESF systems for the duration of the event. Accordingly, the staff concludes that Subsection 3.3.11 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.11 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.11. The staff also verified that Subsections 3.3.11 and B 3.3.11 are consistent with the guidance in CE STS Subsections 3.3.11 and B 3.3.11, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.3.11 and Subsection B 3.3.11 are acceptable.

Subsection 3.3.12 Remote Shutdown Display and Control

Subsection 3.3.12 includes requirements on remote shutdown display and control, which provides the MCR operator with sufficient instrumentation and controls to place and maintain the unit in a safe shutdown condition from a location other than the MCR. This capability is necessary to protect against the possibility that the MCR becomes inaccessible. A safe shutdown condition is defined as Mode 3.

The staff's review of the Remote Shutdown Display and Control System is documented in Section 7.4 of this report.

The following table describes the Specification for the APR1400 Remote Shutdown Display and Control Functions and the Specification for STS Remote Shutdown Functions, including the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.12 Remote Shutdown Display and Control	3.3.12 Remote Shutdown System (Digital) ....

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
....Modes 1, 2, and 3. Table 3.3.12-1 lists 59 Functions	....Modes 1, 2, and 3. Functions not listed.

Although Subsection 3.3.12 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.12 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.12.

Subsection 3.3.12 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
7.4-8	276-8304 ML15302A317 Responses: ML16007A202 ML17251A175	DCD Tier 2, Table 7.4-1, “Remote Shutdown Console Instrumentation and Controls for Hot Shutdown” – correction of errors and enumeration of indication and control Functions – to resolve inconsistencies with Table 3.3.12-1, “Remote Shutdown Display and Control Functions”; Table 3.3.12-1 Function 58 - changed: • Name from “Digital Control Transfer Switch” to “Master Transfer Switch”; • Required number of channels from 2 to 6; • Footnote (g) to say “Includes safety Channels A, B, C and D and non-safety Channels N1 and N2.”	CC	
16-50	162-8055 ML15235A003 Response: ML15301A207	3.3.12 Actions table Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-115.3	295-8263 ML15314A020 Response: ML16134A009	Table 3.3.12-1 Footnote (d) – removed phrase “in opposite trip legs to meet the selective two-out-of-four logic for a reactor trip”	CC	

Subsection 3.3.12 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-200	509-8591 ML16214A101 Response: ML16252A511	Table 3.3.12-1 - Function table column headings: use upper case letters for prepositions (editorial)	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The Specification 3.3.12 LCO statement, Applicability statement, Actions table, separate condition entry allowance for each Remote Shutdown Display and Control Function, and Surveillance requirements table are consistent with those of STS 3.3.12, "Remote Shutdown System (Digital)." The Actions table of Specification 3.3.12 also includes an exception to LCO 3.0.4, which is acceptable for the reasons previously stated in the above evaluation of Specification 3.3.11.

In its response (ML16007A202) to RAI 276-8304, Question 7.4-8, the applicant made changes to both DCD Tier 2, Section 7.4, Table 7.4-1, "Remote Shutdown Console Instrumentation and Controls for Hot Shutdown," and GTS Table 3.3.12-1, "Remote Shutdown Display and Control Functions," to correct errors and inconsistencies.

Completion of the staff's review of Subsection 3.3.12 and Subsection B 3.3.12 was pending incorporation of the changes, highlighted in gray, described in the above RAI Question listing for RAI 276-8304, Question 7.4-8, which was tracked as an open item. In its revised response (ML17251A175) to Question 7.4-8, the applicant made additional corrections to the suggested changes, in DCD Tier 2, Section 7.4, Table 7.4-1, and GTS Subsection 3.3.12, Table 3.3.12-1, so that these tables are consistent. In particular, Table 7.4-1, Item 49, now lists valve position indication and controls for all 10 reactor coolant gas vent (RCGV) valves, by valve designation (RCGV Valves RG-410, RG-411, RG-412, RG-413, RG-414, RG-415, RG-416, RG-417, RG-419, RG-420). These changes corrected inconsistencies between Table 7.4-1 and Table 3.3.12-1 resulting in a complete and accurate list of required remote shutdown display and control station indication and control functions. Therefore, as also described in Section 7.4 of this SER, RAI 276-8304, Question 7.4-8, is resolved.

The staff reviewed Subsection 3.3.12 and Subsection B 3.3.12 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the Remote Shutdown Display and Control Functions, so that in case an event occurs in Mode 1, 2, or 3 that requires evacuation of the control room, the Remote Shutdown Console can be placed in operation, which will provide operators with adequate information and controls to promptly place and maintain the unit in a safe shutdown condition in Mode 3 for an extended period of time. Accordingly, the staff concludes that Subsection 3.3.12 satisfies GDC 19 and paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.12 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements of Subsection 3.3.12. The staff also verified that Subsections 3.3.12 and B 3.3.12 are consistent with the guidance in CE STS Subsections 3.3.12 and B 3.3.12, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff finds that Subsection 3.3.12 and Subsection B 3.3.12 are acceptable.

Subsection 3.3.13 Logarithmic Power Monitoring Channels

Subsection 3.3.13 includes requirements on the logarithmic power monitoring channels, which provide neutron flux power indication from less than 10^{-7} percent of RTP to greater than 100 percent of RTP. They also provide reactor protection when the RTCBs are shut, in the form of a Logarithmic Power Level – High reactor trip (Subsection 3.3.2).

The following table lists the specification for the APR1400 Logarithmic Power Monitoring Channels and the specification for STS [Logarithmic] Power Monitoring Channels (Digital) (With Setpoint Control Program), along with the specified applicable Modes or other specified conditions.

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.13 Logarithmic Power Monitoring Channels ..... Modes 3, 4, and 5 with the reactor trip circuit breakers (RTCBs) open or Control Element Assembly (CEA) Drive System not capable of CEA withdrawal.	3.3.13B [Logarithmic] Power Monitoring Channels.... Modes 3, 4, and 5, with the RTCBs open or CEA Drive System not capable of CEA withdrawal.

Although GTS Subsection 3.3.13 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.3.13 and the deviation report.

The following table lists the RAI questions concerning Subsection 3.3.13.

Subsection 3.3.13 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-52	162-8055 ML15235A003 Response: ML15301A207	3.3.13 Applicability statement – used title case for “Control Element Assembly (CEA) Drive Assembly”	CC	
16-59	189-8057 ML15245A387 Responses: ML15315A035 ML16162A792	3.3.13 Required Action A.2 – removed phrase “if T_{cold} > 99˚C (210˚F) or SR 3.1.2.1 if T_{cold} ≤ 99˚C (210˚F)”	CC	
16-96.b	239-8076 ML15282A602 Responses: ML16028A482 ML16155A103	Replaced “reactor trip switchgear (RTSG)” with “reactor trip circuit breaker (RTCB)” in • 3.3.13 Applicability • B 3.3.13 Background, and Applicability sections	CC	

Subsection 3.3.13 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-113.1	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.13, 3.3.14, 3.9.2, B 3.3.13, B 3.3.14, B 3.9.2, changed to a consistent nomenclature for source range neutron flux monitor, and boron dilution alarm system (BDAS)	CC	
16-128.1	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	Revised 3.3.13 LCO statement to match phrasing of STS 3.3.13 LCO statement	CC	
16-128.2	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	Revised 3.3.13 Applicability statement to use title case for “Control Element Assembly (CEA) Drive System”	CC	
16-128.3	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	B 3.3.13 – removed unnecessary sentence from Bases for SR 3.3.13.2	CC	
16-128.4	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	B 3.3.13 - edited Bases for SR 3.3.13.2 and SR 3.3.13.3 – used “settings” in phrase “as-left and as-found settings”; used “The 31 day Frequency” instead of “This Frequency”	CC	
16-128.5	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	B 3.3.13 - revised Bases for Required Actions A.1 and A.2 by combining first two paragraphs	CC	
16-128.6	439-8524 ML16074A284 Responses: ML16125A546 ML16194A329	B 3.3.13 - revised Bases for Required Action A.1 Note consistent with the STS Bases sentence	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

See evaluation of Subsection 3.1.8 in Section 16.4.6 of this SER for discussion of RAI 17-7917, Question 15.4.6-1 regarding the analysis of the inadvertent RCS boron dilution event.

The staff planned to complete the evaluation of Subsection 3.3.13 and Subsection B 3.3.13 following resolution of RAI 295-8263, Question 16-113, Sub-question 1, which was tracked as an open item. In its revised response (ML16200A320) to Sub-question 1, the applicant revised Subsections 3.3.13, 3.3.14, 3.9.2, B 3.3.13, B 3.3.14, and B 3.9.2 to uniformly refer to startup channels as "startup channels of the excore neutron flux monitoring system (ENFMS)," which is acceptable. Use of a consistent phrase for referring to these instrumentation channels resolves RAI 295-8263, Question 16-113, Sub-question 1.

The staff reviewed Subsection 3.3.13 and Subsection B 3.3.13 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the logarithmic power monitoring channels to aid control room operators in detecting a boron dilution event and loss of SDM with the unit in Mode 3, 4, or 5 with the RTCBs open or CEA Drive System not capable of CEA withdrawal. The required channels will alert operators to such changes in core reactivity by detecting and indicating an increasing neutron flux power level so the operators can stop the deboration event before SDM is lost, in accordance with the assumptions of the boron dilution event safety analyses. Accordingly, the staff concludes that Subsection 3.3.13 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.13 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.13. The staff also verified that Subsections 3.3.13 and B 3.3.13 are consistent with the guidance in CE STS Subsections 3.3.13B and B 3.3.13B, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.3.13 and Subsection B 3.3.13 are acceptable.

Subsection 3.3.14 Boron Dilution Alarms

The following table lists the specification for the APR1400 startup range neutron flux channels and associated alarm circuitry that constitute the Boron Dilution Alarm System (BDAS), along with the specified applicable Modes or other specified conditions. The BDAS is provided to alert control room operators of a possible ongoing inadvertent dilution of reactor coolant boron concentration in the RCS; the alarm setting is based on ensuring that the operators can wait 30 minutes after receiving the alarm before having to manually initiate action to terminate the event before shutdown margin is lost. The operability of two BDAS channels is necessary to meet the assumptions of the safety analyses as described in the APR1400 DCD Tier 2, Section 15.4.6. The BDAS is not required in Mode 6 because LCO 3.9.7 requires isolation of all unborated makeup water sources to the RCS in Mode 6. The STS has no explicit LCO for a boron dilution alarm function in Modes 3, 4, and 5 that uses startup range neutron flux indication.

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
3.3.14 Boron Dilution Alarms .... Mode 3 within 1 hour after the neutron flux is within the startup range following a reactor shutdown,	—

APR1400 Generic TS Section 3.3 Instrumentation	NUREG-1432, Rev. 4, CE STS (Digital) Section 3.3 Instrumentation
Specification / Function .... Applicable Modes	Specification / Function ....Applicable Modes
Modes 4 and 5.	

The following table lists the RAI questions concerning Subsection 3.3.14.

Subsection 3.3.14 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
15.4.6-1	17-7917 ML15146A260 Responses: ML15238B709 ML17244A657	Section 3.1, Subsections 3.3.13, 3.3.14, and 3.9.7 – Evaluation of boron dilution event in Modes 4 and 5; new Subsection 3.1.12; revised Subsection 3.1.8	CC	
15.4.6-7	216-8221 ML15259A829 Response: ML15345A378	New Subsection 3.9.7, “Unborated Water Source Isolation Valve – MODE 6,” to prohibit boron dilution in Mode 6	CC	
16-113.1	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.13, 3.3.14, 3.9.2, B 3.3.13, B 3.3.14, and B 3.9.2, changed to use a consistent nomenclature for startup range excore neutron flux monitoring system (ENFMS) channels, and boron dilution alarm system (BDAS) channels	CC	
16-113.2	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.14 Applicability – revised Mode 3 applicability statement to incorporate proposed Note: “MODE 3 <u>within 1 hour after neutron flux is within the startup range following a reactor shutdown</u>,” for consistency with STS convention for applicability statements	CC	
16-113.3	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.14 Mode 6 Applicability obviated by new Subsection 3.9.7	CC	

Subsection 3.3.14 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-113.4a	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	B 3.1.1, “SDM,” Applicability in Mode 6 ─ explained conservatism in BDAS alarm setpoint	CC	
16-113.5	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.14 Required Action column Note placement for Actions A and B, boron concentration verification required action test interval completion times in COLR	CC	
16-113.6	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.14 Surveillance Requirements table moved to begin on fourth line after Actions table	CC	
16-113.7	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	SR 3.3.14.2 – revised Channel Functional Test Frequency to “31 days of cumulative operation during shutdown” and provided justification	CC	
16-113.8	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	SR 3.3.14.1 Channel Check; B 3.3.14 SR Section Bases for SR 3.3.14.1 and SR 3.3.14.3	CU	16-136
16-136	470-8552 ML16117A247 Response: ML16148A714	SR 3.3.14.1 surveillance column Note – revised to match STS phrasing for Notes that modify the SR’s Frequency of performance	CC	

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory CC Closed Confirmed

In its revised response (ML16200A320) to RAI 295-8263, Question 16-113, the applicant clarified the BDAS requirements as indicated by the following markup of the initial version of Subsection 3.3.14:

- LCO 3.3.14 Two ~~startup channel neutron flux alarms~~ Boron Dilution Alarm System (BDAS) channels shall be OPERABLE.

- APPLICABILITY: MODE 3 within 1 hour after the neutron flux is within the startup range following a reactor shutdown, MODES 4 and 5.

- Condition A: A. One ~~startup channel neutron flux alarm~~ BDAS channel inoperable.
- Condition B: B. Two ~~startup channel neutron flux alarms~~ BDAS channels inoperable.

Also changed were various phrases referring to the startup range instrumentation required by Subsection 3.3.14 and Subsection 3.9.3, "Nuclear Instrumentation," so that such references are consistently stated as startup channels of the ex-core neutron flux monitoring system (ENFMS). To be consistent with STS phrasing, the Channel Function Test Frequency of SR 3.3.14.2 was changed to state "31 days of cumulative operation during shutdown." These and other formatting and editorial changes result in a clearly stated specification for the BDAS consistent with STS style and format conventions.

DCD Tier 2, Chapter 15, Revision 0, Section 15.4.6.1, "Identification of Causes and Frequency Classification," says:

> NUREG-0800, Subsection 15.4.6, states if operator action is required to terminate the transient, the following minimum time intervals must be available between the time an alarm announces an unplanned moderator dilution and the time shutdown margin is lost: (1) during refueling: 30 minutes, or (2) during startup, cold shutdown, hot shutdown, hot standby, and power operation: 15 minutes. However, in this analysis, the operator action time of 30 minutes is conservatively assumed for all operation modes (Modes 1 through 6).
>
> Analysis of the inadvertent decrease in reactor coolant boron concentration event initiated during each of the six operational modes defined in the Technical Specifications is performed. These analyses show that Mode 4 (hot shutdown) results in the least time available for detection and termination of the event as shown in Table 15.4.6-1.

DCD Tier 2, Chapter 15, Revision 0, Section 15.4.6.2, "Sequence of Events and Systems Operation," says:

> For Modes 3, 4, 5, and 6, operation time is calculated from event initiation to loss of shutdown margin. For these modes, 30 minutes is conservatively subtracted from this time to determine the latest allowable time for alarm actuation. In these modes, it is calculated that at 30 minutes prior to loss of shutdown [margin], the source range monitoring (SRM) ratio exceeds its setpoint. An operator response time of at least 30 minutes is demonstrated.
>
> The operator can identify a boron dilution through a neutron flux alarm on the startup flux channel, reactor makeup flow rate, [reactor coolant] sampling, or boric acid flow rate. The operator turns off the charging pump in order to stop further boron dilution.

DCD Tier 2, Chapter 15, Revision 0, Section 15.4.6.3.3, "[Evaluation] Results," states:

> Using the above conservative parameters in Equation (15.4-3), the minimum possible time interval to dilute from 6.5%$\Delta\rho$ subcritical to criticality is 72.8 minutes. Utilizing only the redundant, qualified neutron flux alarm, this time period will provide reasonable assurance of detection of an inadvertent decrease in reactor coolant boron concentration event at least 30 minutes prior to criticality.

In RAI 295-8263, Sub-question 16-113.4a, the staff asked that the applicant

> ...explain why assuming an operator has 30 minutes after receiving a BDAS alarm before a loss of SDM and criticality occurs is more conservative than assuming 15 minutes in Mode 4.

In its responses (ML16006A511, ML16200A320) to Sub-question 16-113.4a, the applicant stated:

> Total dilution time from the initiation of boron dilution to criticality is the same whether assuming 15 minutes for operator action or 30 minutes for operator action. To enable a longer operator action time, the BDAS alarm is set to alert earlier (i.e., alarm setpoint at a lower value) than in the case that assumes 15 minutes for operator action. Due to a lower alarm setpoint, an operator will receive an early BDAS alarm and allow the operator to respond longer than the 15 minutes stated for Mode 4.

Since the alarm setpoint is conservatively chosen to ensure the operator can delay initiating action for 30 minutes and still have at least 30 minutes to terminate the dilution event before loss of shutdown margin, staff agrees that the calculated setpoint will be conservative and consistent with the accident analyses. Therefore, RAI 295-8263, Question 16-113, Sub-question 4a is resolved.

The staff's completion of the evaluation of Subsection 3.3.14 and Subsection B 3.3.14 was pending the resolution of RAI 17-7917, Question 15.4.6-1, which was tracked as an open item. As described in Section 15.4.6 of this SER, the staff concludes that Questions 15.4.6-1 and 15.4.6-7 are resolved based on the applicant's final revised responses. Part of the resolution was to add Subsection 3.1.12, "Unborated Water Source Isolation Valve – MODES 4 and 5," and similar Subsection 3.9.7, "Unborated Water Source Isolation Valve – MODE 6." See Sections 16.4.6 and 16.4.14 of this SER for additional discussion of these requirements.

The staff reviewed Subsection 3.3.14 and Subsection B 3.3.14 and verified that the operability and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the BDAS to alert control room operators of a boron dilution event and loss of SDM with the unit in Mode 3 with neutron flux within the startup range, and in Modes 4 and 5, so the operators can stop the deboration event before SDM is lost, in accordance with the assumptions of the boron dilution event safety analyses. Accordingly, the staff concludes that Subsection 3.3.13 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.3.14 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.3.14. The staff also verified that Subsections 3.3.14 and B 3.3.14 are consistent with the guidance and conventions in the CE STS for preparing TS and TS Bases, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff concludes that Subsection 3.3.14 and Subsection B 3.3.14 are acceptable.

Conclusion for GTS Section 3.3 and Section B 3.3

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Based on the above evaluation, the staff concludes that GTS Section 3.3 and GTS Section B 3.3 are consistent with STS Section 3.3 and STS Section B 3.3, and are therefore acceptable.

16.4.9 TS Chapter 3.0 LCOs and SRs ─ Section 3.4 Reactor Coolant System

GTS Section 3.4 includes requirements for limits on parameters such as reactor coolant pressure, temperature, flow, specific activity, and leakage limits; and for operability of reactor coolant systems and components such as RCS loops, steam generator tubes, the pressurizer and its surge and spray lines and heaters, the pressurizer pilot-operated safety relief valves (POSRVs), reactor coolant gas vent (RCGV) valves, reactor coolant pressure isolation valves, and the low-temperature overpressure protection (LTOP) system. These requirements are intended to ensure that fuel integrity and reactor coolant pressure boundary (RCPB) integrity are preserved during all modes of plant operation.

The GTS Subsections for the RCS correspond to the digital CE STS Subsections for the RCS in the following manner:

STS	GTS	Title (*STS Title, if different)
3.4.1*	3.4.1	RCS Pressure, Temperature, and Flow Limits (*RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits)
3.4.2	3.4.2	RCS Minimum Temperature for Criticality
3.4.3	3.4.3	RCS Pressure and Temperature (P/T) Limits
3.4.4	3.4.4	RCS Loops - MODES 1 and 2
3.4.5	3.4.5	RCS Loops - MODE 3
3.4.6	3.4.6	RCS Loops - MODE 4
3.4.7*	3.4.7	RCS Loops - MODE 5 (Loops Filled) (*RCS Loops - MODE 5, Loops Filled)
3.4.8*	3.4.8	RCS Loops - MODE 5 (Loops Filled) (*RCS Loops - MODE 5, Loops Not Filled)
3.4.9	3.4.9	Pressurizer
3.4.10*	3.4.10	Pressurizer Pilot Operated Safety Relief Valves (POSRVs) (*Pressurizer Safety Valves)
3.4.11*	—	(*Pressurizer Power Operated Relief Valves (PORVs))
3.4.12	3.4.11	Low Temperature Overpressure Protection (LTOP) System
3.4.13	3.4.12	RCS Operational LEAKAGE
3.4.14	3.4.13	RCS Pressure Isolation Valve (PIV) Leakage
3.4.15	3.4.14	RCS Leakage Detection Instrumentation
3.4.16	3.4.15	RCS Specific Activity

—	3.4.16	Reactor Coolant Gas Vent (RCGV) Function
3.4.17*	—	(*Special Test Exception (STE) - RCS Loops)
3.4.18	3.4.17	Steam Generator (SG) Tube Integrity

Unlike typical digital CE PWR designs currently in operation, the APR1400 design does not have pressurizer power operated relief valves (PORVs), which can be used by the control room operator to depressurize the RCS during a steam generator tube rupture (SGTR) event. Accordingly, GTS Section 3.4 does not include the PORV requirements of STS Subsection 3.4.11. Further, for the APR1400 the required startup and physics tests after each refueling outage will be performed during Mode 3 instead of Modes 1 and 2. Accordingly, the special test exception to LCO 3.4.4, “RCS Loops – Modes 1 and 2,” as delineated in STS Subsection 3.4.17 is not needed. Therefore, the staff finds the GTS omission of requirements equivalent to STS Subsections 3.4.11 and 3.4.17 to be acceptable.

Shutdown Cooling System Operability and Testing Requirements: In the APR1400 design, the shutdown cooling system (SCS) is completely separate from the safety injection system (SIS). In the transient and accident safety analyses as described in DCD Tier 2, Chapter 15, operator actions are credited to manually place the SCS in service to support RCS cooling to cold shutdown, Mode 5. In the digital CE PWR design, as reflected in the STS, the SCS pumps also perform the low pressure safety injection (LPSI) function of the ECCS, and are tested as part of STS Subsection 3.5.2, “ECCS – Operating,” during Modes 1 and 2, and in Mode 3 with pressurizer pressure ≥ [1700] psia.

The staff believes that the containment spray system (CSS) pump test of SR 3.6.6.2 should be applied to each SCS pump with the same Frequency as specified for each CSS pump, instead of only when the SCS pump is to be substituted for a CSS pump, as described in the first paragraph of the SR section of Subsection B 3.6.6 (“If the shutdown cooling pump is aligned to meet the requirements of the associated containment spray pump, then the Surveillance Requirements of this LCO must be met before declaring the shutdown cooling pump OPERABLE to satisfy LCO 3.6.6.”)

Section 3.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.24	119-7976 ML15226A542 Response: ML17296A124	Applicant declined to add LCO for shutdown cooling (SC) pump operability testing during Modes 1, 2 and 3	CR	

Status Codes:
CR Closed Resolved with no DCD changes

In RAI 119-7976 (ML15226A542), in Question 16-23, Sub-question 24, the staff requested that the applicant propose an LCO for the SCS, preferably in Section 3.4, in accordance with Criterion 3 of 10 CFR 50.36(c)(2)(ii). Pending a response from the applicant, RAI 119-7976, Question 16-23, Sub-question 24, was tracked as an open item. In its response (ML17296A124), the applicant stated:

24. The “safe shutdown” in the definition of “Safety Function” is to maintain hot standby condition (MODE 3) for APR1400. In this condition, decay heat is

being removed. Therefore, SCS to bring the system to MODE 5 is not a "safety-related system", but a "safety grade system" in accordance to the SRP BTP 5-4. Thus, the SCS is not part of accident mitigation system.

The staff acknowledges that the SCS is not used for decay heat removal in Modes 1, 2, and 3, or in Mode 4 when decay heat removal relies on secondary heat transfer. Safe shutdown following a design basis event involving a reactor trip and a loss of offsite power is Mode 3 with core decay heat removal accomplished by natural circulation of reactor coolant through a steam generator, supplied with water by the SG's steam-turbine-driven train of the auxiliary feedwater (AFW) system, and the release of steam using the SG's atmospheric dump valves. Although the SCS is normally relied upon for decay heat removal in Mode 4 when no RCS loop is operable (no running reactor coolant pump, SG water level less than minimum required, etc.), if the SCS becomes unavailable, a return to the natural circulation safety-related method of decay heat removal may be possible; else, the safety-related method of decay heat removal using the safety injection system, the pilot operated safety relief valves, or the SCS pressure relief valves, and the in-containment refueling water storage tank (IRWST) can be used. Since the SCS is not relied on to prevent or mitigate any design basis accident or transient in Modes 1, 2, and 3, an LCO explicitly requiring SCS operability in Modes 1, 2, and 3 is not required by LCO selection criterion 3. Since SCS operability in Modes 1, 2, and 3 is also not an initial condition to ensure decay heat removal capability following any design basis accident or transient in Modes 1, 2, and 3, and achieving safe shutdown does not require a unit cool down to Mode 5, an LCO explicitly requiring SCS operability in Modes 1, 2, and 3 is not required by LCO selection criterion 2. Therefore, the staff concludes that RAI 119-7976, Question 16-23, Sub-question 24, is resolved, with no DCD changes needed.

Subsection 3.4.1 RCS Pressure, Temperature, and Flow Limits

Subsection 3.4.1 includes requirements for maintaining RCS pressure, temperature, and flow rate within limits assumed in the safety analyses.

The following table lists the RAI questions concerning Subsection 3.4.1.

Subsection 3.4.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.1	119-7976 ML15226A542 Response: ML17296A124	Explained why 3.4.1 Applicability statement and Required Action A.2 deviate from STS	CR	
16-23.2	119-7976 ML15226A542 Response: ML17296A124	3.4.1 LCO statement c – Justified omitting maximum RCS flow limit, even though SR 3.4.1.4 includes it.	CR	
16-23.3	119-7976 ML15226A542 Response: ML17296A124	• SR 3.4.1.4: Justified the 31 day Frequency for a precision calorimetric heat balance • B 3.4.1 SR section, Bases for SR 3.4.1.4: Clarified the	CC	

Subsection 3.4.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		scope of the precision calorimetric heat balance		
16-23.4	119-7976 ML15226A542 Response: ML17296A124	B 3.4.1 Background section – Defined DNB on first use in subsection	CC	
16-23.5	119-7976 ML15226A542 Response: ML17296A124	B 3.4.1 LCO section – Revised discussion of instrument error to include RCS collected total flow rate measurement, RCS pressure, and RCS cold leg temperature measurement	CC	
16-23.6	119-7976 ML15226A542 Response: ML17296A124	B 3.4.1 SR section – Justified omission of and deviation from STS Subsection B 3.4.1 content in the Bases for SR 3.4.1.1, SR 3.4.1.2, and SR 3.4.1.3	CR	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CR Closed Resolved with no DCD changes

Although GTS Subsection 3.4.1 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.1 and the deviation report.

The LCO statement of Subsection 3.4.1 contains explicit limits for pressurizer pressure, cold leg temperature, and RCS total flow rate. This differs from the LCO statement of STS Subsection 3.4.1, which just refers to the limits specified in the COLR (Core Operating Limits Report). In addition, the Applicability statement cites a different Mode of applicability for each of the three parameters as opposed to a single common Mode of Applicability (Mode 1) for all three parameters in the STS; as a result, the Subsection 3.4.1 Actions table Conditions, Required Actions and Completion Times deviate from the STS action requirements. In RAI 119-7976 (ML15226A542), in Question 16-23, Sub-question 1, the NRC staff requested that the applicant justify these deviations. Sub-question 1 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 1, the applicant stated:

1. The core power, as an initial condition of safety analyses for APR1400, is specified in DCD Table 15.0-3. Mode 2 includes the core power of 0%. Pressurizer pressure, cold leg temperature and RCS flow rate are included in LCO 3.4.1 to maintain consistency with the initial conditions in DCD Table 15.0-3. A NOTE on pressurizer pressure limit during power variations is added in Applicability.

The staff agrees that consistency with the initial conditions of the accident analyses justifies the differences in the LCO and Applicability statements. The applicant also added the STS 3.4.1 Applicability Note regarding exceptions to the pressurizer pressure limit during power variations, which had been inadvertently omitted, and the associated basis to the Applicability section of the Bases, consistent with the STS Subsection B 3.4.1. Based on the provided justification for differences and the added Applicability Note, the staff concludes that the LCO and Applicability statements, and associated Bases, are appropriate for the APR1400 design and acceptable. Therefore, RAI 119-7976, Question 16-23, Sub-question 1, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 2, the NRC staff requested that the applicant address why SR 3.4.1.4 specifies a maximum value for RCS flow rate but LCO 3.4.1.c does not. Sub-question 2 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 2, the applicant stated:

> 2. Since the design maximum RCS flow rate is not related to a DNB parameter, there is no need to include it in LCO 3.4.1. SR 3.4.1.4 will be modified to include only the Surveillance for minimum RCS flow rate.

The staff accepts the above rationale for removing the upper flow value from SR 3.4.1.4. Therefore, RAI 119-7976, Question 16-23, Sub-question 2, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 3, the NRC staff requested that the applicant address why SR 3.4.1.4 specifies a Frequency of 31 days, noting that STS SR 3.4.1.4 specifies an 18 month Frequency. Sub-question 3 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 3, the applicant stated:

> 3. The precision calorimetric heat balance is used to measure the RCS flow rate. The surveillance frequency of 31 days in SR 3.4.1.4 has been adopted for Korean plants at the recommendation of the Korean nuclear regulatory organization. Because the RCS flow rate is not expected to vary during operation, a monthly measurement is not required. The frequency of SR 3.4.1.4 will be modified to 18 months to align with NUREG-1432. The bases will also be modified to align with NUREG-1432.

The changes to the SR 3.4.1.4 Frequency and associated Bases to be consistent with the STS are acceptable. In particular, the Bases for SR 3.4.1.4 state:

> The RCS total flow rate is measured by performance of a precision calorimetric heat balance once every 18 months. This allows the installed RCS flow instrumentation to be calibrated and verifies that the actual RCS flow rate is within the bounds of the analyses.
>
> The Frequency of 18 months reflects the importance of verifying flow after a refueling outage where the core has been altered, which may have caused an alteration of flow resistance.
>
> The measurement uncertainty shall be incorporated into measured RCS total flow rate for performing this Surveillance.
>
> The SR is modified by a Note which states the SR is only required to be performed 24 hours after ≥ 95% RTP. <u>The Note is necessary to allow measurement of the flow rate at normal operating conditions at power in</u>

Mode 1. The Surveillance cannot be performed in MODE 2 or below and will not yield accurate results if performed below 95% RTP.

Based on its determination that the Bases for SR 3.4.1.4 is acceptable, the staff concludes that RAI 119-7976, Question 16-23, Sub-question 3, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 4, the NRC staff requested that the applicant revise the Bases for Subsection 3.4.1 to define the acronym "DNB" on first use in the subsection. Sub-question 4 was tracked as an open item. Since the applicant made this change in the response (ML17296A124) to Question 16-23, Sub-question 4 is resolved.

In RAI 119-7976, Question 16-23, Sub-question 5, the NRC staff requested that the applicant explain why the LCO section of the Bases for Subsection 3.4.1 does not address instrumentation error for the DNB parameters of RCS pressure and cold leg temperature, as well as the collected total RCS flow rate. Sub-question 5 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 5, the applicant stated:

5. The bases for LCO 3.4.1 will be updated to indicate how instrument errors are accounted for in the LCO values for pressurizer pressure, RCS cold leg temperature and RCS flow.

The response replaced the second paragraph of the Bases LCO section with the following discussion:

> The LCO values for pressurizer pressure and RCS cold leg temperature account for instrument error. The LCO value for RCS flow rate does not account for instrument error. Plant specific limits of instrument error for RCS flow rate are established by the plant staff to meet the requirements of this LCO.

This change, which is consistent with the LCO section of STS Subsection B 3.4.1, clarifies how LCO 3.4.1 values for DNB parameters account for instrument error. Therefore, RAI 119-7976, Question 16-23, Sub-question 5, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 6, the NRC staff requested that the applicant address why the Bases for SR 3.4.1.1, SR 3.4.1.2, and SR 3.4.1.3 omitted information included in STS Subsection B 3.4.1 for the equivalent SRs. Sub-question 6 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 6, the applicant stated:

6. Those values are not included in the COLR. Values in SR 3.4.1.1, 3.4.1.2 and 3.4.1.3 are taken from input data for safety analyses. The LCOs for pressure and temperature are adjusted for instrument errors. They shall be met to ensure that they are maintained with the value specified in DCD Table 15.0-3. The Note on SR 3.4.1.3, "Only required to be met in MODE 1" was deleted and replaced by APPLICABILITY, "MODE 1 for RCS total flow rate." The second paragraph of Bases for SR 3.4.1.2 will be revised as commented.

The response made no changes to the proposed Bases for SR 3.4.1.1 and SR 3.4.1.2, which omit the first sentence from the STS Bases for SR 3.4.1.1 and SR 3.4.1.2. Since this STS sentence does not address the reason for the SR, its omission is acceptable. In its place, the applicant had inserted "This SR ensures that pressurizer pressure is within limit." for SR 3.4.1.1, and “This SR ensures that RCS cold leg temperature is within limit.” for SR 3.4.1.2. These sentences are acceptable because they state the purpose of the SRs. The response also clarified the second paragraph of the Bases for SR 3.4.1.2, a paragraph which is not included in the STS Bases for SR 3.4.1.2, and which addresses an APR1400 design-specific measurement uncertainty for cold leg temperature. The revised paragraph states:

> Since the measurement uncertainty for RCS cold leg temperature of the Data Processing System is lower than that of the RCS cold leg temperature indicator, whether or not a violation of the LCO has occurred shall be verified using the RCS cold leg temperature of the Data Processing System, if the RCS cold leg temperature indication appears to be outside of the LCO limits.

This paragraph is acceptable because it clearly describes a reasonable method for confirming whether the acceptance criteria of the surveillance are met. The Bases for SR 3.4.1.3 also improves upon the STS Bases for SR 3.4.1.3 by adding the sentence “This SR for RCS total flow rate is performed using the installed flow instrumentation.”, which is acceptable because it states the purpose of SR 3.4.1.3 and clarifies how to perform it correctly as intended. Based on its determination that the Bases for SR 3.4.1.1, SR 3.4.1.2, and SR 3.4.1.3 are acceptable, the staff concludes that RAI 119-7976, Question 16-23, Sub-question 6, is resolved.

The staff reviewed Subsection 3.4.1 and Subsection B 3.4.1 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the RCS DNB parameters of pressure, temperature, and flow rate are maintained within the limits assumed in the safety analyses, with the unit in Mode 1 or 2. Accordingly, the staff concludes that Subsection 3.4.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.4.1. The staff also verified that Subsections 3.4.1 and B 3.4.1 are consistent with the guidance in STS Subsections 3.4.1 and B 3.4.1, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.1 and Subsection B 3.4.1 are acceptable.

Subsection 3.4.2 RCS Minimum Temperature for Criticality

Subsection 3.4.2 includes requirements for the range of RCS cold leg temperatures that must be satisfied when the reactor is critical (Mode 2 with $k_{eff} \geq 1.0$, and Mode 1) to ensure that the RCS temperature is within the initial conditions assumed in the accident analyses.

The following table lists the RAI questions concerning Subsection 3.4.2.

Subsection 3.4.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.7	119-7976 ML15226A542 Response: ML17296A124	3.4.2 Applicability statement – Justified the difference from STS that may cause conflict with 3.4.1 Applicability	CR	

Subsection 3.4.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-145.1	481-8546 ML16133A271 Responses: ML16190A314 ML17244A055	3.4.2 - SR 3.4.2.1 – Added a 12 hour Frequency; combined 30 minute Frequency and its Note, and reordered the three Frequencies from shortest interval to longest interval	CC	

Status Codes:
CR Closed Resolved with no DCD changes RC Resolved Confirmatory CC Closed Confirmed

Although Subsection 3.4.2 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.2 and the deviation report.

Subsection 3.4.2 Applicability requirements are different from STS Subsection 3.4.2 Applicability requirements in that the Applicability statement neither specifies an upper limit on RCS loop average temperature (T_{avg}), like the STS, nor an upper limit on RCS cold leg temperature. The LCO statements and Applicability statements for GTS and STS Subsections 3.4.1 and 3.4.2 are presented below (with metric units omitted) for reference in the subsequent discussion; staff suggested edits of the GTS, which are indicated by markup, reflect RAI 507-8587, Question 16-165, RAI 509-8591, Question 16-216, RAI 119-7976, Question 16-23, Sub-question 1, and RAI 481-8546, Question 16-145:

GTS

LCO 3.4.1 RCS departure from nucleate boiling (DNB) parameters for pressurizer pressure, cold leg temperature (T_{cold}), and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2,201 psia and ≤ 2,299 psia;

b. T_{cold} ≥ 548 °F and ≤ 560 °F for THERMAL POWER < 90% RTP ~~RCS cold leg temperature (Tcold)~~;

c. T_{cold} ≥ 553 °F and ≤ 560 °F for THERMAL POWER ≥ 90% RTP; and

~~c~~d. RCS total flow rate ≥ 166.6E6 lb/hr.

APPLICABILITY: MODES 1 and 2 for pressurizer pressure,
MODE 1 for T_{cold} ~~RCS cold leg temperature (Tcold)~~,
MODE 2 ~~(~~with k_{eff} ≥ 1.0 ~~)~~ for T_{cold} ~~RCS cold leg temperature (Tcold)~~,
MODE 1 for RCS total flow rate.

--NOTE--
Pressurizer pressure limit in MODE 1 does not apply during:

a. THERMAL POWER ramp > 5% RTP per minute or

b. THERMAL POWER step > 10% RTP.

LCO 3.4.2 Each RCS cold leg temperature (T_{cold}) shall be ≥ 548 °F.

APPLICABILITY: MODE 1,
MODE 2 with k_{eff} ≥ 1.0.

<u>STS</u>

LCO 3.4.1 RCS DNB parameters for pressurizer pressure, cold leg temperature, and RCS total flow rate shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1.

---NOTE---

Pressurizer pressure limit does not apply during:

a. THERMAL POWER ramp > 5% RTP per minute or

b. THERMAL POWER step > 10% RTP.

LCO 3.4.2 Each RCS loop average temperature (T_{avg}) shall be ≥ [520] °F.

APPLICABILITY: MODE 1 with T_{avg} in one or more RCS loop < [535] °F,
MODE 2 with T_{avg} in one or more RCS loop < [535] °F and with k_{eff} ≥ 1.0.

The GTS 3.4.2 Applicability statement appears to conflict with the GTS 3.4.1 Applicability statement for the DNB parameter of T_{cold}:

- There is no conflict in Mode 1 with Thermal Power < 90% RTP because LCO 3.4.1 requires T_{cold} to be ≥ 548 °F when Thermal Power is < 90% RTP, and LCO 3.4.2 requires T_{cold} to be ≥ 548 °F in Mode 1, which is when Thermal Power is > 5% RTP.
- There is an apparent conflict in Mode 1 with Thermal Power ≥ 90% RTP because LCO 3.4.1 requires T_{cold} to be ≥ 553 °F when Thermal Power is ≥ 90% RTP, but LCO 3.4.2 requires T_{cold} to be ≥ 548 °F when Thermal Power is > 5% RTP. Since the LCO 3.4.1 requirement on the minimum allowed value of T_{cold} is more restrictive at or above 90% RTP, it would take precedence over the minimum value of T_{cold} allowed by LCO 3.4.2. Therefore, the staff concludes there is no actual conflict.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 7, the staff had requested that the applicant resolve this apparent conflict. Sub-question 7 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 7, the applicant stated:

> 7. Per BACKGROUND of B 3.4.2, “The moderator temperature coefficient used in core operating and accident analysis is typically defined for the normal operating temperature range 285 to 295°C (545 to 563°F).” The temperature is consistent with DCD Table 15.0-3. Core power is 0 ~ 102% per DCD Table 15.0-3 in which Mode 2 is included. Temperature distance of 15°F is provided in NUREG-1432. For APR1400, a temperature distance of 3°F is sufficient per APPLICABLE SAFETY ANALYSES per B 3.4.2. The Frequency of SR 3.4.2.1 is revised to incorporate the response to Question No. 16-145 of RAI 481-8546.

The staff finds that the response provides a reasonable justification for the differences between the Applicability statements of STS 3.4.2 and GTS 3.4.2. The applicant also incorporated the suggested edits to the LCO statement of Subsection 3.4.1. Therefore, RAI 119-7976, Question 16-23, Sub-question 7, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-145, Sub-question 1, the staff requested that the applicant address a deviation from the STS regarding omission of the STS SR 3.4.2.1 specified Frequency of 12 hours in GTS SR 3.4.2.1. In its response (ML16190A314) the applicant proposed to modify SR 3.4.2.1 by adding the 12 hour Frequency and combining the 30 minute Frequency with its Note, so that SR 3.4.2.1 states, with metric units omitted (Words marked with gray highlight are additional staff identified corrections.):

> Verify RCS T_{cold} in each loop is ≥ 548°F. | Once within 15 minutes prior to achieving criticality AND 30 minutes with the reactor critical and T_{cold} < 553°F AND 12 hours

Pending verification that the additional suggested changes are incorporated, this part of RAI 481-8546, Question 16-145, Sub-question 1, was tracked as an open item. In Sub-question 1, the staff also observed that the Bases for Subsection 3.4.2 is unclear in the following places:

- The Background section of the Bases for Subsection 3.4.2 states:

  > The reactor coolant moderator temperature coefficient used in core operating and accident analysis is typically defined for the normal operating temperature range 285 to 295°C (545 to 563°F). Nominal temperature T_{cold} for making the reactor critical is 290.6°C (555°F). Safety and operating analyses for lower temperatures have not been completed.

  The last sentence more logically relates to, and therefore, should come after the first sentence. It is not clear what purpose the second sentence serves since 555 °F is not otherwise cited in the Bases. In DCD Revision 2, the second sentence was removed, as shown in the supplemental response (ML17244A055) to RAI 481-8546, Question 16-145. The staff concludes this change is acceptable, since this operational detail is not needed to understand the basis for LCO 3.4.2.

- The Applicable Safety Analyses section of the Bases for Subsection 3.4.2 states

  > There are no accident analyses which dictate the minimum temperature for criticality, but all low power safety analyses (Reference 1) assume initial temperatures near the 286.7 °C (548 °F) limit. The temperature is a value which is added the lower limit of cold leg temperature, that is, the safety analysis initial condition of 285 °C (545 °F) to 1.7 °C (3 °F) of uncertainty.

  The second sentence needs revising so its meaning is clear; for example:

  > This minimum cold leg temperature limit is the sum of the safety analysis initial condition of 285 °C (545 °F) and an uncertainty of 1.7 °C (3 °F).

  It may also be appropriate to indicate the kinds of uncertainties used to determine the 3 °F uncertainty value provided.

- The LCO section of the Bases for Subsection 3.4.2 states (with staff identified corrections highlighted in gray):

The LCO is only applicable when any RCS loop's T_{cold} is below 289.4 °C (553 °F), which ~~and~~ provides a reasonable distance to the lower limit of 286.7 °C (548 °F). This allows adequate time to trend ~~its~~ the approach of T_{cold} towards the lower limit and take corrective actions prior to ~~exceeding the limit~~ going below it.

The first sentence appears to reflect the intended meaning of the Applicability statement, and is consistent with the STS Bases. However, it does not appear to match the actual meaning of the GTS 3.4.2 Applicability statement, which places no conditions on cold leg temperature, as does the STS for RCS average temperature (T_{avg}). For example, the Applicability statement for T_{cold} could be revised to say:

MODE 1 with T_{cold} in one or more RCS cold legs < 553 °F,
MODE 2 with T_{cold} in one or more RCS cold legs < 553 °F and
with $k_{eff} \geq 1.0$ for T_{cold}.

- The SR section of the Bases for Subsection 3.4.2 needs to be revised by making the following staff identified corrections; among these is the STS SR 3.4.2.1 Bases justification for the added 12 hour Frequency:

SR 3.4.2.1

The first ~~First~~ Frequency requires verifying that T_{cold} ~~to be verified greater than or equal to~~ is ≥ 286.7 °C (548 °F) within 15 minutes prior to achieving criticality. The ~~15-minute time~~ 15 minute time period allows the operator to adjust RCS cold leg temperatures or delay criticality ~~so~~ to avoid violating the LCO ~~will not be violated~~. ~~A Note of~~ The second Frequency ~~states~~ requires performing this Surveillance every 30 minutes ~~is required~~ whenever the reactor is critical and T_{cold} is ~~below~~ ≤ 289.4 °C (553 °F). ~~In this case, T_{cold} is required to be verified at or above 286.7 °C (548 °F) every 30 minutes.~~ The ~~30-minute time is~~ once per 30 minute Frequency is often enough to prevent inadvertent violation of the LCO. The third Frequency requires performing this Surveillance every 12 hours and takes into account indications and alarms that are continuously available to the operator in the control room and is consistent with other routine Surveillances that are typically performed once per shift. In addition, operators are trained to be sensitive to RCS temperature during approach to criticality and will ensure that the minimum temperature for criticality is met as criticality is approached.

Since the measurement uncertainty for RCS cold leg temperature of the Data Processing System is lower than ~~that~~ the measurement uncertainty of the indicator, whether or not ~~the~~ there is a violation of the LCO shall be verified by using the RCS cold leg temperature indication of the Data Processing System, if the RCS cold leg temperature is approaching ~~to~~ the LCO limit.

- The References section of the Bases for Subsection 3.4.2 needs to be revised by making the indicated editorial changes, as previously described:

REFERENCES 1. FSAR ~~DCD Tier 2,~~ Chapter 15~~.~~, "Transient and Accident Analyses."

The staff considers the above requested changes to Subsection 3.4.2 and Subsection B 3.4.2 to be within the scope of Question 16-145, Sub-question 1. Pending verification that these changes (with any necessary technical corrections identified by the applicant) are incorporated in Subsection 3.4.2 and Subsection B 3.4.2, RAI 481-8546, Question 16-145, Sub-question 1, was tracked as an open item.

In its supplemental response (ML17244A055) to Question 16-145, the applicant revised SR 3.4.2.1 as suggested, which is acceptable. Omitting an upper limit on T_{cold} in the Applicability, as well as the LCO statement, is acceptable, because the 553°F value is an operational limit which assures the LCO minimum temperature limit of 548°F is met when k_{eff} is ≥ 1.0. Also revised as suggested above were the Background, LCO, Applicable Safety Analyses, and SR sections of Subsection B 3.4.2. Since the changes improve the clarity and useability of the Bases, the staff finds these changes acceptable. The applicant declined to change Bases Reference 1 by adding the Chapter 15 title, as being inconsistent with other such references and the STS Bases. Based on the acceptable clarifying changes that are incorporated, the staff concludes that RAI 481-8546, Question 16-145, Sub-question 1, is resolved.

The staff reviewed Subsection 3.4.2 and Subsection B 3.4.2 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the RCS cold leg temperature is maintained at or above the specified minimum temperature whenever the unit is in Mode 2 with k_{eff} ≥ 1.0, and in Mode 1, as assumed in the safety analyses. Accordingly, the staff concludes that Subsection 3.4.2 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.2 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.4.2. The staff also verified that Subsections 3.4.2 and B 3.4.2 are consistent with the guidance in STS Subsections 3.4.2 and B 3.4.2, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.2 and Subsection B 3.4.2 are acceptable.

Subsection 3.4.3 RCS Pressure and Temperature (P/T) Limits

Subsection 3.4.3 includes requirements to limit the rate of pressure and temperature changes during RCS heatup and cooldown to within the design assumptions and the stress limits for cyclic operation. It establishes operating limits that provide a margin to brittle failure of the reactor vessel and piping of the reactor coolant pressure boundary (RCPB). The limits do not apply to the pressurizer, which has different design characteristics and operating functions.

The staff’s review and evaluation of the methodology referenced by the Pressure and Temperature Limits Report (PTLR methodology) for the APR1400 is documented in Section 5.3.2 of this report.

The following table lists the RAI question concerning Subsection 3.4.3.

Subsection 3.4.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-146.2a	481-8546 ML16133A271 Response: ML16195A559	3.4.3 Applicability statement – Revised to match STS	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although GTS Subsection 3.4.3 closely follows the STS in format and content, the staff noted the following difference that was not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.3 and the deviation report.

The staff issued RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 2a, to request that the applicant clarify the justification, as described in the deviation report, for GTS 3.4.3 requirements that differ from the corresponding or equivalent STS requirements, or revert to the STS language. In particular, Sub-question 2a requested that the Applicability statement be revised to remove a proposed exception to the STS 3.4.3 Applicability statement of "At all times." In its response (ML16195A559) the applicant stated it would make the requested change by removing the proposed exception, which stated "(except when reactor vessel closure head is fully de-tensioned such that the RCS cannot be pressurized)." Therefore, RAI 481-8546, Question 16-146, Sub-question 2a is resolved.

The staff reviewed Subsection 3.4.3 and Subsection B 3.4.3 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the RCS pressure, temperature, and heatup and cooldown rates are maintained within the limits specified in the PTLR. Accordingly, the staff concludes that Subsection 3.4.3 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.3. The staff also verified that Subsections 3.4.3 and B 3.4.3 are consistent with the guidance in STS Subsections 3.4.3 and B 3.4.3, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.4.3 and Subsection B 3.4.3 are acceptable.

Subsection 3.4.4 RCS Loops – MODES 1 and 2

Subsection 3.4.4 requires two RCS loops with both reactor coolant pumps (RCPs) in operation in each loop for core heat removal with forced flow during power operation. Specifying two RCS loops with one SG per loop provides the minimum necessary heat transport paths for heat removal from the RCS. To meet safety analysis acceptance criteria for DNB, four RCPs are required to be in operation in Modes 1 and 2.

The following table lists the RAI question concerning Subsection 3.4.4.

Subsection 3.4.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-145.2	481-8546 ML16133A271 Responses: ML16190A314 ML17244A055	3.4.4 LCO statement – Revised deviation report to match GTS 3.4.4 LCO statement, "Two RCS loops shall be Operable and in operation *with two reactor coolant pumps operating in each loop*." Note that STS omit the phrase in italics.	CR	

Status Code:
CR Closed Resolved with no DCD changes needed

Although GTS Subsection 3.4.4 closely follows the STS in format and content, the staff noted the following difference that was not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.4 and the deviation report.

In its response (ML16190A314) to RAI 481-8546, Question 16-145, Sub-question 2, the applicant revised the deviation report's version of the Subsection 3.4.4 LCO statement to match the GTS Subsection 3.4.4 LCO statement, but offered no explanation of why the GTS statement includes the phrase "with two reactor coolant pumps operating in each loop," which is not included in the STS Subsection 3.4.4 LCO statement. However, having the LCO statement clarify that two RCPs are required to be operating in each loop for an RCS loop to be considered operable and in operation, when the unit is in Modes 1 and 2, is an acceptable presentation of this condition, which is alternatively presented in the Bases for STS Subsection 3.4.4. Therefore, RAI 481-8546, Question 16-145, Sub-question 2, is resolved.

The staff reviewed Subsection 3.4.4 and Subsection B 3.4.4 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure four RCS loops are in operation providing the specified coolant flow in order to meet safety analysis acceptance criteria for DNB in Modes 1 and 2. Accordingly, the staff concludes that Subsection 3.4.4 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.4. The staff also verified that Subsections 3.4.4 and B 3.4.4 are consistent with the guidance in STS Subsections 3.4.4 and B 3.4.4, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.4.4 and Subsection B 3.4.4 are acceptable.

Subsection 3.4.5 RCS Loops – MODE 3

Subsection 3.4.5 includes requirements for RCS loops in Mode 3 for the removal of core decay heat and transfer of this heat, via the steam generators (SGs), to the secondary plant fluid. The reactor coolant also functions as a carrier for soluble neutron poison, boric acid. The Mode 3 decay heat removal requirements are low enough that a single RCS loop with one RCP running is sufficient to remove core decay heat. However, two RCS loops are required to be operable to satisfy single failure criteria. Only one RCP needs to be operable to declare the associated RCS loop operable.

The following table lists the RAI questions concerning Subsection 3.4.5.

Subsection 3.4.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.8	119-7976 ML15226A542 Response: ML17296A124	3.4.5 LCO Note and Required Action C.1 – Revised to be consistent with STS 3.4.5	CC	
16-23.9	119-7976 ML15226A542 Response: ML17296A124	3.4.5 LCO Note – revised for consistency with STS phrasing; SR 3.4.5.3 – Corrected formatting error	CC	
16-146.2b	481-8546 ML16133A271 Response: ML16195A559	3.4.5 LCO – Revised to match STS phrasing	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although GTS Subsection 3.4.5 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.5 and the deviation report.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 8, the staff requested that the applicant justify the differences in LCO statements and the Actions between the GTS and the STS, and in particular regarding boron dilution activities when no RCP is running. These differences are highlighted in gray in the following quotation of the affected GTS requirements (with metric units omitted), and in italics in the subsequent quotation of the corresponding STS requirements:

<u>GTS</u>

LCO 3.4.5 Two RCS loops shall be OPERABLE with steam generators and at least one reactor coolant pump per loop and at least one RCS loop shall be in operation.

---NOTE---
All reactor coolant pumps may be de-energized for up to ≤ 1 hour per 8 hour period, provided:

a. No operations are permitted that would cause reduction of the RCS boron concentration required to meet the SDM of LCO 3.1.1; and

b. Core outlet temperature is maintained at least 10 °F below saturation temperature.

Condition: C. No RCS loop OPERABLE. <u>OR</u> Required RCS loop not in operation.

Required Actions: C.1 Suspend all operations involving a reduction of RCS boron concentration. | Immediately

AND

C.2 Initiate action to restore one RCS loop to OPERABLE status and operation. | Immediately

STS

LCO 3.4.5 Two RCS loops shall be OPERABLE and one RCS loop shall be in operation.

--NOTE--
All reactor coolant pumps may be *removed from operation* for ≤ 1 hour per *8 hour* period, provided:

a. No operations are permitted that would cause *introduction of coolant into the RCS with boron concentration less than* required to meet the SDM of LCO 3.1.1; and

b. Core outlet temperature is maintained at least 10°F below saturation temperature.

Condition: C. *Two* RCS *loops inoperable*. OR Required RCS loop not in operation.

Required Actions: C.1 Suspend operations *that would cause introduction of coolant into the RCS with boron concentration less than required to meet SDM of LCO 3.1.1*. | Immediately

AND

C.2 Initiate action to restore one RCS loop to OPERABLE status and operation. | Immediately

The staff views the indicated differences to be contrary to the Commission policy on TS standardization. This request also applies to any differences related to these requirements in Subsection B 3.4.5. Pending receipt of a response from the applicant, RAI 119-7976, Question 16-23, Sub-question 8 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 8, the applicant stated:

8. Because Action C.1 described in NUREG-1432 is more optimistic, Technical Specification Action C.1 and relevant Bases will be modified to more closely align with NUREG-1432 as follows.

   - Action C.1, "Suspend all operations involving a reduction of RCS boron concentration", is modified to the following sentence: "Suspend all operations that would cause reduction of the RCS boron concentration below that required to meet the SDM of LCO 3.1.1."

   - The sentence of Bases C.1 and C.2, "all operations involving a reduction of RCS boron concentration must be immediately suspended", will be modified by "all operations involving reduction of the RCS boron concentration *below that* required to meet the minimum SDM of LCO 3.1.1 must be immediately suspended."

- In addition, the following sentences will be added in the Bases C.1 and C.2: "Suspending the introduction of coolant into the RCS with boron concentration less than required to meet the minimum SDM of LCO 3.1.1 is required to assure continued safe operation. With coolant added without forced circulation, unmixed coolant could be introduced to the core, however coolant added with boron concentration meeting the minimum SDM maintains acceptable margin to ensure subcritical operation."

Pages 3.4.5-1 and B 3.4.5-3 will be revised as indicated in [the response letter enclosure’s] Attachment 6.

The staff finds the above changes acceptable because they are consistent with the phrasing of Action C and associated Bases of STS Subsections 3.4.5 and B 3.4.5. In addition, the staff noted that the LCO statement, as revised in DCD Revision 1, now matches the phrasing of STS LCO 3.4.5. Based on the consistency of their phrasing with the STS, these provisions are acceptable. Therefore, RAI 119-7976, Question 16-23, Sub-question 8, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 9, the staff requested that the applicant correct the format of the Note to LCO 3.4.5 and the vertical alignment of the Frequency with the surveillance statement for SR 3.4.5.3. Pending receipt of a response from the applicant, RAI 119-7976, Question 16 23, Sub question 9 was tracked as an open item. In its response (ML17296A124) to Question 16-23, for Sub-question 9, the applicant stated:

9. The format corrections were incorporated into APR1400 DCD Tier 2 Chapter 16 Revision 1. Pages 3.4.5-1 and 3.4.5-3 [have] been revised as indicated in [the response letter enclosure’s] Attachment 7.

The staff verified that the Note to LCO 3.4.5 was revised to match the phrasing of the LCO Note of STS Subsection 3.4.5, which is quoted above. The staff also verified that the second paragraph of the LCO section of the Bases for Subsection 3.4.5 was revised to match the STS Bases for LCO 3.4.5. And the alignment of the Frequency of SR 3.4.5.3 was corrected. Based on the consistency of their phrasing with the STS, the Note to LCO 3.4.5 and the Bases for LCO 3.4.5 are acceptable. Therefore, RAI 119-7976, Question 16-23, Sub-question 9, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 2b, the staff requested that the applicant justify the difference in the LCO statement of STS 3.4.5 and GTS 3.4.5; this difference is shown in the above quotations. In its response (ML16195A559) the applicant proposed to revise the LCO statement of Subsection 3.4.5 to match the STS phrasing. The staff finds this acceptable. Therefore, RAI 481-8546, Question 16-146, Sub-question 2b is resolved.

The staff reviewed Subsection 3.4.5 and Subsection B 3.4.5 and verified that the LCO and associated applicability, action, and surveillance requirements for RCS loops are sufficient to ensure adequate core decay heat removal in Mode 3. Accordingly, the staff concludes that Subsection 3.4.5 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.4.5. The staff also verified that Subsections 3.4.5 and B 3.4.5 are consistent with the guidance in STS Subsections 3.4.5 and B 3.4.5, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open items, the staff concludes that Subsection 3.4.5 and Subsection B 3.4.5 are acceptable.

Subsection 3.4.6 RCS Loops – MODE 4

Subsection 3.4.6 includes requirements for RCS loops in Mode 4 for the removal of core decay heat and transfer of this heat, via the steam generators (SGs) to the secondary side coolant, or via the shutdown cooling (SC) heat exchangers to the component cooling water system. The reactor coolant also functions as a carrier for soluble neutron poison, boric acid.

The following table lists the RAI questions concerning Subsection 3.4.6.

Subsection 3.4.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.10	119-7976 ML15226A542 Response: ML17296A124	3.4.6 LCO Note 1 and Required Action C.1 – Justified differences from STS; 3.4.6 Conditions A and B, Required Action A.1 – Justified differences from STS	CR	
16-23.11	119-7976 ML15226A542 Response: ML17296A124	3.4.6 LCO Note 2 – Justified differences from STS	CR	16-146.2c
16-23.12	119-7976 ML15226A542 Response: ML17296A124	SR 3.4.6.3 – Aligned Frequency with surveillance statement	CC	
16-50	162-8055 ML15235A003 Response: ML15301A207	3.4.6 LCO Notes 1 and 2 should be labeled “NOTES” instead of “NOTE”	CC	
16-146.2c	481-8546 ML16133A271 Response: ML16195A559	3.4.6 LCO Note 2 – Justified omission of maximum pressurizer level reactor coolant pump start condition in Mode 4	CR	

Status Codes:
CU Closed Unresolved (has follow up question) RC Resolved Confirmatory
CR Closed Resolved with no DCD changes CC Closed Confirmed

Although GTS Subsection 3.4.6 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.6 and the deviation report.

The staff observed that the proposed Actions for Subsection 3.4.6 are similar to the Actions of Revision 4 of the CE STS Subsection 3.4.6, which are based on TSTF-422, Revision 2, “Change in Technical Specifications End States.” Since the applicant does not propose to adopt any other applicable STS changes of TSTF-422, there is no APR1400 specific analysis that justifies the GTS adopting a particular change made by this traveler to the Actions of Specification 3.4.6 in Revision 1 of the CE STS. In the response (ML17296A124) to RAI 119-7976, Question 16-23, Sub-question 10, the applicant proposed a revised Specification 3.4.6 and Bases, which are based on Revision 1 of the CE STS Subsections 3.4.6 and B 3.4.6. Since the previous evaluation by the staff, presented in the SER with open items, was based on GTS Revision 0, Subsections 3.4.6 and B 3.4.6 compared to CE STS Revision 4, it does not accurately reflect the applicant’s response to Question 16-23, Sub-question 10. Therefore, the evaluation of Subsection 3.4.6 has been revised to only address the differences between the latest proposed version of GTS Subsection 3.4.6 in Revision 1 of the DCD, and Revision 1 of CE STS Subsection 3.4.6.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 10, the staff stated:

> 10. The [GTS Revision 0 version of] LCO 3.4.6 Note 1 and hence Required Action C.1, are stated differently from those presented in [Revision 4 of the CE STS,] NUREG-1432. As a result, the discussion of these items in the Bases are not consistent with the stated requirements. The applicant is requested to provide the basis for the difference and to address the inconsistency between the TS and the associated bases.

In view of the above discussion about TSTF-422, the staff interprets Sub-question 10 as asking the applicant to justify differences between GTS 3.4.6, Revision 1, and STS 3.4.6, Revision 1 regarding (i) the LCO statements and associated Bases; (ii) LCO Note 1 and associated Bases; and (iii) Action C and associated Bases. Pending a response, RAI 119-7976, Question 16-23, Sub-question 10, was tracked as an open item in the SER with open items.

Following are the LCO statement, LCO Note 1, and Action C in STS Subsection 3.4.6, Revision 1, marked up to match the DCD Revision 1 version of proposed GTS Subsection 3.4.6.

LCO 3.4.6 Two loops or trains consisting of any combination of RCS loops and shutdown cooling (SC) trains shall be OPERABLE and ~~at least~~ one loop or train shall be in operation.

--NOTES--

1. All reactor coolant pumps (RCPs) and ~~SDC~~ <u>SC</u> pumps may be ~~de-energized~~ <u>removed from operation</u> for ≤ 1 hour per 8 hour period, provided:

    a. No operations are permitted that would cause ~~reduction of~~ <u>introduction of coolant into</u> the RCS <u>with</u> boron concentration <u>less than required to meet the SDM of LCO 3.1.1</u>; and

    b. Core outlet temperature is maintained at least 10°F below saturation temperature.

Condition: C. <u>Two required</u> ~~Required~~ RCS loop<u>s</u> or ~~SDC~~ <u>SC</u> trains inoperable.

<u>OR</u>

Required ~~No~~ RCS loop or ~~SDC~~ SC train not in operation.

Required Action: C.1 Suspend all operations that would cause introduction of coolant into the RCS with boron concentration below that required to meet *the* SDM of LCO 3.1.1. ~~involving reduction of RCS boron concentration.~~ | Immediately

AND

C.2 Initiate action to restore one loop or train to OPERABLE status and operation. | Immediately

The staff views the indicated differences to be consistent with the Commission policy on TS standardization because the proposed phrasing conforms to Revision 4 of the CE STS Subsection 3.4.6 phrasing, which is clearer. Therefore, these differences are acceptable. In its response (ML17296A124) to RAI 119-7976, Question 16-23, regarding Sub-question 10, the applicant stated:

10. LCO 3.4.6 and B 3.4.6 revert to GTS 3.4.6 Rev.1, which is basically same as STS LCO 3.4.6 Rev.1, because APR1400 did not incorporate TSTF-422 Rev. 2 which is related to risk assessment and management techniques in TS.

In addition to the differences in the above requirements, the staff reviewed the differences in the Bases and found them to be acceptable because they are consistent with these requirements and Revision 4 of the CE STS Subsection B 3.4.6. Therefore, based on finding these requirements and associated Bases acceptable, the staff concludes that RAI 119-7976, Question 16-23, Sub-question 10, is resolved and closed.

In RAI 119-7976, Question 16-23, Sub-question 12, the staff requested that the applicant correct the vertical alignment of the Frequency with the surveillance statement for SR 3.4.6.3. Pending receipt of a response from the applicant, RAI 119-7976, Question 16-23, Sub-question 12 was tracked as an open item. In its response ((ML17296A124) to RAI 119-7976, Question 16-23, regarding Sub-question 12, the applicant stated:

12. The format corrections were incorporated into APR1400 DCD Tier 2 Chapter 16 Revision 1.

The staff verified that the alignment of the Frequency with the surveillance statement is correct in Revision 1 of GTS Subsection 3.4.6. Therefore, Question 16-23, Sub-question 12, is resolved and closed.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 11, the staff requested that the applicant justify the differences between the LCO Note 2 statements of GTS 3.4.6 and STS 3.4.6, which state (Differences in text are highlighted with gray shading in GTS and italic font in STS.):

GTS

--NOTES--

2. No RCP shall be started with any RCS cold leg temperatures less than or equal to the LTOP enable temperature specified in the PTLR, unless secondary side water temperature in each steam generator (SG) is < 100 °F above each of the RCS cold leg temperatures.

STS

--NOTES--

2. No RCP shall be started with any RCS cold leg temperature less than or equal to the LTOP enable temperature specified in the PTLR *unless:*

   a. Pressurizer water level is < [60]% or

   b. Secondary side water temperature in each steam generator (SG) is < [100]°F above each of the RCS cold leg temperatures.

The issue raised in general by RAI 119-7976, Question 16-23, Sub-question 11, was specifically raised in RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 2c. In its response (ML16195A559) to Question 16-146, regarding Sub-question 2c, the applicant provided the following justification for the omission of the pressurizer water level requirement (The staff observed that this explanation was also inserted into the deviation report.):

> The LTOP analyses in FSAR Section 5.2.2.10 are performed with the pressurizer in a water solid condition with a temperature difference of ≥ 139 °C (250 °F) between RCS cold leg and secondary side in each steam generator. There are no analyses performed with the pressurizer at a lower water level. Therefore, the option in NUREG-1432 is not utilized and this is conservative and consistent with the analyses.

In addition, in its response to Question 16-23, regarding Sub-question 11, the applicant stated:

> 11. A pressurizer [water] solid condition is not limited because the POSRVs are qualified for steam, steam-water mixture and liquid conditions. Refer to DCD Section 5.2.2.4.1 and Table 5.4-14.1.

The staff agrees with the above stated position in that a pressurizer water level upper limit is not assumed as an initial condition of the LTOP analyses and therefore, is not required to be specified in any LTOP related TS requirement such as LCO 3.4.6 Note 2. Also, the SCS pressure relief valves, which are used for LTOP with the SCS unisolated from the RCS, and the POSRVs, which are used for overpressure protection when the SCS is isolated from the RCS, are able to prevent an RCP start from overpressurizing the RCS, provided the primary to secondary water temperature difference is within the limit of LCO 3.4.6 Note 2. Therefore, RAI 481-8546, Question 16-146, Sub-question 2c, and RAI 119-7976, Question 16-23, Sub-question 11, are considered resolved and closed, with no DCD changes needed.

Subsection 3.4.6 Surveillances - Deviations from STS Subsection 3.4.6 Surveillances

The staff observed that the phrasing of Subsection 3.4.6 surveillance requirements (not previously described above) deviates from Revision 1 of the CE STS Subsection 3.4.6, as indicated in the markup of each of the corresponding STS requirements; each markup is followed by the staff's evaluation:

- SR 3.4.6.1 Verify one RCS loop or SC ~~SDC~~ train is in operation. | 12 hours

Evaluation: Using the APR1400 naming convention for the SCS is acceptable.

- SR 3.4.6.3 Verify correct breaker alignment and indicated power available to ~~the~~ each required pump ~~that is not in operation~~. | 7 days

Evaluation: Using the phrasing of Revision 4 of STS SR 3.4.6.3 is acceptable.

- SR 3.4.6.4 Note—Not required to be performed until 12 hours after entering MODE 4. Verify required SC train locations susceptible to gas accumulation are sufficiently filled with water. | 31 days

Evaluation: The deviation report indicates that the addition of this surveillance is based upon an NRC approved generic change traveler to the CE STS, TSTF-523, "Generic Letter 2008-01, Managing Gas Accumulation," Revision 2, dated February 21, 2013 (ML13053A075). This traveler modified the existing SRs related to gas accumulation for the emergency core cooling system (ECCS) and added new SRs on entrained gas to the STS Subsections governing the shutdown cooling (SDC) system and containment spray (CS) system. Existing SRs were revised to facilitate the performance of the proposed gas accumulation SR. The STS Bases were also revised to reflect the change to the SRs. The LCO section of the Bases for each of the affected Subsections was revised to add an acknowledgement that management of gas voids is important to system operability.

Existing STS SRs related to gas accumulation were revised to match the new SR that was added to those STS Subsections for which there was no SR related to gas accumulation; the new SR states:

> Verify the [system name] locations susceptible to gas accumulation are sufficiently filled with water. | 31 days

A surveillance column Note is included with the proposed gas accumulation SR for the SDC system STS Subsection that is initially applicable during a unit shutdown, STS Subsection 3.4.6, 'RCS Loops – MODE 4." The Note states:

> Not required to be performed until 12 hours after entering MODE 4.

Surveillances are normally performed prior to entering the Applicability. During a rapid shutdown, there may be insufficient time to verify all susceptible locations in the SDC system before entering the Applicability. The Note provides a limited time to perform the Surveillance after entering the Applicability of the LCO; however, under the SR usage rules of STS Section 1.4, the requirement to manage gas accumulation is not affected. The operator must have confidence that the SR can be met after entering Mode 4, or the LCO must be declared not met upon entering Mode 4.

A Note was added to SRs that require verification that manual valves are in the correct position. For system vent flow paths, the correct position is closed. The Note allows the SR to not be met for system vent flow paths opened under administrative control, to allow system venting and performance of the gas accumulation SR. This Note was added to STS SR 3.5.2.2 and SR 3.6.6.1, and states:

> Not required to be met for system vent flow paths opened under administrative control.

In summary, this traveler made the described changes to the listed surveillances of the following STS Subsections; each STS SR is marked up to show the TSTF-523 changes, and with gray highlight to indicate different phrasing of the corresponding GTS SR, which is also listed:

STS 3.4.6, “RCS Loops – MODE 4,” and B 3.4.6
– Added SR 3.4.6.4 with Note .... corresponds to GTS SR 3.4.6.4

> -----------------------------------NOTE--------------------------------
> Not required to be performed until 12 hours after entering MODE 4.
> ---
> Verify required ~~SDC~~ SC train locations susceptible to gas accumulation are sufficiently filled with water.

STS 3.4.7, “RCS Loops - MODE 5, Loops Filled,” and B 3.4.7
– Added SR 3.4.7.4 .... corresponds to GTS SR 3.4.7.4

> Verify required ~~SDC~~ SC train locations susceptible to gas accumulation are sufficiently filled with water.

STS 3.4.8, “RCS Loops - MODE 5, Loops Not Filled,” and B 3.4.8
– Added SR 3.4.8.3 .... corresponds to GTS SR 3.4.8.3

> Verify required ~~SDC~~ SC train locations susceptible to gas accumulation are sufficiently filled with water.

STS 3.5.2, “ECCS - Operating,” and B 3.5.2
– Revised SR 3.5.2.2 by adding a Note .... corresponds to GTS SR 3.5.2.2

> -------------------------------------NOTE-----------------------------
> Not required to be met for system vent flow paths opened under administrative control.
> ---
> Verify each ~~ECCS~~ SIS manual, power-operated, and automatic valve in the flow path, that is not locked, sealed, or otherwise secured in position is in ~~the~~ correct position.

– Revised SR 3.5.2.3 to match phrasing of new SR .... corresponds to GTS SR 3.5.2.3

> Verify ~~ECCS~~ SIS piping locations susceptible to gas accumulation are sufficiently filled with ~~piping is full of~~ water.

STS 3.6.6A, “Containment Spray and Cooling Systems,” and B 3.6.6A
– Revised SR 3.6.6.1 by adding a Note .... corresponds to GTS SR 3.6.6.1

> ~~-------------------------------------NOTE-----------------------------~~
> ~~Not required to be met for system vent flow paths opened under administrative control.~~
> ~~---~~
> Verify each containment spray manual, power-operated, and automatic valve in the flow path~~,~~ that is not locked, sealed, or otherwise secured in position~~,~~ is in ~~the~~ correct position.

The new STS Note is not included in GTS Subsection 3.6.6.

– Added SR 3.6.6.5 and renumbered SR 3.6.6.5 through SR 3.3.6.9

~~Verify containment spray locations susceptible to gas accumulation are sufficiently filled with water.~~

No equivalent SR is included in GTS Subsection 3.6.6.

STS 3.9.4, "SDC and Coolant Circulation – High Water Level," and B 3.9.4
– Added SR 3.9.4.2 .... GTS SR 3.9.4.2

Verify required ~~SDC loop~~ SC~~S~~ train piping locations susceptible to gas accumulation are sufficiently filled with water.

STS 3.9.5, "SDC and Coolant Circulation – Low Water Level," and B 3.9.5
– Added SR 3.9.5.3 .... GTS SR 3.9.5.4

Verify required ~~SDC loop~~ SC train piping locations susceptible to gas accumulation are sufficiently filled with water.

Except for GTS Subsection 3.6.6, the staff verified that the above listed GTS SRs are consistent with the corresponding STS SRs, as revised, with suitable differences to account for APR1400 system names; note that the use of "SC train" instead of "SCS train" was tracked as an open item, but is resolved based on Revision 1 of the GTS and Bases. The staff also verified that the GTS Bases are consistent with the TSTF-523 changes made to the STS Bases. Therefore, the staff concludes that TSTF-523 has been correctly incorporated in the GTS and Bases, and that the listed GTS SRs are acceptable. Pending an explanation of why the new Note to STS SR 3.6.6.1 was not included with GTS SR 3.6.6.1, and why STS SR 3.3.6.5 was not added to GTS Subsection 3.6.6, TSTF-523 was tracked as an open item. In a revised response (ML17241A147) to RAI 478-8568, Question 16-140, regarding Subsection 3.6.6, the applicant incorporated the missing surveillance column note in SR 3.6.6.1, and the missing SR as SR 3.6.6.7. Based on these changes and the above evaluation of GTS provisions related to the adoption of TSTF-523, the open item related to this traveler and RAI 478-8568, Question 16-140, is resolved. See evaluation of response to Question 16-140 in the evaluation of Subsection 3.6.6 in Section 16.4.11 of this SER.

The staff reviewed Subsection 3.4.6 and Subsection B 3.4.6 and verified that the LCO and associated applicability, action, and surveillance requirements for RCS loops and shutdown cooling (SC) trains are sufficient to ensure adequate core decay heat removal in Mode 4. Accordingly, the staff concludes that Subsection 3.4.6 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.6 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.6. The staff also verified that Subsections 3.4.6 and B 3.4.6 are consistent with the guidance in STS Subsections 3.4.6 and B 3.4.6, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.6 and Subsection B 3.4.6 are acceptable.

Subsection 3.4.7 RCS Loops – MODE 5 (Loops Filled)

Subsection 3.4.7 includes requirements for RCS loops in Mode 5 with the RCS loops filled for the removal of core decay heat and transfer of this heat, via the shutdown cooling (SC) heat exchangers to the component cooling water system with forced flow provided by a SC pump, or via the steam generators (SGs) to the secondary side coolant, with forced flow provided by a RCP in each loop, or by natural circulation. The principal means for decay heat removal is via the SC system; the two SGs are specified to contain a minimum secondary side coolant inventory as a backup means for redundancy. The reactor coolant also functions as a carrier for soluble neutron poison, boric acid. LCO 3.4.7 requires forced circulation to remove decay heat from the core and to provide proper boron mixing.

The following table lists the RAI questions concerning Subsection 3.4.7.

Subsection 3.4.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.13	119-7976 ML15226A542 Response: ML17296A124	3.4.7 LCO Note 1 and Required Action C.1 – Revised to match STS phrasing	CC	Same as issue of 16-23.10
16-23.14	119-7976 ML15226A542 Response: ML17296A124	3.4.7 LCO Note 3 – Justified omission of maximum pressurizer level reactor coolant pump start condition in Mode 5	CR	Similar to issue of 16-23.11
16-23.15	119-7976 ML15226A542 Response: ML17296A124	3.4.7 SR 3.4.7.3 – Aligned Frequency with surveillance statement	CC	Same as issue of 16-23.12
16-31.12	133-7978 ML15227A011 Response: ML16036A378	3.4.7 – Added minimum SC system flow acceptance criterion to SR 3.4.7.1	CU	16-151
16-50	162-8055 ML15235A003 Response: ML15301A207	3.4.7 LCO Notes 1 through 5 should be labeled “NOTES” instead of “NOTE”	CC	
16-149.2K	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	B 3.4.7 - explained meaning of “MODE 5 – RCS Loops Filled”	CC	See evaluation of 3.4.8
16-151	481-8546 ML16133A271 Responses:	3.4.7 – Added minimum SC system flow acceptance criterion of 4,150 gpm to	CC	

Subsection 3.4.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16312A528 ML17262A353	SR 3.4.7.1		

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Although GTS Subsection 3.4.7 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.7 and the deviation report.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 13, the staff requested that the applicant justify the differences between the GTS and the STS regarding boron dilution activities when no SC pump is running in Mode 5. This deviation from STS phrasing in Subsection 3.4.7, LCO Note 1, also exists in LCO Note 1 of Subsections 3.4.5 and 3.4.6, and was identified in Sub-questions 8 and 10, respectively. The staff views the indicated differences to be contrary to the Commission policy on TS standardization. This request also applies to any differences related to these requirements in Subsection B 3.4.7. In RAI 119-7976, Question 16-23, Sub-question 15, the staff requested that the applicant correct the vertical alignment of the Frequency with the surveillance statement for SR 3.4.7.3. Pending receipt of a response from the applicant, RAI 119-7976, Question 16-23, Sub-questions 13 and 15 were tracked as open items. In its response (ML17296A124) to Question 16-23, regarding Sub-question 13, the applicant revised LCO 3.4.7 Note 1 to match the same note in LCO 3.4.5 and LCO 3.4.6. The response also corrected the vertical alignment of the Frequency with the surveillance statement of SR 3.4.7.3. Therefore, Question 16-23, Sub-questions 13 and 15 are resolved.

In RAI 119-7976, Question 16-23, Sub-question 14, the staff requested that the applicant justify the differences between the LCO Note 3 statements of GTS 3.4.7 and STS 3.4.7, regarding omission of a maximum pressurizer level reactor coolant pump start condition in Mode 5. This issue was identified in RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 2c for the similar LCO Note 2 of Subsection 3.4.6. In its response (ML16195A559) to Question 16-146, Sub-question 2c, the applicant provided an acceptable justification for this omission with the unit in Mode 4. Based on that response, Sub-question 2c is closed, as discussed above in the evaluation of Subsection 3.4.6. However, the response to Sub-question 2c did not specifically state that the provided justification also applies in Mode 5 and did not address Subsection 3.4.7. Therefore, RAI 119-7976, Question 16-23, Sub-question 14 was tracked as an open item. In its response (ML17296A124) to Question 16-23, regarding Sub-question 14, the applicant stated:

> 14. Refer to the responses to 16-23.[11] and 16.23-13. And the LTOP analysis was done with the pressurizer (also RCS) water-solid condition. In this condition a mass and energy addition cases were analyzed. The mass addition case is for four SIPs running and one charging pump running, and the energy addition is for a higher SG temperature than the RCS temperature. This LTOP transient is discussed in FSAR 5.2.2.2.2.

Based on the above response, the staff concludes that the responses, which resolved RAI 481-8546, Question 16-146, Sub-question 2c, and RAI 119-7976, Question 16-23, Sub-question 11, concerning LCO Note 2 of Subsection 3.4.6, also apply to the similar

LCO Note 3 of Subsection 3.4.7. Therefore, Note 3 of LCO 3.4.7 is acceptable, and Question 16-23, Sub-question 14, is resolved.

The staff observed that the Bases for Subsections 3.4.7 and 3.4.8 do not explain what specific RCS configurations fall within the RCS "loops filled" condition and the RCS "loops not filled" condition. In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2K, the staff asked if the means of satisfying LCO 3.4.11, LTOP, (either using SC system operable suction relief valves, or an operable RCS vent flow path) would be a part of this explanation. That is, can the RCS be open (e.g., a vent flow path) and still be in the RCS loops filled condition? In its response (ML16312A528) the applicant proposed no changes to the Bases for Subsections 3.4.7 and 3.4.8 that would clarify the point of when and how the "Mode 5 with RCS loops not filled" condition is entered; and the point of when and how the "Mode 5 with RCS loops not filled" condition is exited. Pending receipt of an acceptable revised response to Sub-question 2K, which includes an addition of such an explanation to the Bases for Subsections 3.4.7 and 3.4.8, RAI 481-8546, Question 16-149, Sub-question 2K, was tracked as an open item.

In its second revised response (ML17291A634) to RAI 481-8546, Question 16-149, regarding Sub-question 2K, the applicant added the following passage to the Applicability section of the Bases for Subsection 3.4.7:

> The MODE 5 with RCS loops filled condition is when the SGs can be used for core decay heat removal. This loops filled condition can be maintained while draining the RCS, provided the reactor coolant level is maintained above 134 ft, since below this level containment atmospheric pressure can no longer completely support the column of water remaining in the SG tubes above the reactor coolant level. At reactor coolant level below 134 ft, water vapor voids begin forming in the horizontal portions of SG tubes, beginning with the highest tubes. The number of affected tubes increases as RCS level decreases until all tubes contain water vapor voids. SG tubes containing voids of water vapor, at the saturation temperature vapor pressure of the coolant in the tubes, block coolant flow and secondary heat transfer. When reactor coolant level has decreased to 119 ft 1 in (just above the high point of the hot leg), air can begin entering the hot leg through the surge line connection and displace the coolant remaining in the SG tubes. This results in the SG tubes being filled with non-condensible gases. The condition in MODE 5 with RCS water level within the top half of the hot legs is called mid-loop operation.
>
> Restoring the unit to the MODE 5 with RCS loops filled condition requires raising RCS level above 134 ft during a draining operation, provided no air was introduced into the SG tubes. Restoring the unit to the MODE 5 with RCS loops filled condition following mid-loop operation requires closing the pressurizer manway, filling the pressurizer, and dynamically venting non-condensible gases from the SG tubes and reactor vessel closure head using the Reactor Coolant Gas Vent (RCGV) System and the reactor coolant pumps (RCPs).
>
> Forced circulation by the RCPs in the MODE 5 with loops not filled condition is possible when the static head of the water from pressurizer water level establishes an RCS pressure high enough to run an RCP.

The staff finds this description of RCS conditions in Mode 5 for transitioning between an RCS loops filled condition and an RCS loops not filled condition complete and accurate. With this explanation, the staff concludes that the transition point to the RCS loops not filled state is clear (RCS level < 134 ft), and the transition back to the loops filled state is also unambiguous. Therefore, RAI 481-8546, Question 16-149, Sub-question 2K for Subsection 3.4.7 is resolved.

The staff reviewed Subsection 3.4.7 and Subsection B 3.4.7 and verified that the LCO and associated applicability, action, and surveillance requirements for RCS loops and shutdown cooling (SC) trains are sufficient to ensure adequate core decay heat removal in Mode 5 with RCS loops filled. Accordingly, the staff concludes that Subsection 3.4.7 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.7 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.7. The staff also verified that Subsections 3.4.7 and B 3.4.7 are consistent with the guidance in STS Subsections 3.4.7 and B 3.4.7, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.7 and Subsection B 3.4.7 are acceptable.

Subsection 3.4.8 RCS Loops – MODE 5 (Loops Not Filled)

Subsection 3.4.8 includes requirements for RCS loops in Mode 5 with the RCS loops not filled for the removal of core decay heat and transfer of this heat, via the shutdown cooling (SC) heat exchangers to the component cooling water system with forced flow provided by a SC pump.

The following table lists the RAI questions concerning Subsection 3.4.8.

Subsection 3.4.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.16	119-7976 ML15226A542 Response: ML17296A124	3.4.8 LCO Note 1 and Required Action B.1 – Changed to be consistent with STS	CC	Same as issue of 16-23.10
16-23.17	119-7976 ML15226A542 Response: ML17296A124	3.4.8 SR 3.4.8.2 – Aligned Frequency with surveillance statement	CC	Same as issue of 16-23.12
16-23.18	119-7976 ML15226A542 Response: ML17296A124	3.4.8 LCO, LCO Note 3, Required Action B.3 – Revised to be consistent with proposed changes to Subsection 3.9.5	CC	(see evaluation of 3.9.5) 16-31.10 16-140.5 16-145.4
16-25.5	125-7975 ML15216A651 Response: ML16032A596	1.1, 3.4.8 – Used 127 ft 1/4 in instead of defined term of REDUCED RCS INVENTORY	CU	16-149.2A (see evaluation of Section 1.1) 16-149.2B
16-31.12	133-7978 ML15227A011	3.4.8 – Add minimum SC system flow acceptance	CU	16-151

Subsection 3.4.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16036A378	criterion to SR 3.4.8.1 (renumbered as SR 3.4.8.2)		
16-50	162-8055 ML15235A003 Response: ML15301A207	3.4.8 LCO Notes 1, 2, 3, and 4 re-labeled “NOTES” instead of “NOTE”	CC	
16-149.2	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Applicability of shutdown risk mitigation features. • Replaced “RCS level < 127 ft 1/4 in (REDUCED RCS INVENTORY)” as indicated: 3.4.8 – no change; 3.6.7 – Mode 5 <u>with any RCS loop not filled</u>, Mode 6 <u>with the water level < 23 ft above top of the reactor vessel flange</u>; LCO 3.9.5.b – No change; 3.9.5 Applicability is Mode 6 with < 23 ft above top of reactor vessel flange; 3.9.5 Action B.3 – No change. Initiate action to raise RCS level to ≥ 127 ft 1/4 in • Applicant declined to replace “RCS level < 130 ft 0 in (1/4 in below top of reactor vessel flange elevation)” as indicated: 3.5.3: “RCS loops not filled”; 3.5.4: “RCS loops not filled”	CR	See evaluation of Subsection 3.9.5
16-149.2B	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Replace “REDUCED RCS INVENTORY” with “< 127 ft 1/4 in” in 3.4.8, 3.5.3, 3.5.4, 3.6.7, and 3.9.5; and associated Bases	CC	
16-149.2C	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Applicant declined to provide default action requirements (Action C) in the event the SCS requirements of LCO 3.4.8 are not met, or the actions to restore compliance	CR	

Subsection 3.4.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		with LCO 3.4.8 are not met. Applicant declined to change Required Actions A.2, B.3, and C.2 to say "Initiate action to raise RCS level to > 130 ft 0 in."		
16-139.5	478-8568 ML16131A614 Responses: ML16189A174 ML17138A937 ML17240A398 ML17296A128 ML17319A417	3.4.8 and B 3.4.8 – replaced "MID-LOOP" with "mid-loop"	CC	
19-6	232-7864 ML16203A437 Responses: ML16064A057 ML16123A301 ML16175A652 ML16203A442	Response proposed adding to 3.4.8 Applicability in parenthesis: "MODE 5 with RCS loops not filled (Mid-loop operation shall be started at least 4 days after shutdown and equal to or less than 57.2°C (135°F of initial hot leg temperature.)" Superseded by 16-149.2D response.	CC	16-149.2D
16-149.2D	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	3.4.8 – Added LCO Note 4: "Operation in the mid-loop condition (RCS level ≤ 119 ft 1 in) is allowed if the time after reactor shutdown is ≥ 96 hours and core exit temperature is maintained ≤ 57.2°C (135°F)."	CC	See 16-139.5 16-149.2F
16-149.2E	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	• 3.4.8 – Added Condition E: "Core exit temperature > 57.2°C (135°F) during mid-loop operation. <u>OR</u> RCS level ≤ 36.30 m (119 ft 1 in) (mid-loop condition) with < 96 hours after reactor shutdown." • Added SR 3.4.8.1 • Made conforming changes to B 3.4.8	CC	See 16-139.5

Subsection 3.4.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-149.2F	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Requested RCS level corresponding to just below the reactor vessel flange (130 ft) in place of the level of 127 ft 1/4 in, or mid-loop, as suggested in proposed LCO 3.4.8 Note 4 (Sub-question 2D) and Required Actions A.2, B.3, and C.2 (Sub-question 2C) because of the resulting greater reactor vessel water volume to mitigate a loss of decay heat removal event	CR	
16-149.2K	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	B 3.4.8 – Revised to explain meaning of “MODE 5 – RCS Loops Not Filled”	CC	See evaluation of 3.4.7
16-151	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353	3.4.8 – Added minimum SC system flow acceptance criterion of 3,800 gpm to SR 3.4.8.2	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory CR Closed Resolved (no DCD change needed)

Although GTS Subsection 3.4.8 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.8 and the deviation report.

The enclosure to the applicant’s letter (ML16312A528) in response to RAI 481-8546, Question 16-149, contained five attachments consisting of markups of affected pages of DCD Chapter 16. Attachment 4 addressed changes to Subsections 3.4.8 and B 3.4.8; in addition to showing changes associated with the response to Question 16-149, the markup depicted changes associated with RAI 119-7976, Question 16-23, Sub-questions 16, 17, and 18, even though a formal response to these sub-questions was still pending.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 16, the staff requested that the applicant justify the differences between the GTS and the STS regarding boron dilution activities when no SC pump is running in Mode 5. This deviation from STS phrasing in Subsection 3.4.8, LCO Note 1, also exists in LCO Note 1 of Subsections 3.4.5, 3.4.6, and 3.4.7, and was identified in Sub-questions 8, 10, and 13, respectively. The staff views the indicated differences to be contrary to the Commission policy on TS standardization. This request also applies to any differences related to these requirements in Subsection B 3.4.8. While a formal response to RAI 119-7976, Question 16-23, Sub-question 16, is pending, the applicant's response (ML16312A528) to RAI 481-8546, Question 16-149 (response letter enclosure's Attachment 4, pages 1 and 6), indicates that LCO 3.4.8 Note 1 will be revised to be consistent with the STS. A markup of DCD Revision 0 of LCO 3.4.8 Note 1 is provided below. Based on this response, RAI 119-7976, Question 16-23, Sub-question 16, is resolved. This conclusion is supported by the applicant's response (ML17296A124) to RAI 119-7976, Question 16-23.

In RAI 119-7976, Question 16-23, Sub-question 17, the staff requested that the applicant correct the vertical alignment of the Frequency with the surveillance statement for SR 3.4.8.2. While a formal response to RAI 119-7976, Question 16-23, Sub-question 17, is pending, the applicant's response (ML16312A528) to RAI 481-8546, Question 16-149 (response letter enclosure's Attachment 4, page 5), indicates that the Frequency misalignment for SR 3.4.8.2 will be corrected. Therefore, RAI 119-7976, Question 16-23, Sub-question 17, is resolved. This conclusion is supported by the applicant's response (ML17296A124) to RAI 119-7976, Question 16-23.

In RAI 119-7976, Question 16-23, Sub-question 18, the staff requested that the applicant revise Subsection 3.4.8 to be more consistent with similar requirements proposed in Subsection 3.9.5 that are intended to address safety concerns during reduced RCS inventory conditions, including mid-loop operation as described in Generic Letter (GL) 88-17. While a formal response to RAI 119-7976, Question 16-23, Sub-question 18, is pending, the applicant's response (ML16312A528) to RAI 481-8546, Question 16-149 (response letter enclosure's Attachment 4, pages 1, 6, 7, 8, 9, and 10), indicates that Subsection 3.4.8 and Subsection B 3.4.8 will be revised to be consistent with changes to Subsection 3.9.5 and Subsection B 3.9.5. A markup of the affected requirements is provided below. Based on this response, RAI 119-7976, Question 16-23, Sub-question 18, is resolved. This conclusion is supported by the applicant's response (ML17296A124) to RAI 119-7976, Question 16-23.

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2, the staff requested the applicant to address additional questions (2A through 2I) related to the proposed requirements of GTS subsections that apply during the shutdown conditions of Mode 5 with RCS level < 127 ft 1/4 in, and Mode 6 with RCS level < 127 ft 1/4 in.

In Sub-question 2A the staff requested the applicant to delete the defined term, "REDUCED RCS INVENTORY," and replace every occurrence of this term with a phrase with an equivalent meaning to the definition, a phrase similar to "RCS level < 127 ft 1/4 in"; related to this request was the staff's observation in Sub-question 2:

> Due to the estimated short time period following a loss of shutdown cooling (decay heat removal) until the reactor coolant in the RV [reactor vessel] begins to boil (time-to-boil) when RCS inventory is less than normal (MODE 5 with RCS loops not filled, or MODE 6 with refueling pool level < 23 ft above RV flange), the requirements of the above LCOs [3.4.8, 3.5.3, 3.5.4, 3.6.7, 3.9.3, and 3.9.5] may need to be applicable at an RCS water level > 127 ft 1/4 in, the REDUCED RCS INVENTORY elevation threshold, and even an RCS water level > 130 ft 1/4 in; i.e., above the top of the RV flange, to adequately address the safety concerns of GL 88-17.

The GTS Revision 0 requirements for Subsections 3.4.8 and 3.9.5, which are intended to address safety concerns while the unit has reduced reactor coolant inventory in the RCS, are the basis of the final version of the these subsections, as indicated by the markup below; metric and centigrade units are omitted to improve readability. The quoted GTS Revision 0 requirements are marked up to indicate acceptable changes that resolved the RAI questions listed below. In the markup, each change related to an RAI question resolution or response is annotated with a curly-bracketed superscript prefix of the Question number with the "16-" part omitted. RAI question numbers, which were tracked as open items, are in italics in the following list.

16-23.16	*16-139.5*	*16-149.2*	16-149.2F
16-23.18	16-140.3	16-149.2B (16-25.5)	*16-149.2M*
16-31.8	*16-140.4*	*16-149.2C*	16-151
16-31.9	*16-140.5*	16-149.2D (19-6)	
16-52	16-145.4 (16-31.10)	16-149.2E	

Although Question 16-140 only addressed Subsection 3.9.5, the associated issue also applies to Subsection 3.4.8; therefore, appropriate changes are indicated in the markup.

Subsection 3.4.8, Revision 0, markup

- LCO 3.4.8 {23.18} The heat removal system shall be in the following status:
  - a. Two shutdown cooling (SC) trains shall be OPERABLE and one SC train shall be in operation; and
  - {23.18, 140.4} b. The containment spray pump in the same electrical division as the operating SC train shall be OPERABLE.
- LCO 3.4.8 Notes
  - {23.18} 1. All SC pumps may be ~~de-energized~~ removed from operation for ≤ 15 minutes when switching from one train to another provided:
    - a. Core outlet temperature is maintained at least 10°F below saturation temperature;
    - {23.16, 149.2D} b. No operations are permitted that would cause ~~a reduction~~ introduction of coolant into the RCS with boron concentration less than required to meet the SDM of LCO 3.1.1; and
    - c. No draining operations to further reduce RCS water volume are permitted.
  - 2. One SC train may be inoperable for ≤ 2 hours for surveillance testing provided the other SC train is OPERABLE and in operation.
  - {23.18, 140.4} 3. ~~A~~ The containment spray pump in the same electrical division as the SC train in operation ~~can~~ may be manually ~~realigned~~ aligned to meet the requirements of ~~a~~ its associated SC pump.
  - {19-6, 139.5, 149.2D, 149.2F} 4. *Operation in the mid-loop condition (RCS level ≤ 119 ft 1 in) is allowed if the time* after reactor shutdown *is* ≥ 96 hours and core exit temperature is maintained ≤ 135°F.
- 3.4.8 Applicability MODE 5 with RCS loops not filled.
- 3.4.8 Condition A. One SC train inoperable.

- Required Action — A.1 {149.2C,149.2F} Initiate action to restore SC train to OPERABLE status. | Immediately
- 3.4.8 Condition — B. {149.2C} ~~Required~~ Two SC trains inoperable. OR No SC train in operation.
- Required Actions — B.1 {23.16} Suspend ~~all~~ operations ~~involving reduction of RCS boron concentration~~ that would cause introduction of coolant into the RCS with boron concentration less than that required to meet SDM of LCO 3.1.1.

  AND

  B.2 {149.2C} Initiate action to restore one SC train to OPERABLE status and operation. | Immediately

  AND

  B.3 {149.2C, 149.2F} Initiate action to raise RCS level to > 127 ft 1/4 in. | Immediately
- 3.4.8 Condition — {23.18, 140.4, 149.2C} C. Containment *s*pray pump in the same electrical division as the operating SC train inoperable.
- Required Actions — {23.18, 140.4, 149.2C} C.1 If the containment spray pump in the same electrical division as the alternate SC train is OPERABLE, initiate action to place the alternate SC train in operation. | Immediately

  AND

  {149.2F} C.2 Monitor SC *System* performance. | Every 30 minutes

  AND

  C.3 Restore containment spray pump to OPERABLE status. | 48 hours
- 3.4.8 Condition — {23.18, 149.2C} D. Required Action and associated Completion Time of *Required Action* C.3 not met.
- Required Action — {23.18, 149.2C} D.1 Raise RCS level > 127 ft 1/4 in. | 6 hours
- 3.4.8 Condition — {149.2C, 149.2E} E. Core exit temperature > 135°F {149.2F, 139.5} during *mid-loop* operation.

  OR

  {139.5} RCS level ≤ *119 ft 1 in with* < 96 hours after reactor shutdown.
- Required Actions — {149.2C, 149.2E } E.1 Initiate action to restore core exit temperature to ≤ 135°F. | Immediately

  AND

  E.2 Initiate action to raise RCS level {149.2F, 139.5} above *mid-loop* condition (> 119 ft 1 in). | Immediately
- Surveillances — {149.2E, 149.2F, 139.5} SR 3.4.8.1 NOTE ─ Only required to be met when in *mid-loop* operation. ─ Verify core exit temperature is ≤ 135°F. | 15 minutes

{23.18, 151} SR 3.4.8.~~1~~2 Verify one SC train is in operation with circulating reactor coolant at a flow rate of ≥ 3,800 gpm and < 4,150 gpm. | 12 hours

{23.18, 149.2E} SR 3.4.8.~~2~~3 NOTE ─ Not required to be performed until 24 hours after a required pump is not in operation. ─ Verify correct breaker alignment and indicated power available to the required SC pump. | 7 days

{23.18, 149.2E} SR 3.4.8.4 Verify correct breaker alignment and indicated power available to the required containment spray pump that is not in operation. | 24 hours

{149.2E} SR 3.4.8.~~3~~5 Verify required SC~~*S*~~ train locations susceptible to gas accumulation are sufficiently filled with water. | 31 days

Subsection 3.9.5, Revision 0, markup

- LCO 3.9.5 — The heat removal system shall be in the following status:
  - a. Two SC~~*S*~~ trains shall be OPERABLE and one SC~~*S*~~ train shall be in operation.
  - {149.2B} b. When ~~With REDUCED RCS INVENTORY~~ RCS level {149.2} *is* < 127 ft 1/4 in, the containment spray pump in the same {140.4} ~~train~~ electrical division as an operating SC~~*S*~~ train shall be OPERABLE.
- Applicability — MODE 6 with the water level < 23 ft above the top of *the* reactor {52} vessel flange.
- 3.9.5 Condition — A. One SC~~*S*~~ train inoperable.
- Required Actions — A.1 Initiate action to restore SC~~*S*~~ train to OPERABLE status. | Immediately

  {31.8} OR ~~AND~~

  A.2 Initiate ~~*actions*~~ *action* to establish ≥ 23 ft of water above the top of *the* reactor vessel flange. | Immediately
- 3.9.5 Condition — B. {149.2C} ~~*No SCS train OPERABLE*~~ *Two SC trains inoperable.* *OR* ~~*or*~~ *No SC train* in operation.
- Required Actions — B.1 Suspend operations {31.9} that would cause introduction of coolant into the Reactor Coolant System (RCS) with ~~involving a reduction in reactor coolant~~ boron concentration less than required to meet the boron concentration of LCO 3.9.1. | Immediately

  AND

  B.2 Initiate action to restore one SC~~*S*~~ train to OPERABLE status and to operation. | Immediately

  AND

  B.3 Initiate action to {149.2M} raise RCS level to ≥ 127 ft 1/4 in.
  {149.2B} ~~> EL 38.72 m (127'-1/4") when in REDUCED RCS INVENTORY.~~ | Immediately

{31.10} AND

{145.4} B.4 Place the containment building penetrations in the required status as specified in LCO 3.6.7. | 4 hours

- 3.9.5 Condition C. Containment spray pump in the same {140.4} ~~train~~ electrical division as an operating SC~~S~~ train inoperable {149.2} *with RCS level ≤ 127 ft 1/4 in*.
- Required Actions C.1 If the containment spray pump in the {140.4} same electrical division as the alternate SC~~S~~ train is OPERABLE, initiate action to place ~~*that*~~ *the alternate* SC~~S~~ train in operation. | Immediately

AND

{149.2F} C.2 Monitor ~~*SCS*~~ *SC System* performance. | Every 30 minutes

AND

C.3 Restore containment spray pump to OPERABLE status. | 48 hours

- 3.9.5 Condition D. Required Action and *associated* Completion Time of ~~*Item*~~ *Required Action* C.3 not met.
- Required Action D.1 {149.2} Raise RCS level *to* > 127 ft 1/4 in. ~~EL 127'-1/4".~~ | 6 hours
- 3.9.5 Condition {31.10} ~~E. Required Actions and associated Completion Times of Conditions A, B, and C not met not met.~~
- Required Actions {31.10} ~~E.1 Close equipment hatch and secure with [four] bolts.| 4 hours AND~~

~~E.2 Close one door in each air lock. | 4 hours AND~~

~~E.3.1 Close each penetration providing direct access from the containment atmosphere to the outside atmosphere with a manual or automatic isolation valve, blind flange, or equivalent. | 4 hours OR~~

~~E.3.2 Verify each penetration is capable of being closed by an OPERABLE containment purge system. | 4 hours~~

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2C, the staff stated:

> Since Subsection 3.4.8 attempts to address concerns about the risk of activities involving low RCS water level conditions in MODE 5, it is logical to provide default action requirements in the event the SCS requirements of LCO 3.4.8 are not met and the actions to restore compliance with LCO 3.4.8 are not met. Therefore, the applicant is requested to consider the following changes to the Actions table of Subsection 3.4.8.
>
> Note that these suggested changes are the staff's attempt to craft action requirements to
>
> - Limit the time that low inventory conditions are permitted with no shutdown cooling flow through the core to avoid onset of boiling in the core while in mid-loop operation;
> - Allow reasonable time to recover from a maintenance activity during mid-loop conditions (e.g., complete installation of nozzle dams or close the

steam generator manway) and establish an intermediate reactor vessel level, such as > 127 ft 1/4 in, or > 130 ft 0 in, following a loss of shutdown cooling, to increase the time to core uncovery; and

- If shutdown cooling is not restored, require initiating action to increase level until RCS loops are filled, which would exit the Mode of applicability for Specification 3.4.8; or transitioning to Mode 6 and raising level to 23 ft above the top of the reactor vessel flange, which would also exit the Mode of applicability for Specification 3.4.8.

In its response (ML16312A528) to RAI 481-8546, Question 16-149, regarding Sub-question 2C, the applicant declined to make the following staff suggested changes:

(1) Changes to Required Actions A.1 and B.2 ─ The staff suggested replacing the completion time of Immediately for Required Action A.1 (initiate action to restore the inoperable SC train to operable status) with a completion time of 4 hours to restore an inoperable SC train to operable status. The applicant responded that this could unduly delay operators taking the appropriate action, such as rapidly closing RCS openings that would otherwise preclude raising reactor vessel level to exit mid-loop conditions; also Subsection 3.4.8 Required Action A.1 matches equivalent STS Subsection 3.4.8 Required Action A.1. For the same reasons, the completion time of Immediately for Required Action B.2 (initiate action to restore one of two inoperable SC trains to operable status and operation), is not changed to 1 hour, since without forced flow through and diminished capability for heat removal from the core with the RCS in the mid-loop condition, there may not be an hour before boiling occurs. The staff finds not including the proposed changes to Required Actions A.1 and B.2 is acceptable for the reasons stated.

(2) Addition of new Required Action A.2 (within 4 hours raise RCS water level above 130 ft 0 in) and revision to Required Action B.3 (within 1 hour raise RCS water level above 130 ft 0 in) – Instead of specifying that the operator immediately initiate action to raise RCS level to > 127 ft 1/4 in for Condition B, the staff suggested a completion time of 1 hour to raise RCS water level to > 130 ft 0 in, for both Condition A and Condition B, to increase the time available before boiling commences in the event decay heat removal is lost in Mode 5 with RCS water level initially below 130 ft 0 in.

The applicant responded that the proposed Required Action A.2 was not needed because of the design feature of a containment spray pump being interchangeable with the inoperable SC pump in the same electrical division, which implies that recovery from Condition A would likely occur within a short time, and a low probability of a second SC train failing. Also, in Condition A, one SC train is still operable and in operation providing the needed core heat removal. The staff finds that not including proposed Required Action A.2 is acceptable for these reasons also recognizing that LCO 3.5.3 provides assurance that operators will be able to respond to an extended loss of decay heat removal and subsequent reactor coolant inventory loss by manual actuation of safety injection.

The applicant responded that the existing Required Action B.3 (immediately initiate action to raise RCS level to > 127 ft 1/4 in) of Subsection 3.4.8 is based on GL 88-17, which defines reduced RCS inventory as three feet below the reactor vessel flange, which for APR1400 corresponds to 127 ft 1/4 in. Since additional safety margin would be afforded by raising level to 130 ft, Required Action B.3 of Subsection 3.4.8 was tracked as an open item. Subsequently, the staff concluded that the requirement for two operable manual SI trains by LCO 3.5.3 in MODE 5 regardless of RCS water level, and in MODE 6 with reactor vessel level below 130 ft elevation provides adequate capability to mitigate a loss of shutdown cooling event or a loss of coolant event with vessel level below 127 ft 1/4 in elevation. Finding that Required Action B.3 is acceptable, RAI 481-8546, Question 16-149, Sub-question 2C2 is resolved.

(3) Addition of a Condition to address not meeting LCO 3.4.8 Note 4 regarding conditions on time (> 96 hours since reactor shutdown) and temperature (core exit temperature ≤ 135°F) that must be satisfied before beginning mid-loop operation. The applicant responded that it would add a similar Condition, as Condition E, that would apply when RCS level is in the mid-loop condition (≤ 119 ft 1 in, but > 117 ft 4 in, the minimum level for SCS operation), instead of the staff's proposal of < 127 ft 1/4 in. Also, the applicant stated it would replace the staff proposed phrase "< 96 hours since the reactor was last critical" with "< 96 hours after reactor shutdown" in the Condition statement. The need for Condition E resulted from an issue raised by the staff in RAI 232-7864 (ML16203A437), Question 19-6, that the technical specifications should ensure meeting the initial conditions assumed in the safety analysis of a loss of decay heat removal event in Mode 5 with reactor vessel level in the mid-loop condition. Therefore, using the mid-loop condition is acceptable, although the condition of reduced RCS inventory would afford additional safety margin (more time for operator action) to recover from a loss of decay heat removal event before initiation of boiling in the reactor vessel.

    The applicant also responded that the Required Actions to initiate action to restore core exit temperature to ≤ 135°F and to raise RCS level above the mid-loop condition would specify a Completion Time of Immediately, which is consistent with GL 88-17 recommendations on recovery actions. Therefore, the staff concludes that proposed Required Actions E.1 and E.2 are acceptable. Note that the applicant uses "core outlet temperature" in LCO Note 1 of Subsections 3.4.5, 3.4.6, 3.4.7, and 3.4.8, but "core exit temperature" elsewhere in Subsection 3.4.8; the staff concludes these terms refer to the same temperature instrumentation sensors and indication.

(4) In RAI 119-7976, Question 16-23, Sub-question 18, the staff requested that the applicant add provisions regarding operability of a containment spray pump in the same electrical division as the operating SC train in Mode 5 *with loops not filled* for consistency with LCO 3.9.5. In Attachment 4 to the applicant's response letter (ML16312A528) to RAI 481-8546, Question 16-149, the markup of Subsection 3.4.8 depicts changes to the LCO statement and LCO Note 3, and the addition of new Action C made in response to Question 16-23, Sub-question 18. As shown in the above markup of Subsection 3.4.8 provisions, the applicant proposed revising the LCO statement to require an operable containment spray pump in the same electrical division as the operating SC train, but not just when RCS level is < 127 ft 1/4 in, but when RCS loops are not filled, which occurs during an RCS draining evolution at approximately 134 ft, which is consistent with the Applicability of the LCO's operability requirement for the containment spray pump. Because LCO 3.4.8 requires an operable containment spray pump in Mode 5 roughly 7 feet

above the RCS level of 127 ft 1/4 in, the proposed applicability for the containment spray pump operability requirement is acceptable.

In Attachment 5 to the applicant's response letter (ML16312A528) to RAI 481-8546, Question 16-149, the markup of Subsection 3.9.5 depicts changes to the LCO statement and Required Action B.3 to replace the reduced RCS inventory defined term with < 127 ft 1/4 in, which is acceptable. With additional changes made in the responses (ML16182A594, ML17241A147) to RAI 478-8568, Question 16-140, Sub-question 4, LCO 3.9.5.b will state:

> b. When RCS level *is* < 127 ft 1/4 in, the containment spray pump in the same electrical division as an operating SC~~S~~ train shall be OPERABLE.

(5) The applicant declined to add to LCO 3.4.8 the staff's suggested default Action to initiate action to exit the Applicability, either by raising RCS level to the Mode 5 RCS loops filled condition, or the Mode 6 high RCS level condition; in both states, an operable SC pump is required to be in operation. Proposed Condition D stated "Required Action and associated Completion Time [of Condition A, B, or C] not met." The applicant pointed out that these actions would be impractical. Placing the unit in the loops filled condition according to the applicant would require an RCS vent operation including filling SG U-tubes to satisfy the LCO 3.4.7 allowance to use a SG for decay heat removal. Placing the unit in the Mode 6 with high water level to satisfy LCO 3.9.4 would require removing the reactor vessel closure head. Neither action can be accomplished before initiation of boiling in the reactor vessel, and both actions also require an operating operable SC train. Therefore not adopting the staff's suggested Action D is acceptable.

Based on the above evaluation of the applicant's response, RAI 481-8546, Question 16-149, Sub-question 2C, which was tracked as an open item regarding Required Action B.3 of Subsection 3.4.8, is resolved.

In RAI 481-8546, Question 16-149, Sub-question 2D, the staff suggested adding LCO 3.4.8 Note 4 to specify mid-loop reactor vessel level entry conditions that would apply below 127 ft 1/4 in. Since these entry conditions are assumptions in the analysis of a loss of decay heat removal event from the mid-loop condition, the staff finds the applicant's response (ML16312A528) to require meeting the mid-loop entry conditions of ≥ 96 hours after reactor shutdown and core exit temperature ≤ 135 °F only when in mid-loop operation, is acceptable. Therefore, RAI 481-8546, Question 16-149, Sub-question 2D, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2E, the staff observed that since proposed LCO 3.4.8 Note 4 specifies a core outlet (or exit) reactor coolant temperature of ≤ 57.2°C (135°F) as a precondition for reducing reactor vessel level to ≤ 119 ft 1 in (mid-loop operation), Subsection 3.4.8 needs to specify a corresponding Condition in the Actions table, and also an associated Surveillance Requirement. The above markup of Subsection 3.4.8 includes the staff's suggestions for such provisions. In its initial response (ML16312A528) to Question 16-149, regarding Sub-question 2E, the applicant proposed adding Action E, which is discussed above in the evaluation of Sub-question 2C, item (3). In addition, the applicant added SR 3.4.8.1 ("Verify core exit temperature is ≤ 135°F. | 15 minutes") as requested by the staff, but with a much shorter performance interval, and with a surveillance column Note that the SR is only required to be met in mid-loop operation, which the staff finds acceptable. The staff also finds the proposed Bases for SR 3.4.8.1 acceptable. Based on this and the above evaluation of Action E, RAI 481-8546, Question 16-149, Sub-question 2E, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2F, the staff requested that the applicant consider using the RCS level corresponding to just below the reactor vessel flange (130 ft) in place of the "reduced RCS inventory" level of 127 ft 1/4 in, as initially proposed by the staff in the above suggested LCO 3.4.8 Note 4 (Sub-question 2D) and Required Actions A.2, B.3, and C.2 (Sub-question 2C) because of the resulting greater reactor vessel water volume to mitigate a loss of decay heat removal event. As previously evaluated under Sub-question 2C, in its response (ML16312A528), the applicant adequately justified the cited requirements maintaining a level of 127 ft 1/4 in. Therefore, RAI 481-8546, Question 16-149, Sub-question 2F, for Subsection 3.4.8 is resolved. The staff notes that the scope of Sub-question 2F also applies to Subsections 3.5.3, 3.5.4, 3.6.7, 3.9.3, and 3.9.5; and associated Bases. For the same reasons, Sub-question 2F is also resolved for these Subsections.

The staff observed that the Bases for Subsections 3.4.7 and 3.4.8 do not explain what specific RCS configuration constitutes the RCS "loops filled" condition and RCS "loops not filled" condition. In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2K, the staff asked if the means of satisfying LCO 3.4.11, LTOP, (either using SC system operable suction relief valves, or an operable RCS vent flow path) would be a part of this explanation. That is, can the RCS be open (e.g., a vent flow path) and still be in the RCS loops filled condition?

In its second revised response (ML17291A634) to RAI 481-8546, Question 16-149, regarding Sub-question 2K, the applicant added the following passage to the Applicability section of the Bases for Subsection 3.4.8:

> In the MODE 5 with RCS loops not filled condition, the steam generators (SGs) cannot be used for core decay heat removal because the SG tubes contain water vapor voids or non-condensible gases that restrict the flow of reactor coolant through the SG tubes to less than the flow needed for adequate secondary heat transfer. The loops not filled condition is entered during draining of the RCS when the reactor coolant level is below 134 ft, which is about 28 ft below the highest SG tubes. Below this level, containment atmospheric pressure can no longer completely support the column of water remaining in the SG tubes above the reactor coolant level. At reactor coolant levels below 134 ft, water vapor voids begin forming in the horizontal portions of SG tubes, beginning with the highest tubes. The number of affected tubes increases as RCS level decreases until all tubes contain water vapor voids. SG tubes containing voids of water vapor, at the saturation temperature vapor pressure of the coolant in the tubes, block coolant flow and secondary heat transfer. When reactor coolant level has decreased to 119 ft 1 in (just above the high point of the hot leg), air can begin entering the hot leg through the surge line connection and displace the coolant remaining in the SG tubes. This results in the SG tubes being filled with non-condensible gases. The condition in MODE 5 with RCS water level within the top half of the hot legs is called mid-loop operation.
>
> Restoring the unit to the MODE 5 with RCS loops filled condition requires raising RCS level above 134 ft during a draining operation, provided no

> air was introduced into the SG tubes. Restoring the unit to the MODE 5 with RCS loops filled condition following mid-loop operation requires closing the pressurizer manway, filling the pressurizer, and dynamically venting non-condensible gases from the SG tubes and reactor vessel closure head using the Reactor Coolant Gas Vent (RCGV) System and the reactor coolant pumps (RCPs). A forced circulation by the RCPs in the MODE 5 with loops not filled condition is possible when the static head of the water from pressurizer water level establishes an RCS pressure high enough to run an RCP.

The staff finds this description of RCS conditions in Mode 5 for transitioning between an RCS loops filled condition and an RCS loops not filled condition complete and accurate. With this explanation, the staff concludes that the transition point to the RCS loops not filled state is clear (RCS level < 134 ft), and the transition back to the loops filled state is also unambiguous. Therefore, RAI 481-8546, Question 16-149, Sub-question 2K for Subsection 3.4.8 is resolved.

Discussion of the applicant's responses to Sub-questions 2G, 2H, 2I, 2J, 2L, 2K, and 2M of RAI 481-8546, Question 16-149, is provided in the evaluation of Subsection 3.6.7 (2G); Subsection 3.5.3 (2H, 2I); Subsection 3.3.6 (2J); Subsection 3.5.4 (2L), Subsection 3.4.7 (2K), and Subsection 3.9.5 (2M) in Section 16.4 of this SER.

The staff reviewed Subsection 3.4.8 and Subsection B 3.4.8 and verified that the LCO and associated applicability, action, and surveillance requirements for RCS loops and shutdown cooling (SC) trains are sufficient to ensure adequate core decay heat removal in Mode 5 with RCS loops not filled, which includes during reduced RCS inventory operation and mid-loop operation. Accordingly, the staff concludes that Subsection 3.4.8 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.8 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.8. The staff also verified that Subsections 3.4.8 and B 3.4.8 are consistent with the guidance in STS Subsections 3.4.8 and B 3.4.8, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.8 and Subsection B 3.4.8 are acceptable.

Subsection 3.4.9 Pressurizer

Subsection 3.4.9 includes requirements for maintaining required primary system pressure during steady state operation and limiting the pressure changes caused by reactor coolant thermal expansion and contraction during normal load transients.

Subsection 3.4.9 requirements on controls of pressurizer water level and operation of back-up pressurizer heaters match those in STS Subsection 3.4.9. There is no difference between the APR1400 design and the digital CE PWR design with respect to controls for operation of the pressurizer except design-specific numerical values for water level limits and backup heater capacity that are applicable to the APR1400 design. The staff's evaluation of these design parameters is provided in Section 5.4, "[RCS] Component and Subsystem Design," of this SER.

There were no RAI questions concerning Subsection 3.4.9. Based on its review, the staff concludes that Subsection 3.4.9 and Subsection B 3.4.9 are acceptable.

Subsection 3.4.10 Pressurizer Pilot Operated Safety Relief Valves (POSRVs)

In the APR1400 design, RCS overpressure protection is provided by pressurizer pilot operated pressure relief valves (POSRVs) instead of pressurizer safety valves (SRVs). Two spring-loaded pilot valves are employed to meet the single active failure criterion for the POSRV to fulfill its safety function. In addition to the lift setting pressure limit, a limit is also established for the POSRV opening time. The staff evaluation of the lift setpoints and opening times is provided in Section 5.2.2, "[RCS] Overpressure Protection," of this SER.

Subsection 3.4.10 requirements for POSRVs generally match those in STS Subsection 3.4.10 for SRVs, with additional requirements in the LCO statement and surveillance requirements to capture the POSRV unique design features, including the associated opening time.

The following table lists the RAI questions concerning Subsection 3.4.10.

Subsection 3.4.10 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.19	119-7976 ML15226A542 Response: ML17296A124	SR 3.4.10.6 – Clarified location of downstream isolation valves for each POSRV on DCD Figure 5.4.10-1.	CR	
16-23.20a	119-7976 ML15226A542 Response: ML17296A124	3.4.10 Applicability – Added Note about allowing 72 hours after entry into Mode 3 from Mode 4 to complete performance of POSRV opening time measurement and lift pressure setting; – revised to state: "...MODE 4 with <u>all</u> RCS cold leg <u>temperatures</u> ~~temperature~~..."	CC	
16-23.20b	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 Background section – Corrected third paragraph, last sentence: "...valves be set while in a hot condition."; for clarity, edited fourth and fifth paragraphs, and sixth paragraph, first sentence.	CC	
16-23.20c	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10-4 ASA section – For clarity, edited first paragraph; – In second paragraph, cited the FSAR Chapter 15 Subsection for "loss of load event with delayed reactor trip"; – Replaced third paragraph	CC	

Subsection 3.4.10 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		with "The pressurizer POSRVs satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii)."		
16-23.20d	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 LCO section –For clarity, edited first, second, and third paragraphs; edited fourth paragraph to explain how the POSRVs protect the DNBR reactor core Safety Limit of 1.29.	CC	
16-23.20e	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 Applicability section – First paragraph, explained why the four required POSRVs have no excess capacity in case one POSRV fails to open; – Second paragraph, removed redundant phrase in first sentence; explained how cold leg temperature being below low temperature overpressure protection (LTOP) enable temperature ensures LTOP is provided.	CC	
16-23.20f	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 SR section – Corrected inconsistencies between SR 3.4.10.2 and associated Bases. – Corrected last phrase of Bases for SR 3.4.10.3, as indicated: "then ~~it~~ <u>the POSRV</u> is OPERABLE ~~status~~." – Revised Bases sentence for the 18 month Frequency of SR 3.4.10.4 and SR 3.4.10.5; – Revised Bases for SR 3.4.10.6 by • replacing "changed position" with "repositioned' in second sentence, and • rewriting third sentence as indicated, "The ~~18-month~~ <u>18 month</u> Frequency is based on <u>the POSRVs being easily</u>	CC	

Subsection 3.4.10 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		accessible only ~~accessibility~~ during the shutdown conditions of a refueling ~~cycle~~ outage ~~and consideration of nuclear plant practices~~.		
16-23.20g	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 References section – FSAR Chapter 5 is adequate; declined to add a reference to the FSAR Subsection for “loss of load event with delayed reactor trip”	CR	
16-23.21	119-7976 ML15226A542 Response: ML17296A124	B 3.4.10 References section – FSAR Chapter 5 is adequate; declined to add FSAR Subsection 5.4.10 as a reference	CR	
16-108.1	289-8215 ML15307A004 Response: ML16027A196	B 3.4.10 Background section – Provided DCD locations that describe when and how the rapid depressurization function of the POSRVs is designed to be used	CR	
16-145.3	481-8546 ML16133A271 Response: ML16190A314 ML17244A055	3.4.10 – Added Applicability Note, which is stated in the deviation report	CC	See 16-148
16-146.1a	481-8546 ML16133A271 Response: ML16195A559	Corrected deviation report regarding STS SR 3.4.10.1 equivalence to SR 3.4.10.3	CC	
16-146.2d	481-8546 ML16133A271 Response: ML16195A559	3.4.10 – Clarified deviation report’s justification for Required Action B.2.2	CC	
16-148.1 16-148.2 16-148.3	481-8546 ML16133A271 Response: ML16190A314	3.4.10 Applicability Note – Added note to allow not meeting the LCO limits on POSRV opening time (SR 3.4.10.3c) and lift pressures (SR 3.4.10.3a, 3b)	CC	

Subsection 3.4.10 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		for 72 hours after Mode 3 entry provided a preliminary cold setting was made prior to heatup, consistent with STS 3.4.10.		
16-148.4	481-8546 ML16133A271 Response: ML16190A314	SR 3.4.10.3 – Corrected the as-left lift pressure setting limits for the POSRV pilot valves to within ± 0.75% of lift pressure setpoint. B 3.4.10 SR section – Made conforming changes to Bases for SR 3.4.10.3	CC	
16-148.5	481-8546 ML16133A271 Response: ML16190A314	LCO 3.4.10.b and SR 3.4.10.3 – Corrected the POSRV opening time limit to say "≤ 0.5 seconds"; B 3.4.10 SR section – Made conforming changes to Bases for SR 3.4.10.3	CC	
16-148.6 16-148.7	481-8546 ML16133A271 Response: ML16190A314	B 3.4.10 SR section – Clarified the phrase "including dead time" of LCO 3.4.10.b and SR 3.4.10.3, and in the Bases for SR 3.4.10.3; SR 3.4.10.3 – Made editorial improvements; B 3.4.10 – Made editorial improvements to Bases SR section	CC	

Status Codes:
RC Resolved Confirmatory
CR Closed Resolved with no DCD changes
CC Closed Confirmed

Although Subsection 3.4.10 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.10 and the deviation report.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 19, the staff requested that the applicant identify the location of the "downstream manual valves of [the] spring-loaded pilot valves" in DCD Tier 2, Figure 5.4.10-1, "Pilot Operated Safety Relief Valve Schematic Diagram," (underlined text is for emphasis) that are referred to in SR 3.4.10.6. Pending receipt of a response from the applicant, RAI 119-7976, Question 16-23, Sub-question 19 was tracked as an open item. In its response (ML17296A124) the applicant stated:

19. Downstream manual valves of spring-loaded pilot valves are shown on Figure 5.1.2-3. Valve tags are V310, V311, V312, V313, V314, V315, V316 and V317.

The staff finds this response provides the requested information. Therefore, Question 16-23, Sub-question 19, is resolved.

In RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 20, the staff requested that the applicant resolve inconsistencies between the scope of SR 3.4.10.2 requirements and the scope as described in the associated discussion in the Surveillance Requirements section of the Bases. The staff also requested that the applicant rewrite nearly all paragraphs in the Bases for Subsection 3.4.10 using correct and clear English. Pending receipt of a satisfactory response from the applicant, RAI 119-7976, Question 16-23, Sub-question 20, was tracked as an open item. In its response (ML17296A124) the applicant stated:

20. In DCD Rev. 1, the NOTE of LCO 3.4.10 was added in accordance with RAI 481-8546 Q16-148 with deviation in cold setting compared to STS 3.4.10. The LCO Note is needed to include cold setting requirement to comply with STS 3.410. The cold setting of the POSRVs should be performed before entry into MODE 4 in order to provide assurances that the valves are operable near their design condition for the POSRV tests. This cold setting may be performed in removed condition or installed condition before MODE 4 but it may have deviation from hot setting. Detailed acceptance criteria for cold setting will be developed at a site based on the information from the POSRV supplier considering the deviation from cold condition to hot condition to ensure the function of overpressure protection. The lift setting by cold setting does not need to meet the range of As-left setpoint in SR 3.4.10.3 because its purpose is to perform the tests in MODE 3 with overpressure protection and the lift settings will be verified and adjusted within the range of As-left setpoint in SR 3.4.10.3. The LCO Note will be revised.

Sub-question 20 included seven parts labeled a, b, c, d, e, f, and g. The staff reviewed the markups of Subsections 3.4.10 and B 3.4.10 associated with the response to each part, and found the changes improved the clarity of each section of the Specification and the Bases. Regarding the concern about there being no excess relief capacity for the four POSRVs, the applicant pointed out that having redundant spring loaded pilot valves for each POSRV ensures the POSRV's ability to open on demand in the event one pilot valve fails to operate. The staff acknowledges this feature of the POSRVs and has no further questions. Therefore, Question 16-23, Sub-question 20, is resolved.

In RAI 119-7976, Question 16-23, Sub-question 21, the staff requested that the applicant add the relevant FSAR Section 5.4.10, not just FSAR Chapter 5, to the References section of Subsection B 3.4.10. Pending receipt of a response from the applicant, RAI 119-7976, Question 16-23, Sub-question 21, was tracked as an open item. In its response (ML17296A124) the applicant explained that Chapter 5 is the correct reference for information about the limiting event used to design POSRV relief capacity. Therefore, Question 16-23, Sub-question 21 is resolved.

In RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 1a, the NRC staff requested that the applicant clarify the deviation report, which shows STS SR 3.4.10.1 ("Verify each pressurizer safety valve is OPERABLE in accordance with the Inservice Testing Program.") as being equivalent to generic TS SR 3.4.10.1 (“Verify open and close positions for the following valves in the main control room (MCR): ...”). In its response (ML16195A559) the applicant stated that it had “...intended to compare generic TS SRs 3.4.10.1 [through] 3.4.10.6 with STS SR 3.4.10.1 because pressurizer POSRVs have some different characteristics compared to typical pressurizer safety valves,” and added the following explanation to the deviation report for each of these SRs, which are listed in Table III-1 on pages 71 and 72 of Revision 1 of the deviation report. However, this explanation was further edited in Revision 2 on pages 100 and 101, as shown by markup of the Revision 1 version:

> ~~The deviations reflect the APR1400 plant specific Pressurizer Safety Valve that is the Pressurizer POSRV.~~ The SRs reflect ~~Pressurizer~~ POSRV characteristics. The testing and inspection for ~~Pressurizer~~ POSRVs are given in DCD Section 5.2.2.10.

In addition, on page 72 of Revision 1 of the deviation report, the applicant clarified the justification for not including an LCO equivalent to STS LCO 3.4.11, “Pressurizer Power Operated Relief Valves (PORVs).” However, this explanation was further edited in Revision 2 on page 101, as shown by markup of the Revision 1 version:

> There is no PORV in ~~the~~ APR1400 (plant specific)~~, and STS 3.4.11 is considered not exactly equivalent to generic TS 3.4.16, “Reactor Coolant Gas Vent (RCGV) Function,” for the purpose of mitigating a steam generator tube rupture (SGTR) event since the SGTR safety analysis does not take credit for the RCGV function in APR1400~~.

Finding these clarifying changes acceptable, staff concludes that RAI 481-8546, Question 16-146, Sub-question 1a, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-146, Sub-question 2d, the NRC staff requested that the applicant clarify the deviation report’s justification for including Subsection 3.4.10 Required Action B.2.2 (“<u>OR</u> Be in MODE 4 on shutdown cooling with the requirements of LCO 3.4.11 met.”), which is an action requirement not included in corresponding STS Subsection 3.4.10 Action B. In its response (ML16195A559) the applicant stated, “The Required Action B.2.1 in the generic TS 3.4.10[, which nearly matches STS 3.4.10 Required Action B.2,] requires only the LTOP temperature. However, when the POSRVs are inoperable and the RCS [temperature and pressure] decrease[s] to LTOP conditions, additional actions like [those proposed in] LCO 3.4.11 are needed.” The applicant also revised the justification (in Table III-1 on page 71 of Revision 1 of the deviation report (page 99 of Revision 2) as indicated:

> ~~The REQUIRED ACTIONs reflect the APR1400 design.~~ <u>The deviations reflect the APR1400 plant specific design for LTOP operable conditions.</u> When the POSRV(s) are inoperable<u> and the RCS decreases to LTOP conditions</u>, LTOP relief valves shall be aligned for OPP [overpressure protection]. Alignment of LTOP relief valves can be allowed by meeting <u>LCO 3.4.11 </u>conditions by reducing the cold leg temperature down to the LTOP enable temperature and by opening SCS isolation valves.

The staff finds that this response is acceptable because it clarifies the need for proposed Required Action B.2.2. Since the SCS suction relief valves are used as a means of LTOP in the APR1400 design, instead of the pressurizer PORVs as in typical previous CE PWR designs, specifying alternate Required Action B.2.2 will allow for a smooth transition from the Mode 4 applicability of LCO 3.4.10 to the Mode 4 applicability of LCO 3.4.11. Therefore, RAI 481-8546, Question 16-146, Sub-question 2d, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-148, Sub-questions 1 through 7, the staff requested that the applicant make technical corrections and editorial improvements to the Subsection 3.4.10 Applicability Note and SR 3.4.10.3, including conforming changes to the Bases. In its response (ML16190A314) the applicant made the changes described in the above table listing RAI questions about Subsection 3.4.10. Indicative of most of these changes are the following markups of the DCD Revision 0 version of LCO 3.4.10 and associated Applicability; and SR 3.4.10.3 and its Bases explanation of “dead time” (additional staff suggested edits are highlighted in gray). (Note that specification and bases formatting, such as indentation and table column widths are utilized in these markups.) As discussed above, the response to RAI 119-7976, Question 16-23, Sub-question 20, reinstated the phrase at the end of the STS Subsection 3.4.10 Applicability Note regarding a preliminary cold setting of the POSRVs, and also inserted the word “each” before “POSRV”:

APPLICABILITY: MODES 1, 2, and 3,
MODE 4 with all RCS cold leg temperatures greater than the LTOP enable temperature specified in the PTLR.

------------------------------------NOTE---
The opening time measurement and lift pressure setting of each POSRV are not required to be within LCO limits during MODES 3 and 4 for the purpose of setting the POSRVs under ambient (hot) conditions. This exception is allowed for 72 hours following entry into MODE 3 provided a preliminary cold setting was made prior to heatup.

SR 3.4.10.3 ~~Verify~~ For each pressurizer POSRV ~~meets the following~~:

a. ~~The~~ Verify lift pressure settings of each of the two spring-loaded pilot valves are set ~~within limit (~~ ≥ 171.1 kg/cm^{2}A (2,433 psia) and ≤ 176.3 kg/cm^{2}A (2,507 psia)~~)~~. ~~Adjust lift settings within limit if lift setting pressure ≥ 172.4 kg/cm^{2}A (2,451.4 psia) and ≤ 175.0 kg/cm^{2}A (2,488.5 psia).~~

b. Adjust each spring-loaded pilot valve, as necessary, so that the lift pressure ~~settings are~~ setting is ≥ 172.4 kg/cm^{2}A (2,451.4 psia) and ≤ 175.0 kg/cm^{2}A (2,488.5 psia).

~~b~~c. ~~Opening~~ Verify opening time of pressurizer POSRV ~~shall be within~~ is ≤ 0.5 seconds, including dead time.

SR 3.4.10.3

... The specified pressurizer POSRV opening time including dead time of 0.5 seconds or less is consistent with the safety analyses. The dead time is from when the pressure reaches the spring-loaded pilot valves' opening setpoint until the main valve begins to move (open). ...If the two spring-loaded pilot valves ~~per valve~~ of a pressurizer POSRV both satisfy the requirements of lift setting and opening time, then ~~it~~ the pressurizer POSRV is OPERABLE ~~status~~.

The applicant stated it had originally intended to incorporate the same requirements presented in the Applicability Note for STS LCO 3.4.10, but omitted the phrase "provided a preliminary cold setting was made prior to heatup." The applicant reasoned the phrase is not necessary because the plant operators need to test, verify and adjust the lift set pressure and the opening time of the POSRVs in Mode 3. Accordingly, the applicant proposed to delete this phrase. However, as discussed above, the response to RAI 119-7976, Question 16-23, Sub-question 20, reinstated the phrase. The staff verified that DCD Revision 1, GTS Subsections 3.4.10 and B 3.4.10 incorporated the changes indicated above. The staff finds that the applicant's response is acceptable because it results in a technically correct and clear set of requirements and Bases for the pressurizer POSRVs in Subsections 3.4.10 and B 3.4.10, respectively. Therefore, RAI 481-8546, Question 16-148, Sub-questions 1 through 7, are resolved.

The staff reviewed Subsection 3.4.10 and Subsection B 3.4.10 and verified that the LCO and associated applicability, action, and surveillance requirements for pressurizer POSRVs are sufficient to ensure their operability in Modes 1, 2, and 3, and in Mode 4 with all cold leg temperatures above the LTOP enable temperature, so that if an event occurs involving an increasing pressure transient, RCS pressure does not exceed the RCPB Safety Limit of 110 percent of design pressure. Accordingly, the staff concludes that Subsection 3.4.10 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.10 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.10. The staff also verified that Subsections 3.4.10 and B 3.4.10 are consistent with the guidance in STS Subsections 3.4.10 and B 3.4.10, and STS Subsections 3.4.11 and B 3.4.11, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.10 and Subsection B 3.4.10 are acceptable.

Subsection 3.4.11 Low Temperature Overpressure Protection (LTOP) System

Subsection 3.4.11 includes requirements for low temperature overpressure protection (LTOP) of the reactor coolant pressure boundary (RCPB). This LCO requires the LTOP function to be operable at low reactor coolant temperatures to prevent reactor coolant pressure from reaching a pressure that could compromise RCPB integrity. Unlike the typical digital CE PWR design, which is assumed in the STS, that uses the pressurizer power operated relief valves (PORVs) for LTOP, the APR1400 design uses the two shutdown cooling system (SCS) suction line relief valves for LTOP. The staff's evaluation of LTOP is provided in Section 5.2.2, "Overpressure Protection," of this SER.

Subsection 3.4.11 LTOP requirements also differ from those in corresponding STS Subsection 3.4.12 in other ways. The Subsection 3.4.11 LCO statement specifies (1) no restrictions on the rate of mass input into the RCS from the safety injection (SI) pumps and charging pumps; (2) no requirements to prevent inadvertent discharge from the safety injection tanks (SITs); and (3) no upper limit on pressurizer water level as one of the pre-conditions for starting a reactor coolant pump (RCP) when LTOP requirements are in effect.

The following table lists the RAI questions concerning Subsection 3.4.11.

Subsection 3.4.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-108.2	289-8215 ML15307A004 Response: ML16027A196	B 3.4.11 – for consistency with STS level of detail regarding LTOP design (APR1400 requirements for SCS suction line relief valve capacity, RCS vent area, and RCP start criterion), revised: • Background section, first and third paragraphs; • ASA section, first, second, and third paragraphs; and • entire LCO section	CU	16-152.1b
16-108.3	289-8215 ML15307A004 Response: ML16027A196	B 3.4.11 Background section – Removed sentence in third paragraph about operator action terminating increasing pressure events at low RCS temperatures	CC	
16-108.4	289-8215 ML15307A004 Response: ML16027A196	B 3.4.11 References section – Revised Reference 3 from DCD Tier 2, Chapter 15 to DCD Tier 2, Chapter 5	CC	
16-108.5	289-8215 ML15307A004 Response: ML16027A196	B 3.4.11 Applicability section – Clarified first sentence by removing the phrase “during heatup”	CC	
16-108.6	289-8215 ML15307A004 Response: ML16027A196	B 3.4.11 Actions section – Revised Bases to be consistent with Required Actions A.1 and A.2	CC	
16-152.1a	481-8546 ML16133A271 Responses: ML16196A271 ML16197A426 ML16250A189 ML16337A102 ML17244A629	3.4.11 LCO statement “a” – Removed LTOP relief valve lift setting value, because this value is maintained in the PTLR, which the statement references	CC	
16-152.1b	481-8546 ML16133A271 Responses: ML16196A271	B 3.4.11 Background section – Appended to first paragraph “The required vent capacity may be	CC	

Subsection 3.4.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16197A426 ML16250A189 ML16337A102 ML17244A629	provided by opening one or more vent paths.” – Clarified the last sentence of the revised Background section, which was proposed in response to 16-108.2 B 3.4.11 ASA section – Replaced paragraph regarding SCS suction line relief valve performance – Replaced paragraph regarding RCS vent performance B 3.4.11 LCO section – Clarified second sentence of first paragraph – Third paragraph, replaced ‘proven’ in phrase “... and testing has demonstrated ~~proven~~ its ability to open ...”		
16-152.2a	481-8546 ML16133A271 Responses: ML16196A271 ML16197A426 ML16250A189 ML16337A102 ML17244A629	3.4.11 LCO statement - Justified omission of the STS LCO 3.4.12 restriction on the number of charging pumps capable of injecting coolant into the RCS	CR	
16-152.2b	481-8546 ML16133A271 Responses: ML16196A271 ML16197A426 ML16250A189 ML16337A102 ML17244A629	3.4.11 LCO statement - Justified omission of the STS LCO 3.4.12 requirement that the SITs be isolated	CR	

Status Codes:

CU	Closed Unresolved (has follow up question)	RC	Resolved Confirmatory
CR	Closed Resolved with no DCD changes	CC	Closed Confirmed

Although Subsection 3.4.11 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Section 3.4.11 and the deviation report.

The staff found that the deviation report (Rev. 1) did not provide sufficient information to explain and justify why LCO 3.4.11 omits the three requirements of STS LCO 3.4.12, described above.

In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 2, the staff requested that the applicant add additional information to the Background and Applicable Safety Analyses (ASA) sections of the Bases for Subsection 3.4.11, so that these sections are comparable to the discussion in the Bases for STS Subsection 3.4.12 regarding the LTOP design requirements for relief valve flow capacity (the SCS suction line relief valve capacity) and the minimum size of the RCS vents. In its response (ML16027A196) the applicant proposed changes to the Background, Applicable Safety Analyses (ASA), and LCO sections of the Bases for Subsection 3.4.11. In particular, the first sentence of the Background section was replaced with the first sentence from the STS ("The LTOP System controls RCS pressure at low temperatures so the integrity of the reactor coolant pressure boundary (RCPB) is not compromised by violating the pressure and temperature (P/T) limits of 10 CFR Part 50, Appendix G (Ref. 1)."). In addition, the third paragraph of the Background section was replaced with a detailed discussion of the SCS relief valve capacity and vent sizing required for LTOP. The staff found that these changes provided the requested information. However, the staff considered Sub-question 2 to be closed but unresolved, because the staff noted additional needed improvements to Subsection B 3.4.11. For example, the last sentence of the revised Background section needs clarification:

> For an RCS vent to meet the specified flow capacity, it requires removing a pressurizer manway that located above the level of reactor coolant, so as not to drain the RCS when open.

In follow up RAI 481-8546 (ML16133A271), Question 16-152, Sub-question 1b, the staff requested that the applicant clarify the above proposed sentence, as well as the other noted sentences of Subsection B 3.4.11 in need of clarification. In its initial response and first revised response letters (ML16196A271, ML16197A426) to Question 16-152, the applicant addressed Sub-question 1b by proposing the following revision to the above sentence; the markup shows additional changes suggested by the staff for clarity:

> For an RCS vent to meet the specified flow capacity, ~~it requires removing~~ a pressurizer manway ~~that its~~, with a flow area ~~is more~~ greater than the flow area of one ~~of the~~ SCS suction line relief valve discharge ~~paths~~ path, must be opened. ~~Thus, opening the~~ An open pressurizer manway vent of this size ensures that the capabilities of the vent ~~exceeds~~ exceed the pressure relieving requirements of the limiting RCS pressure transient. The ~~pressurizer manway is located above the~~ level of reactor coolant in the RCS must be below the elevation of the pressurizer manway, which is opened for LTOP, ~~so as not~~ to avoid draining reactor coolant from ~~drain~~ the RCS through the ~~when~~ open manway.

In addition, the applicant appended a new sentence to the first paragraph about RCS vent requirements in the Background section of the Bases, as indicated:

> Once the RCS is depressurized, a vent exposed to the containment atmosphere will maintain the RCS at containment ambient pressure in an RCS overpressure transient, if the relieving requirements of the transient do not exceed the capabilities of the vent. Thus, the vent path must be capable of relieving the flow resulting from an RCS overpressure transient and maintaining pressure below

> the P/T limits. The required vent capacity may be provided by opening one or more vent paths.

The staff finds that the added sentence is acceptable because it clarifies that two or more RCS openings may be employed to provide the required vent flow area of 28 square inches, which corresponds to an approximately 6 inch diameter circular opening.

In the first revised response (ML16197A426) to Question 16-152, Sub-question 1b, the staff noted that the revised ASA section of the Bases for Subsection 3.4.11 also needed clarification, and suggested the changes indicated by the following markups of the affected sentences:

> SCS suction line relief valve Performance
>
> The two SCS suction line relief valves ~~are opened~~ open when ~~if~~ the RCS pressure increases to the ~~LTOP~~ relief valve opening setpoints for LTOP. When SCS suction line relief valves ~~are opened in~~ open during an increasing pressure transient, the release of coolant ~~causes~~ slows the rate of pressure increase ~~to slow~~ and limits the peak RCS pressure to below the P/T limits.
>
> RCS Vent Performance
>
> With the RCS depressurized, a vent ~~size~~ with at least the flow area of ~~more than~~ one ~~of~~ SCS suction line relief valve ~~flow area~~ is capable of mitigating the limiting ~~allowed LTOP overpressure~~ increasing pressure transient. ~~In that event,~~ An RCS vent of this size ~~vent maintains~~ will limit peak RCS pressure ~~less than the maximum RCS pressure on~~ to below the P/T limits.

In addition, the staff noted that the revised LCO section of Subsection B 3.4.11 also needed clarification, and suggested the changes indicated by the following markups of the affected sentences:

> (first sentence) This LCO is required to ensure that the LTOP System is OPERABLE. The LTOP System is OPERABLE when ~~one of the limiting low temperature overpressurization transients occurs and its pressure relief capabilities are~~ ~~OPERABLE~~ it is capable of preventing over pressurization of the RCPB in the event of the limiting low temperature overpressurization transient.
>
> (third paragraph) ~~A~~ An SCS suction line relief valve is OPERABLE for LTOP when its lift setpoint is set within the limits specified in the P/T limits and testing has ~~proven~~ demonstrated its ability to open at that setpoint.

Pending receipt of a revised response addressing the above clarifications suggested by the staff, RAI 481-8546, Question 16-152, Sub-question 1b, was tracked as an open item. In its supplemental response (ML17244A629) to Question 16-152, regarding Sub-question 1b, the applicant incorporated the suggested clarifications. Therefore, RAI 481-8546, Question 16-152, Sub-question 1b, is resolved.

In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 3, the staff requested that the applicant clarify the following sentence of the third paragraph of the Background section: "The open RCS vent or the SCS suction line relief valves are the overpressure protection devices which provide backup to the operator in terminating increasing pressure events." In its response (ML16027A196) the applicant stated, "Operator action is not required for terminating

RCS pressure increasing transients during low temperature conditions," and deleted the subject sentence. This change is acceptable because the sentence does not reflect the APR1400 design's reliance on either the open vent path or the relief valves to ensure LTOP of the RCPB. Therefore, RAI 289-8215, Question 16-108, Sub-question 3, is resolved.

In the ASA section of the Bases for Subsection 3.4.11, the first sentence states, "Safety analyses (Reference 3) demonstrate that the reactor vessel is adequately protected against exceeding the P/T limits during shutdown." DCD Tier 2, Chapter 15 is listed as Reference 3. The staff could not identify any design basis events described in Chapter 15 for which LTOP is needed or assumed. In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 4, the staff requested that the applicant revise the TS Bases to reference the applicable DCD section. In its response (ML16027A196) the applicant stated it will revise Reference 3 from Chapter 15 to Chapter 5, since the design bases for LTOP are provided in DCD Tier 2, Section 5.2.2.1.2 (Design Bases for LTOP) and Section 5.2.2.2.2 (Design Evaluation for LTOP). The staff finds that this response is acceptable. Therefore, RAI 289-8215, Question 16-108, Sub-question 4, is resolved.

In the Applicability section of the Bases for Subsection 3.4.11, the first sentence states, "This LCO is applicable in MODE 4 with the temperature of *any* RCS cold leg less than or equal to the LTOP enable temperature specified in the PTLR *during heatup*, in MODE 5, and in MODE 6 with the reactor vessel head on." In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 5, the staff requested that the applicant replace the term "heatup" with "cooldown" to reflect the actual plant evolution described in DCD Tier 2, Subsection 5.4.7. In its response (ML16027A196) the applicant stated, "During RCS heatup and cooldown, RCS cold leg temperature remains less than or equal to the LTOP enable temperature," and proposed to remove the phrase "during heatup." The staff finds that this response is acceptable. Therefore, RAI 289-8215, Question 16-108, Sub-question 5, is resolved.

In the Actions section of the Bases for Subsection 3.4.11, the first four sentences of the discussion of Required Actions A.1 and B.1 state (emphasis added):

> With one SCS suction line relief valve inoperable, overpressure relieving capability is reduced. The other SCS suction line relief valve remains OPERABLE *or the RCS must be depressurized through an open vent. Either of these paths* provides adequate overpressure protection. However, redundancy has been lost.

Required Actions A.1 and B.1 both state, "Restore required SCS suction line relief valve to OPERABLE status." Neither specifies the option to depressurize the RCS through an open vent. In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 6, the staff requested that the applicant revise the Bases to be consistent with the stated action requirements. In its response (ML16027A196) the applicant removed the inconsistent information, as follows:

> With one SCS suction line relief valve inoperable, overpressure relieving capability is reduced. The other SCS suction line relief valve remains OPERABLE ~~or the RCS must be depressurized through an open vent. Either~~ <u>and one</u> of these paths provides adequate overpressure protection. However, redundancy has been lost.

The staff finds that this response is acceptable. Therefore, RAI 289-8215, Question 16-108, Sub-question 6, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-152, Sub-question 1a, the staff requested that the applicant revise the Subsection 3.4.11 LCO statement to remove the explicit pressure value of the setpoint for opening the SCS suction line relief valves, since the statement refers to the lift settings specified in the PTLR. This request reflects the staff's recommendations in GL 96-03, "Relocation of the Pressure Temperature Limit Curves and Low Temperature Overpressure Protections System Limits." In its revised response (ML16250A189) to Question 16-152, regarding Sub-question 1a, the applicant proposed to revise the LCO statement as requested and indicated by the following markup of LCO 3.4.11.a.

> Two OPERABLE Shutdown Cooling System ~~shutdown cooling system~~ (SCS) suction line relief valves with lift settings ~~≤ 37.3 kg/cm²G (530 psig)~~ specified in the PTLR, or

The staff finds this response acceptable because the revised statement conforms to guidance in the STS about referring to the LTOP relief valve lift settings specified in the PTLR instead of providing explicit values for these settings in the LCO statement. Therefore, RAI 481-8546, Question 16-152, Sub-question 1a, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-152, Sub-question 2a, the staff requested that the applicant discuss whether generic TS 3.4.11 should include an SR to verify that the charging flow restriction orifices limit the flow rate from both charging pumps to the flow of one charging pump. In its first revised response (ML16197A426) to Question 16-152, the applicant responded to Sub-question 2a as follows:

> Only one charging pump is assumed to be in operation (Refer to DCD Tier 2, Subsection 5.2.2.2.2.1). There are two centrifugal charging pumps [CCP] in CVCS. Only one CCP runs during the plant operational modes and the other CCP is in standby mode. The standby CCP is not running during any modes of operation except for pump switching operation. Thus, only one CCP is considered to operate in calculating the mass addition during LTOP condition. Additionally CVCS charging line has charging flow restricting orifices which limit the charging flow when the RCS pressure is low. The charging flow is restricted to 150 gpm by the flow restricting orifices when the RCS pressure is low. However in the calculation of the mass addition a charging flow of 200 gpm is considered for additional conservatism. A SR to verify that the charging pump flow restrictor limits the flow rate from both charging pumps to the flow of one charging pump is not required.

The staff finds that this paragraph fails to provide the requested information. In the unlikely event that both centrifugal charging pumps were running during LTOP conditions in Mode 4, Mode 5, or Mode 6 with the reactor vessel closure head on, the staff needs to understand how the operator would have assurance that CVCS charging flow would still be restricted to the flow of one charging pump, which was assumed (along with flow from the four safety injection pumps) in determining the design mass flow capacity of the SCS suction line relief valves. Pending clarification of the response to address this concern, RAI 481-8546, Question 16-152, Sub-question 2a, was tracked as an open item.

In its supplemental response (ML17244A629) to Question 16-152, regarding Sub-question 2a, the applicant stated that the "switch-over operation of the charging pumps will be performed during power operation only for in-service test purpose. During shutdown operation only one charging pump will be operated." In addition, the response stated that "during shutdown operation, CV-576 shall be closed administratively with power removed by the operator when [RCS] pressure reaches 700 psig as per ‘Background’ of LCO B 3.1.8 of DCD, Tier 2, Rev. 1. The response concluded that “there is no challenge that the charging flow will exceed 180 gpm, which is less than [the] 200 gpm assumed in [the] LTOP analysis, when RCS pressure is below 700 psig.” Regarding an SR to verify that the flow restricting orifices limit charging flow to 180 gpm with CV-576 closed, and 150 gpm with CV-577 also closed, the response further concluded that such an SR is not needed because these limits are verified by ITAAC 9.d, which is stated in Table 2.4.6-4 of DCD, Tier 1, Rev. 1. The staff concludes that ITAAC 9.d will demonstrate these flow limits are met with just one centrifugal charging pump in operation. This is acceptable because of the LCO 3.1.8 restriction on charging flow, the administrative control to close and remove electrical motive power from CV-576 below 700 psig, the administrative control that allows running just one CCP in other than Mode 1, and only briefly during CCP switchover when in Mode 1 (while meeting the flow limit of LCO 3.1.8), and the LCO 3.1.12 requirement to isolate unborated water sources when RCPs are idle, including during mid-loop conditions.

Since the charging flow of one CCP will be restricted as stated by diverting flow through the orifices, which will have been verified by testing as required by ITAAC 9.d, the staff concludes that an SR to periodically repeat the flow verification of ITAAC 9.d is not necessary. These charging flow limits are based on the assumed charging flow of the inadvertent boron dilution event in MODES 1, 2, 3, 4, and 5 with any reactor coolant pump (RCP) in operation (the 180 gpm limit); and in MODE 5 with RCS loops not filled (RCP operation not allowed) and RCS level < 119 ft 1 in (mid-loop operation) (the 150 gpm limit), which KHNP had initially proposed to be ensured by the LCO 3.1.8 requirement that two flow restricting orifice bypass valves (CV-576 and CV-577) be closed during mid-loop operation. LCO 3.4.8, “RCS Loops – MODE 5 (loops not filled),” also requires that before entering the mid-loop condition, the reactor must have been shutdown for ≥ 96 hours and that core exit temperatures must be maintained ≤ 135°F. The 150 gpm requirement need not be explicitly specified in LCO 3.1.8, however, because proposed LCO 3.1.12, “Unborated Water Source Isolation Valve – MODES 4 and 5,” will require isolation of unborated water sources when all RCPs are idle in Modes 4 and 5. But, to ensure the 180 gpm limit is satisfied when one or more RCPs are in operation (which ensures adequate mixing of boric acid in the reactor coolant and the validity of the boron dilution alarm system setpoints), the applicant has revised LCO 3.1.8 to explicitly require that charging flow be maintained below 180 gpm in Modes 1, 2, 3, 4, and 5. Considering that (1) revised LCO 3.1.8 will ensure that the charging flow limit of 180 gpm will not be exceeded, (2) normal operating practice is to operate just one centrifugal charging pump at a time, and (3) the charging flow assumption in the SCS suction line relief valve capacity sizing calculation is 200 gpm, the staff concludes that the capacity of the SCS suction line relief valves is adequate. Therefore, RAI 481-8546, Question 16-152, Sub-question 2a, is resolved

In RAI 481-8546 (ML16133A271), Question 16-152, Sub-question 2b, the staff requested that the applicant discuss omission of the STS LCO 3.4.12 requirement for SIT isolation in LCO 3.4.11. On page 73 of Revision 1 (page 23 in Section III.5.2.2 of Revision 2) of the deviation report, the justification for this omission states:

> SIT operating pressure is 610 psig and SIT discharge cannot pressurize over LTOP limit pressure of 625 psia because RCS pressure can be assumed to be less than 450 psia (SCS cut in pressure), and RCS volume is larger than SIT. Therefore, there is no need to include SIT isolation in the APR1400 Technical Specification.

The staff notes that this discussion seems inconsistent with LCO 3.4.11.a, which requires SCS suction line relief valves with lift settings ≤ 37.3 kg/cm^{2}G (530 psig). The staff requested that the applicant explain this apparent inconsistency. In its first response (ML16197A426) to Question 16-152, the applicant responded to Sub-question 2b as follows:

> Normal operating pressure of SIT is 610 psig. When RCS pressure is decreased below 640 psia, the SIT pressure is lowered to 400 psig. When RCS pressure reaches 475 psia, the SIT discharge line is isolated. During heatup, the SIT isolation valves automatically open when RCS pressure reaches 600 psia. The operator repressurizes the SIT to 610 psig once RCS pressure reaches 640 psia. The SCS is put into operation for normal shutdown cooling below the RCS pressure of 450 psia. The lowered SIT pressure (400 psig) cannot pressurize the RCS during a low temperature condition. Therefore, the requirement for SIT isolation in LCO 3.4.11 is not necessary.

The response seems to say that, according to the plant procedure for RCS cooldown and depressurization below 475 psia (460 psig) in Mode 4 and Mode 5, the SIT discharge isolation valves are required to be closed to preclude SIT discharge when RCS pressure goes below the SIT pressure of 400 psig (415 psia). Since SIT injection flow was not considered in determining the design mass flow capacity of the SCS suction line relief valves, it appears that SIT isolation would satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii), at least when RCS pressure is reduced below the SIT pressure during LTOP conditions. Pending additional justification for omitting, or inclusion of a requirement for SIT isolation in LCO 3.4.11, RAI 481-8546, Question 16-152, Sub-question 2b, was tracked as an open item.

In its supplemental response (ML17244A629) to Question 16-152, regarding Sub-question 2b, the applicant stated

> Each LTOP relief valve is sized to accommodate the all SIP injections and a maximum 200 gpm of charging for a mass addition transient. This capacity is greater than the total SIT blowdown flow rates. For this reason a CONDITION for SIT isolation failure does not need. As described in responses to 2a, overflow of charging pump should not be considered in LTOP operation.

The response implies that the capacity sizing determination of an SCS suction line relief valve is not required to assume flow from an SIT (at 400 psig) to occur simultaneously with the flow of four SI pumps and a charging flow of 200 gpm. It further points out that the assumed flow from the SI system and the CVCS system are greater than the flow from an SIT (at 400 psig) when RCS pressure is below 400 psig in Modes 4 and 5. And so, the capacity is adequate to relieve a mass addition transient resulting from inadvertently unisolating an SIT. The staff considers that the implied assumption is reasonable because of the low probability of an SIT blow down concurrent with an event requiring manual actuation of four trains of safety injection with an existing charging flow of 200 gpm. The staff finds that explicitly requiring isolation of the SITs in LCO 3.4.11 is not necessary to ensure adequate LTOP in Modes 4 and 5, and in Mode 6 with the reactor vessel closure head on, and that SIT isolation does not satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii) in these Modes. Therefore, RAI 481-8546, Question 16-152, Sub-question 2b, is resolved.

The staff reviewed Subsection 3.4.11 and Subsection B 3.4.11 and verified that the LCO and associated applicability, action, and surveillance requirements are adequate to ensure the operability of the LTOP function to prevent RCS pressure from reaching a pressure that could compromise RCPB integrity in Mode 4 with any cold leg temperature less than the LTOP enable temperature, in Mode 5, and in Mode 6 when the reactor vessel closure head is on. Accordingly, the staff concludes that Subsection 3.4.11 satisfies paragraphs (1)(ii)(A), (2), and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.11 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.4.11. The staff also verified that Subsections 3.4.11 and B 3.4.11 are consistent with the guidance in STS Subsections 3.4.12 and B 3.4.12, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.11 and Subsection B 3.4.11 are acceptable.

Subsection 3.4.12 RCS Operational LEAKAGE

Subsection 3.4.12 includes requirements for limiting unit operation in the presence of RCS operational leakage to amounts that do not compromise safety. This subsection specifies limits on the amount of leakage for each type of RCS operational leakage, which are RCPB leakage, unidentified leakage, identified leakage, and primary-to-secondary leakage. The term "Leakage" is defined in Section 1.1.

The following table lists the RAI questions concerning Subsection 3.4.12.

Subsection 3.4.12 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
5.4.2.2-3	299-8310 ML15314A024 Response: ML16062A276	B 3.4.12 SR section – revised Bases for SR 3.4.12.2 to match STS	CC	
5.4.2.2-6.a	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.12 ASA section – restored first sentence to match STS	CC	
5.4.2.2-6.b	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.12 ASA section, first paragraph – changed primary to secondary leakage assumption to that for both SGs – 2.27 L/min (0.6 gpm) for main steam line break	CC	
15.0.3-2.d	108-7973 ML15206A005 Responses: ML16130A546 ML16201A274 ML17234A540	B 3.4.12 ASA section, first paragraph – Provided information about primary coolant activity concentration calculations	CC	
16-50	162-8055 ML15235A003 Response:	SR 3.4.12.1 - surveillance column Notes 1 and 2 should	CC	

Subsection 3.4.12 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML15301A207	be labeled "NOTES" instead of "NOTE"		

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although Subsection 3.4.12 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Section 3.4.12 and the deviation report.

The markup of page B 3.4.12-6 in the attachment to the enclosure of the applicant's letter (ML16062A276) in response to RAI 299-8310, Question 5.4.2.2-3, included two changes to the Bases for SR 3.4.12.2. One change corrected the first sentence to say "This SR verifies that primary to secondary LEAKAGE is less <u>than</u> or equal to 0.39 L/min (150 gpd) through any one SG. The other change appended a statement to the second paragraph as indicated:

> The 0.39 L/min (150 gpd) limit is measured at room temperature as described in Reference 5. The operational LEAKAGE rate limit applies to LEAKAGE through any one SG. <u>If it is not practical to assign the leakage to an individual SG, all the primary to secondary LEAKAGE should be conservatively assumed to be from one SG.</u>

The staff finds these changes acceptable because they match the same discussion in the STS Bases for equivalent SR 3.4.13.2, and are technically correct for the APR1400 design. See evaluation of Subsection 3.4.17 below for the staff's assessment of the other changes made in response to RAI 299-8310, Question 5.4.2.2-3.

In its response (ML16208A488) to Sub-question "a" of RAI 494-8620, Question 5.4.2.2-6, the applicant stated that it will retain the opening phrase, indicated here using italics, in the first sentence of the Applicable Safety Analyses (ASA) section of GTS Subsection B 3.4.12: "*Except for primary to secondary LEAKAGE, the* safety analyses do not address operational LEAKAGE." The applicant had previously proposed to delete this phrase. Since this phrase is consistent with the ASA section of equivalent STS Subsection B 3.4.13 and the APR1400 safety analyses, retaining it is acceptable. Therefore, RAI 494-8620, Question 5.4.2.2-6, Sub-question "a" is resolved.

See the evaluation of Subsection 3.4.17 below regarding the staff's assessment of the applicant's response (ML16208A488) to RAI 494-8620, Question 5.4.2.2-6, Sub-question "b" and its resolution.

In RAI 108-7973 (ML15206A005), Question 15.0.3-2, the staff stated that DCD Chapter 15A provides a description of the methods used to estimate coolant activity concentrations for input to the DCD Chapter 15 safety assessments. The staff requested that KHNP provide certain information on the primary coolant concentration calculations; in particular, Question 15.0.3-2, Sub-question "d" stated:

> In technical specification (TS) 3.4.12 the RCS primary-to-secondary leakage is limited to 0.39 L/min through any one SG. The bases for TS 3.4.12 state that the initial condition in the dose analyses assumes 0.39 L/min per SG primary-to-

> secondary leakage. In the DBA dose analyses, contrary to this, DCD Tables 15.1.5-12, 15.2.8-3, 15.3.3-3, 15.4.8-4, 15.6.2-4 and 15.6.3-5 list the primary-to-secondary leakage as 2.27 L/min total for two SGs. RG 1.183 guidance states that the primary-to-secondary leak rate in the steam generators should be assumed to be the leak rate limiting condition for operation specified in the technical specifications. What is the basis for this dose analysis assumption which greatly exceeds the technical specification limit?

In its responses (ML16130A546 and ML16201A274) to Question 15.0.3-2, the applicant stated:

> According to RG 1.183, Appendix F, Section 5.1, the primary-to-secondary leak rate in the SGs should be assumed to be the leak rate limiting condition for operation specified in the Technical Specifications (TS). The RCS operational leakage in technical specifications 3.4.12 is intended to limit [the primary-to-secondary leak rate] to 150 gpd (0.39 L/min) per any one SG. In the DBA analysis [(radiological dose assessment)] for APR1400, however, the primary-to-secondary leakage of 0.6 gpm (2.27 L/min) for both SGs (total SGs) was used, which is higher than this TS limit. The [last sentence of the first paragraph of the] "Applicable Safety Analyses (ASA)" section of the Bases for Subsection 3.4.12 indicates that:
>
>> The safety analysis for an event resulting in steam discharge to the atmosphere conservatively assumes a 1.13 L/min (0.3 gpm) primary to secondary leakage as the initial condition.
>
> In addition, the primary to secondary leakage of 0.3 gpm for any one SG applied to the dose analysis corresponds to the maximum accident-induced leakage limit specified in the technical specification 5.5.9 "Steam Generator (SG) Program," which is determined based on design basis accident considerations. Therefore, although the primary-to-secondary leakage assumed in the radiological dose assessment is not consistent with the guidance specified in RG 1.183, Appendix F, Section 5.1, this leakage is conservatively used in the dose analyses to maximize the offsite doses.

The staff finds the above response reasonable, but observed that the above quoted last sentence of the first paragraph of the ASA section of Subsection B 3.4.12 was revised, as indicated, in the applicant's response (ML16208A488) to RAI 494-8620, Question 5.4.2.2-6, to state:

>> The safety analysis for an event resulting in steam discharge to the atmosphere assumes a ~~1.13 L/min (0.3 gpm)~~ 2.27 L/min (0.6 gpm) primary to secondary leakage as the initial condition.

Pending resolution of this inconsistency in the two responses, RAI 108-7973, Question 15.0.3-2, Sub-question "d" was tracked as an open item. In its third revised response (ML17234A540) to Question 15.0.3-2, the applicant revised the above response to Sub-question "d" to match the above change to the GTS Subsection B 3.4.12 ASA section made by the response to RAI 494-8620, Question 5.4.2.2-6, which is addressed in Section 5.4.2.2, "Steam Generator Program," of this report. Since this removed the inconsistency in the responses, the open item about RAI 108-7973, Question 15.0.3-2, Sub-question "d" is resolved.

The staff reviewed Subsection 3.4.12 and Subsection B 3.4.12 and verified that the LCO and associated applicability, action, and surveillance requirements are adequate to ensure that unit operation in Modes 1, 2, 3, and 4 is allowed in the presence of RCS operational leakage only when the amount of leakage is within the specified limits so that safety is not compromised. Accordingly, the staff concludes that Subsection 3.4.12 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.12 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.4.12. The staff also verified that Subsections 3.4.12 and B 3.4.12 are consistent with the guidance in STS Subsections 3.4.13 and B 3.4.13, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.4.12 and Subsection B 3.4.12 are acceptable.

Subsection 3.4.13 RCS Pressure Isolation Valve (PIV) Leakage

Subsection 3.4.13 includes requirements for RCS pressure isolation valve (PIV) leakage such that RCS high pressure operation is allowed only when leakage through these valves exists in amounts that do not compromise safety.

The following table lists the RAI question concerning Subsection 3.4.13.

Subsection 3.4.13 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	3.3.13 Actions table Notes 1 and 2; and SR 3.4.13.1 surveillance column Notes 1, 2, and 3 should be labeled “NOTES” instead of “NOTE”	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The staff reviewed Subsection 3.4.13 and Subsection B 3.4.13 and verified that the LCO and associated applicability, action, and surveillance requirements are adequate to ensure that unit operation in Modes 1, 2, 3, and 4 is allowed in the presence of RCS PIV leakage only when the amount of leakage is within the limits specified in SR 3.4.13.1 so that safety is not compromised. Accordingly, the staff concludes that Subsection 3.4.13 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.4.13 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.4.12. The staff also verified that Subsections 3.4.12 and B 3.4.12 are consistent with the guidance in STS Subsections 3.4.14 and B 3.4.14, and the APR1400 design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.4.13 and Subsection B 3.4.13 are acceptable.

Subsection 3.4.14 RCS Leakage Detection Instrumentation

Subsection 3.4.14 includes requirements for leakage detection systems, which must have the capability to detect significant reactor coolant pressure boundary (RCPB) degradation as soon after occurrence as practical to minimize the potential for propagation to a gross failure.

The following table lists the RAI questions concerning Subsection 3.4.14.

Subsection 3.4.14 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-143.1	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 - Clarified actions for Condition A - inoperable containment sump (level) monitor	CC	
16-143.2 16-143.3	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 - Clarified actions for Condition B - inoperable containment atmosphere radioactivity (particulate) monitor	CC	
16-143.4	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 - Clarified actions for Condition C - inoperable containment atmosphere humidity monitor	CC	
16-143.5 16-143.6	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 - Clarified actions for • Condition D - inoperable containment sump (level) monitor and containment atmosphere humidity monitor; and • Condition E - inoperable containment atmosphere radioactivity (particulate) monitor and containment atmosphere humidity monitor	CC	
16-143.7	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 – Added new Condition F and associated actions for inoperable containment sump (level) monitor and containment atmosphere radioactivity (particulate) monitor	CC	
16-143.8	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 and B 3.4.14 - • Revised the phrase “of the required containment … monitor” in all SR statements; • Added “(particulate)” after “radioactivity,” and “(level)” after “sump”	CC	

Subsection 3.4.14 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-143.9	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	B 3.4.14 – Made conforming changes consistent with other 16-143 changes to Subsection 3.4.14	CC	
16-143.10	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189 ML16321A432 ML17240A403	B 3.4.14 SR section, SR 3.4.14.1 - explain how a Channel Check for the containment atmosphere radioactivity (particulate) monitor will be performed	CC	
16-143.11	481-8546 ML16133A271 Responses: ML16197A426 ML16250A189	3.4.14 and B 3.4.14 - Added SR 3.4.14.2 for a Channel Check and SR 3.4.14.4 for a Channel Functional Test of the containment atmosphere humidity monitor	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although GTS Subsection 3.4.14 closely follows equivalent STS Subsection 3.4.15 in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.14 and the deviation report.

Subsection 3.4.14 requirements are different from those of STS Subsection 3.4.15 in that the containment humidity is selected as a third measure for early detection of leakage from the RCS instead of the condensate flow from the containment air coolers as presented in the STS. The containment humidity monitor is considered a qualitative reactor coolant leakage detection instrument, as opposed to the condensate flow monitor, which is considered to be a quantitative reactor coolant leakage detection instrument in accordance with the staff’s guidance in Regulatory Guide (RG) 1.45, Revision 1, “Guidance on Monitoring and Responding to Reactor Coolant System Leakage.” Therefore, proposed Subsection 3.4.14 should have been written to reflect the use of the containment humidity as a third measure of leakage detection, and should not have just simply adapted the requirements of STS Subsection 3.4.15.

In RAI 481-8546 (ML16133A271), Question 16-143, the staff requested that the applicant consider various recommendations for TS requirements to address leakage detection instrument design differences between APR1400 and the typical CE PWR, and provide design-appropriate reactor coolant leakage detection instrument requirements in Subsection 3.4.14.

In its initial response (ML16197A426) to Question 16-143, the applicant proposed changes to Subsection 3.4.14 and Subsection B 3.4.14 as recommended by the staff; however, the staff noted some editorial errors in the proposed changes that needed to be corrected. These editorial errors were communicated to the applicant on July 22, 2016. In its second response

(ML16250A189) to Question 16-143, the applicant addressed each of the eleven sub-questions, as follows.

- In response to RAI 481-8546, Question 16-143, Sub-question 1, the applicant agreed to revise Action A as indicated:

  Condition: A. Required containment sump (level) monitor inoperable. ~~One or more required channel(s) inoperable.~~

  Required Actions: A.1 --------------------------------NOTE--------------------------------
  Not required until 12 hours after establishment of steady state operation.

  Perform SR 3.4.12.1. | Once per 24 hours

  AND

  A.2 Restore required containment sump (level) monitor to OPERABLE status. | 30 days ~~31 days~~

- In response to RAI 481-8546, Question 16-143, Sub-questions 2 and 3, the applicant agreed to revise Action B as indicated:

  Condition: B. Required containment atmosphere radioactivity (particulate) monitor inoperable. ~~One or more required channel(s) inoperable.~~

  Required Actions: B.1.1 Analyze grab samples of the containment atmosphere. | Once per 24 hours

  OR

  B.1.2 --------------------------------NOTE--------------------------------
  Not required until 12 hours after establishment of steady state operation.

  Perform SR 3.4.12.1. | Once per 24 hours

  AND

  B.2~~.1~~ Restore required containment atmosphere radioactivity (particulate) ~~sump~~ monitor to OPERABLE status. | 30 days ~~31 days~~

  ~~OR~~

  ~~B.2.2~~ ~~Restore required containment sump monitor to OPERABLE status.~~ | ~~31 days~~

- In response to RAI 481-8546, Question 16-143, Sub-question 4, the applicant agreed to revise Action C as indicated:

  Condition: C. ~~Containment~~ Required containment atmosphere humidity monitor inoperable.

Required Actions: C.1.1 Perform SR 3.4.14.1. | Once per 8 hours

OR

C.1.2 --------------------------------NOTE---------------------------------
Not required until 12 hours after establishment of steady state operation.

Perform SR 3.4.12.1. | Once per 24 hours

AND

C.2~~.2~~ Restore required containment atmosphere humidity monitor to OPERABLE status. | 30 days

- In response to RAI 481-8546, Question 16-143, Sub-questions 5 and 6, the applicant agreed to revise Actions D and E as indicated:

Condition: ~~-----------------------------------NOTE----------------------------------~~
~~Only applicable when the containment atmosphere gaseous radiation monitor is the only OPERABLE monitor.~~
~~---~~

D. Required containment sump (level) monitor inoperable.

AND

~~Containment~~ Required containment atmosphere humidity monitor inoperable.

Required Actions: D.1 ~~Analyze grab samples of containment atmosphere. | Once per 12 hours~~

~~AND~~

~~D.2.1~~ Restore required containment sump (level) monitor to OPERABLE status. | 30 days ~~7 days~~

OR

D.2~~.2~~ Restore required containment atmosphere humidity monitor to OPERABLE status. | 30 days ~~7 days~~

Condition: E. Required containment atmosphere radioactivity (particulate) monitor inoperable.

AND

~~Containment~~ Required containment atmosphere humidity monitor inoperable.

Required Actions: E.1 Restore required containment atmosphere radioactivity (particulate) monitor to OPERABLE status. | 30 days ~~31 days~~

OR

E.2 Restore required containment atmosphere humidity monitor to OPERABLE status. | 30 days ~~31 days~~

- In response to RAI 481-8546, Question 16-143, Sub-question 7, the applicant agreed to add new Action F as indicated; existing Actions F and G were relabeled Actions G and H, respectively:

  Condition: F. Required containment sump (level) monitor inoperable.

  AND

  Required containment atmosphere radioactivity (particulate) monitor inoperable.

  Required Actions: F.1 Restore required containment sump (level) monitor to OPERABLE status. | 7 days

  OR

  F.2 Restore required containment atmosphere radioactivity (particulate) monitor to OPERABLE status. | 7 days

The following table summarizes the logic behind the above changes to Actions A, B, C, D, and E, and the addition of Action F, for one (A, B, C) or two (D, E, F) of the three specified RCS leak detection instruments—the containment monitors for sump level, atmosphere particulate radioactivity, and atmosphere humidity—being inoperable. A 30 day completion time is specified to restore an inoperable monitor to operable status for Conditions A, B, C, D, and E because in these conditions, at least one quantitative monitor is still operable. But a 7 day completion time is specified to restore an inoperable monitor to operable status for Condition F because only a qualitative monitor is still operable. These completion times are also predicated upon meeting the other remedial actions (as applicable) specified for Conditions A, B, and C, which still apply if Condition D, E, or F are concurrently entered.

Condition	Inoperable Monitor(s)			Actions	
	Sump Water Level	Atmosphere Particulate Radioactivity	Atmosphere Humidity	Time to restore (either) monitor to operable status	Other remedial actions
A	X			30 days	Perform SR 3.4.12.1 (RCS water inventory balance) once per 24 hours
B		X		30 days	Analyze containment atmosphere grab samples once per 24 hours OR Perform SR 3.4.12.1 (RCS water inventory balance) once per 24 hours
C			X	30 days	Perform SR 3.4.14.1 (Channel Check of particulate monitor) once per 8 hours OR Perform SR 3.4.12.1 (RCS water inventory balance) once per 24 hours
D	X		X	30 days	See Conditions A and C

Condition	Inoperable Monitor(s)			Actions	
	Sump Water Level	Atmosphere Particulate Radioactivity	Atmosphere Humidity	Time to restore (either) monitor to operable status	Other remedial actions
E		X	X	30 days	See Conditions B and C
F	X	X		7 days	See Conditions A and B

- In response to RAI 481-8546, Question 16-143, Sub-question 8, the applicant (i) revised the phrase "of the required containment … monitor" in all SR statements; and (ii) added "(particulate)" after "radioactivity," and "(level)" after "sump" in all locations in Subsection 3.4.14 and Subsection B 3.4.14 when referring to these quantitative leakage monitors required by LCO 3.4.14.

- In response to RAI 481-8546, Question 16-143, Sub-question 9, the applicant made changes to Subsection B 3.4.14 in conformance with the above described changes to Subsection 3.4.14, including appropriate discussion of the containment atmosphere humidity monitor as a qualitative leakage detection instrument.

- In RAI 481-8546, Question 16-143, Sub-question 10, the staff requested that the applicant explain how a Channel Check for the containment atmosphere radioactivity (particulate) monitor will be performed, since LCO 3.4.14.b requires just one channel of this function to be operable. A Channel Check involves comparison of the output signals of two independent instruments, both expected to be operable, that are measuring the same parameter. In its response, the applicant stated:

  > The containment atmosphere radioactivity (particulate) is monitored by two independent monitors, RE-039A and RE-040B. The measuring range and sampling point of these two monitors are identical. When the CHANNEL CHECK of the RE-039A is performed, RE-040B continuously monitors the containment atmosphere particulate radioactivity. The particulate radioactivity of the containment atmosphere is monitored even when the CHANNEL CHECK of one monitor is being performed.

  The staff notes that the response addressed a different issue than asked by the staff. Pending an explanation of how both channels are ensured to be operable to support a Channel Check, RAI 481-8546, Question 16-143, Sub-question 10, was tracked as an open item.

  In its third revised response (ML17240A403) to Question 16-143, the applicant added a discussion to the Bases for SR 3.4.14.1 explaining that the CHANNEL CHECK of a "radioactivity particulate monitor channel is performed by using a radioactive check source...built into the detector assembly...remotely activated by the operator." The staff finds that this is an acceptable method of assessing channel behavior. Therefore, RAI 481-8546, Question 16-143, Sub-question 10, is resolved.

- In response to RAI 481-8546, Question 16-143, Sub-question 11, the applicant added SR 3.4.14.2 for a Channel Check and SR 3.4.14.4 for a Channel Functional Test of the containment atmosphere humidity monitor. Existing SR 3.2.14.2, SR 3.4.14.3, SR 3.4.14.4, and SR 3.4.14.5 were relabeled SR 3.2.14.3, SR 3.4.14.5, SR 3.4.14.6, and SR 3.4.14.7, respectively. The staff observes that the Bases proposed for SR 3.4.14.4 is appropriate for an analog instrument that uses relays and contacts. The staff also finds no information regarding the analog and digital aspects of the design of the containment atmosphere humidity monitoring system and associated alarms and indications in DCD Tier 2, Section 5.2.5.

Based on finding the responses to Sub-questions 1 through 11 acceptable, RAI 481-8546, Question 16-143, is resolved.

Based on its review, the above evaluation, and resolution of the identified open item, the staff therefore concludes that Subsection 3.4.14 and Subsection B 3.4.14 are acceptable.

Subsection 3.4.15 RCS Specific Activity

GTS Subsection 3.4.15 requirements on reactor coolant specific activity match those in STS Subsection 3.4.16, including the changes introduced in NRC approved TSTF-490-A, "Deletion of E-Bar Definition and Revision to RCS Specific Activity Tech Spec," Revision 0, approved March 15, 2007 (ML052630462, ML070250176). There is no design difference between the APR1400 design and the digital CE PWR design with respect to RCS specific activity other than numerical values for dose equivalent I-131 and dose equivalent Xe-133 limits to reflect related assumptions in the accident analyses.

The following table lists the RAI question concerning Subsection 3.4.15.

Subsection 3.4.15 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-130.2.B4	439-8524 ML16074A284 Response: ML16187A196	B 3.4.15 SR section, Bases discussion of surveillance column Note for SR 3.4.15.1 and SR 3.4.15.2 ─ Identified no other such Notes warranting clarification in the Bases similar to the subject Bases discussion	CR	

Status Codes:
CR Closed Resolved with no DCD changes

Since GTS reactor coolant specific activity requirements closely follow STS Subsection 3.4.16 and Subsection B 3.4.16 in format and content, the staff concludes that GTS Subsection 3.4.15 and Subsection B 3.4.15 are acceptable.

Subsection 3.4.16 Reactor Coolant Gas Vent (RCGV) Function

In the APR1400 design, the RCS high point venting system is used to manually depressurize the RCS during a non-loss of coolant accident (LOCA) event such as a loss of off-site power (LOOP) event. There are no equivalent requirements in the digital CE STS.

The following table lists the RAI questions concerning Subsection 3.4.16.

Subsection 3.4.16 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-23.22	119-7976 ML15226A542 Response: ML17296A124	3.4.16 ─ Revise Applicability statement and SR 3.4.16.1 Frequency; added Actions table Note for separate condition entry; B 3.4.16 SR section ─ Clarified discussion of SR 3.4.16.2 and SR 3.4.16.3	CC	
16-108.7	289-8215 ML15307A004 Response: ML16027A196	Provide justification for the completion time of 6 hours for Required Action B.1 where Condition B appears to indicate a loss of the RCGV function (both flow paths in one or both locations inoperable)	CU	16-152.3
16-108.8	289-8215 ML15307A004 Response: ML16027A196	Revise SR 3.4.16.3 for verification of valves in the vent flow paths to be in the correct position	CU	16-152.3 16-152.6
16-146.1b	481-8546 ML16133A271 Response: ML16195A559	• Revised deviation report and B 3.4.16 ASA and Applicability sections to remove RCGV RCS pressure reduction capability as a means of steam generator tube rupture (SGTR) event mitigation; • Justified not revising DCD Tier 2, Subsection 5.4.12 to describe using the RCGVs to mitigate an SGTR event	CC	
16-152.3 16-152.6	481-8546 ML16133A271 Responses: ML16196A273 ML16250A189 ML16337A102 ML17244A632	Revised Actions table Note and Conditions A and B to adopt STS phrasing regarding separate condition entry for each RCGV flow path; made conforming changes to B 3.4.16	CC	
16-152.4	481-8546 ML16133A271 Responses: ML16196A273 ML16250A189	B 3.4.16 SR section – Revised discussions of SR 3.4.16.1 and SR 3.4.16.4 to identify RCGV system parallel solenoid-operated	CC	

Subsection 3.4.16 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16337A102 ML17244A632	valves RG-419 and RG-420 as part of common line in the vent flow path to the IRWST.		
16-152.5	481-8546 ML16133A271 Responses: ML16196A273 ML16250A189 ML16337A102 ML17244A632	B 3.4.16 SR section – Revised discussion of SR 3.4.16.3 to identify two normally locked open locally operated manual isolation valves, V212 (reactor vessel vent) and V2300 (pressurizer vent), in RCS vent lines, which are depicted in DCD Tier 2, Figure 5.1.2-1 and Figure 5.1.2-3, respectively, in addition to V1430, which is depicted in Figure 5.2.12-1.	CC	
16-159	507-8587 ML16214A057 Response: ML16305A436	B 3.4.16 References section – Restored the reference to FSAR Section 5.4.12, "RCS High Point Vents."	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CU Closed Unresolved (has follow up question)

The Subsection 3.4.16 requirements, in general, conform to guidance in the STS. However, in consideration of the unique piping configuration for multiple vent paths from the RCS pressure vessel closure head and the top of the pressurizer to the IRWST in the APR1400 design, in RAI 119-7976 (ML15226A542), Question 16-23, Sub-question 22, the staff asked that the applicant respond to the following comments:

(a) Remove the RCS pressure condition from the Mode 4 Applicability statement, because Mode 4 is only entered when RCS cold leg temperature is < 350°F, and the SCS is only put into operation for normal shutdown cooling below the RCS pressure of 450 psia (but observe that DCD Tier 2, Section 5.4.7.2.6.a, states that the RCS needs to be depressurized to below the maximum pressure for SCS operation, 450 psia, in order to clear the permissive SCS interlock). With both SCS RCS isolation valves open in at least one of the two SCS suction lines, the two SCS suction line relief valves automatically limit RCS pressure, and the RCGV function is not needed to support maintaining natural circulation in the RCS. Therefore, it is more meaningful for the Mode 4 applicability to state:

MODES 1, 2, and 3,
MODE 4 with Shutdown Cooling (SC) System not aligned for Low Temperature Overpressure Protection (LTOP) of the reactor

coolant pressure boundary (RCPB). ~~RCS pressure ≥ 31.6 kg/cm²A (450 psia).~~

(b) Change the Frequency of SR 3.4.16.1 ("Cycle each RCGV valve to the fully closed and fully open position.") from "18 months" to "In accordance with the Inservice Testing Program," since these valves are designated safety-related.

(c) Add an Actions table Note that states, "Separate condition entry is allowed for each RCGV flow path location." Replace associated discussion, first paragraph of the Actions section of Subsection B 3.4.16, regarding this Note to state:

> The ACTIONS are modified by a Note to clarify that separate condition entry is allowed for each of the two RCS reactor coolant gas vent flow path locations, the reactor vessel closure head and the pressurizer steam space.

These changes were incorporated in the applicant's response (ML16250A189) to RAI 481-8546, Question 16-152; therefore Sub-question 22(c) of Question 16-23 of RAI 119-7976 is resolved.

(d) The discussion of SR 3.4.16.2 in the TS Bases states, in part, "This SR requires verification of flow through each vent path and the Surveillance test must be performed in MODE 5 or 6." The safety function of the vent path is venting non-condensible gases or steam from the RCS at operating RCS pressure and temperature. The applicant is requested to explain how testing at Mode 5 or 6 will produce equivalent results.

Pending receipt of a response from the applicant regarding these comments, RAI 119-7976, Question 16-23, Sub-questions 22(a), 22(b), and 22(d) were tracked as open items. In its response (ML17296A124) to RAI 119-7976, Question 16-23, regarding Sub-question 22(a), the applicant revised the Mode 4 Applicability statement, as requested; and regarding Sub-question 22(b), changed the Frequency of SR 3.4.16.1 to "In accordance with the Inservice test Program." Appropriate changes were also made to the Applicability and SR sections of the Bases for Subsection 3.4.16. Therefore, Question 16-23, Sub-questions 22(a) and 22(b) are resolved. And regarding Sub-question 22(d), the applicant revised the Bases for SR 3.4.16.2 to state:

> <u>SR 3.4.16.2</u>
>
> This SR requires verification of flow through each vent path and must be performed in MODE 5 during venting of non-condensible gases from the RCS after operations that involved entering the RCS loops not filled condition. The 18 month Frequency is based on a typical refueling cycle and operating experience, which has shown this interval provides adequate assurance that the vent flow paths are not obstructed.

Since the subject surveillance cannot be performed in Mode 6, and the revised paragraph includes the changes suggested by the staff, Question 16-23, Sub-question 22(d) is resolved.

In RAI 289-8215 (ML15307A004), Question 16-108, Sub-questions 7 and 8, the staff requested that the applicant provide justification for a completion time of 6 hours where the potential for a loss of RCGV function exists, and clarification of the scope of various proposed surveillance requirements to allow full understanding and effective implementation of the GTS requirements by the plant operators. In its response (ML16027A196) to RAI 289-8215, Question 16-108, regarding Sub-questions 7 and 8, the applicant did not fully address the staff's concerns; accordingly, the staff issued follow up RAI 481-8546 (ML16133A271), Question 16-152, Sub-questions 3, 4, 5, and 6, requesting further clarification on the required vent flow paths, adoption of STS phrasing in some of the requirements, and a clear definition of the scope of SR 3.4.16.3 in the Bases discussion. In its response (ML16250A189) and in its second revised response (ML16337A102) to Question 16-152, the applicant made the following changes; the staff suggested additional clarifications denoted by italic font highlighted in gray (metric units omitted for clarity):

- Revised LCO statement for Subsection 3.4.16:

  LCO 3.4.16   The following RCGV flow paths shall be OPERABLE.

  a. Two flow paths from the reactor vessel closure head to the in-containment refueling water storage tank (IRWST), and

  b. Two flow paths from the pressurizer steam space to the IRWST.

- Revised the Actions table by adding a Note:

  --NOTE--
  Separate condition entry is allowed for each RCGV flow path location.

- Revised Condition A:

  A. One ~~required~~ or both locations with one RCGV flow path inoperable. | A.1 Restore RCGV flow path to OPERABLE status. | 72 hours.

- Revised Condition B and Required Action B.1:

  B. One or both locations with two ~~Two required~~ RCGV flow paths ~~from the same location~~ inoperable. | B.1 Restore one RCGV flow path in each location to OPERABLE status. | 6 hours.

- Added Condition C and Required Action C.1:

  C. One or two RCGV valves in the common flow path to the IRWST inoperable. | C.1 Restore RCGV valve(s) in the common flow path to the IRWST to OPERABLE status. | 6 hours

- Relabeled Condition C and Required Actions C.1 and C.2:

  ~~C~~D.   Required Action and associated Completion Time of Condition A ~~*or*~~*, B,* or C not met. | ~~C~~D.1 Be in MODE 3. | 6 hours AND ~~C~~D.2 Be in MODE 4 with ~~RCS pressure < 450 psia~~ SC System aligned for LTOP of the RCPB. | 12 hours

- Revised Subsection B 3.4.16 Background section, last paragraph:

  The two isolation valves in each parallel *vent flow* path are normally powered from the 125 Vdc buses and emergency power is provided to the valves by batteries. ~~A failure modes and effect analysis (FMEA) (Reference 1) demonstrates that the RCGV function will~~ The RCGV System is designed to maintain a vent *flow* path after a single failure of any single valve or its power source. This ~~demonstration~~ design feature satisfies the requirements of GDC 17 and GDC 34.

- Revised Subsection B 3.4.16 Actions section, first paragraph:

  The ACTIONS are modified by a Note to clarify that separate condition entry is allowed for each of the two RCS reactor coolant gas vent flow path locations, the reactor vessel closure head and the pressurizer steam space. ~~The ACTIONS are modified by a Note which is added to provide clarification that each RCS gas vent path of the reactor vessel closure head and the pressurizer steam space allows a separate entry into a Condition.~~

- Revised Subsection B 3.4.16 Actions section by adding Bases for new Required Action C.1 (and relabeling Action C as Action D):

  C.1

  With inoperable components, such that one or two common flow paths to the IRWST are inoperable, the common flow path(s) must be returned to OPERABLE status within 6 hours. The Completion Time of 6 hours is reasonable to allow time to correct the situation, considering the importance of restoring common flow path(s). If the common flow path(s) are not restored to OPERABLE *status* within 6 hours, then ~~*Required Action*~~ *Condition* D is entered.

- Revised Bases for SR 3.4.16.1:

  At least one complete cycling for all remote control valves in each vent *flow* path from the MCR verifies the RCGV ~~*function*~~ *system* valves will function when necessary. There are *two in-series* solenoid operated valves in *each of* the two *parallel* flow paths from ~~*each of*~~ *the* reactor vessel closure head, and *two in-series solenoid-operated valves in each of the two parallel flow paths from the* pressurizer *upper head that connect to a common header, which contains two solenoid-operated valves in parallel lines, which connect to a* ~~including the~~ common flow path to the IRWST. The Surveillance ~~*test*~~ must be performed in MODE 5. The 18 month Frequency is based on the Inservice Testing Program since these valves are designated as safety-related.

- Revised Bases for SR 3.4.16.3:

  There ~~*is one*~~ *are three* locally operated manual ~~*valve for*~~ *valves in* the RCGV ~~*function*~~ *system that are normally locked open. One valve is* in the vent path from the reactor vessel closure head*; one valve is*~~. It is~~

> ~~necessary to verify that this valve is locked open to ensure that a vent path can be established from the reactor vessel closure head to the IRWST.~~ ~~*There is also one locally operated manual valve for the RCGV function*~~ in the vent path from the pressurizer*; and one valve is*~~.~~ ~~*There is also one locally operated manual valve for the RCGV function*~~ in the common vent flow path to the IRWST. It is necessary to verify that ~~this valve is~~ these valves are locked open to ensure that a vent path can be established from the reactor vessel closure head and *from* the pressurizer *steam space* to the IRWST. The Surveillance ~~*test*~~ must be performed in MODE 5 or 6. ...

The applicant's response (ML17296A124) to RAI 119-7976, Question 16-23, regarding Sub-question 22, revised the remainder of this paragraph, as follows:

> The 18 month Frequency is based on avoiding containment entry to access these valves during unit operation and the ease of accessing these valves during a refueling outage in MODE 5 or 6. The administrative control of locking the valves in the open position and the difficulty in accessing the valves during unit operation make an inadvertent closure of these valves unlikely.~~ accessibility during the refueling cycle and industry accepted practice.~~

- Revised Bases for SR 3.4.16.4:

> Verification of the correct breaker alignment and valve position indication ensures that the *solenoid-operated* valves are able to actuate and the valve positions are able to be monitored when necessary. There are *two in-series* solenoid-operated valves in *each of* the two *parallel* flow paths from ~~each of~~ *the* reactor vessel closure head and *in each of the two parallel flow paths from the* pressurizer ~~*including*~~ *steam space, and two in-parallel solenoid-operated valves in* the common flow path to the IRWST. The 7 day Frequency has been shown to be acceptable by operating experience.

The staff found that the above changes proposed in the applicant's responses (ML16250A189 and ML16337A102) to RAI 481-8546, Question 16-152, Sub-questions 3, 4, 5, and 6, needed the additional clarifications suggested by the staff. Pending incorporation of these clarifications, Question 16-152 Sub-questions 3, 4, 5, and 6 were tracked as open items.

In its supplemental response (ML17244A632) to RAI 481-8546, Question 16-152, the applicant stated that the above suggested changes had been incorporated into Revision 1 of the DC application in generic TS Subsections 3.4.16 and B 3.4.16. Therefore, RAI 481-8546, Question 16-152, Sub-questions 3, 5, and 6 are resolved.

Regarding Question 16-152, Sub-question 4, however, the staff needed more information concerning the effects of a failure of the two in-parallel solenoid-operated valves in the common flow path to the IRWST. This issue was communicated to the applicant on October 3, 2016. In the second revised response (ML16337A102) to Question 16-152, regarding Sub-question 4, the applicant stated:

> The Bases of SR 3.4.16.1 and SR 3.4.16.4 will be revised as shown in the Attachment_Rev.02 to clearly identify RG-V419 and RG-V420. Also, additional

Action Conditions will be added to address the failure of two solenoid operated valves RG-V419 and RG-V420, Bases of Actions will be revised as shown in the Attachment_Rev.02.

The staff noted that the stated revision to the Bases for SR 3.4.16.1 and SR 3.4.16.4 was not included in the markup of the Bases (response letter Attachment page 5). Receipt and resolution of a corrected response from the applicant was tracked as a part of the open item on RAI 481-8546, Question 16-152, Sub-question 4. In its supplemental response (ML17244A632) to Question 16-152, regarding Sub-question 4, the applicant included the previously omitted changes to the Bases for SR 3.4.16.1 and SR 3.4.16.4; these changes are shown in the above markup of these Bases paragraphs. Therefore, RAI 481-8546, Question 16-152, Sub-question 4, is resolved.

The RCGV function is a unique feature of the APR1400 design, but the staff is uncertain about which LCO selection criterion the RCGV function satisfies, especially after a discussion of its apparent role in mitigating a steam generator tube rupture (SGTR) event was removed from Subsection B 3.4.16 in response to RAI 481-8546, Question 16-146, Sub-question 1b. Subsection B 3.4.16 states that the RCGV function satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii), but the staff finds no information in DCD Tier 2, Chapter 15 that indicates any particular transient or accident for which manual operation of the RCGV valves is a part of the primary success path.

The staff notes that the system description in DCD Tier 2, Section 5.4.12.3 states "The RCGVS is designed to provide remote noncondensible gas venting from the reactor vessel closure head and the pressurizer steam space during post-accident conditions. Section 5.4.12.2 states that the reactor vessel closure head vent connection to the RCGV system and the pressurizer vent connection to the RCGV system may be used by the operator to cooldown and depressurize the plant in the event the pressurizer main spray and auxiliary spray systems are not operable. Note (12) of DCD Tier 2, Table 3.9-13 states that the RCGV solenoid valves are "active valves and are designed to be used during safety-grade cooldown of the RCS." The RCGV flow and the RCS depressurization rate are controlled by opening and closing the following RCGV system solenoid valves:

- Through manual valve V2300 in the common vent line from the top of the pressurizer, through valves RG-410 and RG-412 in one vent line, and valves RG-411 and RG-413 in the parallel vent line, through one or both of the common header vent valves RG-0419 and RG-0420, which are arranged in parallel lines, through a common line to the IRWST; and

- Through manual valve V212 in the common vent line from the top of the reactor vessel closure head, through valves RG-414 and RG-416 in one vent line, and valves RG-415 and RG-417 in the parallel vent line, through one or both of the common header vent valves RG-0419 and RG-0420, which are arranged in parallel lines, through a common line to the IRWST.

A minimum of one vent flow path to the IRWST from each RCGV system vent location is necessary to support the RCGV function. The valves in each vent flow path, with the Class 1E 125 Vdc power train (Division I – Trains A and C; Division II – Trains B and D) supporting each valve indicated in parenthesis (based on DCD Table 5.4.12-1 and DCD Figures 5.1.2-1, 5.1.2-3, and 5.4.12-1), are:

Pressurizer Vent to IRWST ─ Vent Flow Paths through V2300 (locked open manual)

(div I) RG-410(A) → RG-412 (C) → RG-420 (A) → V1430 (locked open manual) → IRWST
(div II) RG-411(B) → RG-413 (D) → RG-419 (B) → V1430 (locked open manual) → IRWST

Reactor Vessel Vent to IRWST ─ Vent Flow Paths through V212 (locked open manual)

(div I) RG-414(A) → RG-416 (C) → RG-420 (A) → V1430 (locked open manual) → IRWST
(div II) RG-415(B) → RG-417 (D) → RG-419 (B) → V1430 (locked open manual) → IRWST

Based on its review, the above evaluation, and resolution of the identified open items, the staff therefore concludes that Subsection 3.4.16 and Subsection B 3.4.16 are acceptable.

Subsection 3.4.17 Steam Generator (SG) Tube Integrity

Subsection 3.4.17 includes requirements for SG tube integrity. SG tube integrity means that the tubes are capable of performing their intended RCPB safety function consistent with the licensing basis, including applicable regulatory requirements. Subsection 3.4.17 requirements for steam generator (SG) tubes, in general, match those of STS Subsection 3.7.18.

The following table lists the RAI questions concerning Subsection 3.4.17.

Subsection 3.4.17 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
5.4.2.2-3.d	299-8310 ML15314A024 Response: ML16062A276	B 3.4.17 – SR 3.4.17.1 – added *sentence* to end of last paragraph to be consistent with TSTF-510	CC	
5.4.2.2-3.e	299-8310 ML15314A024 Response: ML16062A276	B 3.4.17 – Revised to use “flaw” or “flaws” in place of “degradation,” which is consistent with 5.5.9 and TSTF-510	CC	
5.4.2.2-3.h	299-8310 ML15314A024 Response: ML16062A276	B 3.4.17 Applicable Safety Analyses section does not appear to match the intent of the STS regarding primary-to-secondary leakage during design basis accidents; show that the Bases are consistent with the accident analyses.	CU	5.4.2.2-6.c
5.4.2.2-3.i	299-8310 ML15314A024 Response: ML16062A276	Page B 3.4.17-4 – value of assumed accident-induced primary-to-secondary leakage (does not exceed 0.39 L/min (150 gpd) per SG) appears to be incorrect	CU	5.4.2.2-6.c

Subsection 3.4.17 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
5.4.2.2-6.a	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.17 ASA section – restored first sentence to match STS	CC	
5.4.2.2-6.b	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.17 ASA section, first paragraph – changed primary to secondary leakage assumption to that for both SGs – 2.27 L/min (0.6 gpm) for main steam line (MSL) break	CC	
5.4.2.2-6.c	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.17 ASA section, – changed primary to secondary leakage assumption to that for both SGs – 2.27 L/min (0.6 gpm) for MSL break	CC	
16-23.23	119-7976 ML15226A542 Response: ML15265A596	3.4.17, 5.5.9 – Adopted TSTF-510	CC	

Status Codes:
RC Resolved Confirmatory
CC Closed Confirmed
CU Closed Unresolved (has follow up question)

Although Subsection 3.4.17 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.4.17 and the deviation report.

Steam Generator Program Consistency with TSTF-510 and STS

Changes to Subsections 3.4.17 and 5.5.9 (and also 3.4.12 and 5.6.7) were made to incorporate TSTF-510, "Revision to Steam Generator Program Inspection Frequencies and Tube Sample Selection," Revision 2, which was approved by the staff on October 19, 2011 (ML110610350), as described in the applicant's response (ML15265A596) to RAI 119-7976, Question16-23, Sub-question 23. The response stated:

> The TS and TS Bases of 3.4.17 and 5.5.9 will be revised to reflect TSTF-510. KHNP had previously committed to incorporate TSTF-510 into the APR1400 Technical Specifications in reply to issues that were transmitted and discussed in a public meeting on July 1, 2015 pertaining to DCD Section 5.4.2.2. KHNP subsequently documented our incorporation of this TSTF in Letter MKD/NW-15-0061L, dated August 4, 2015. Specifically, Enclosure 8, Issue #9 and the associated attachments (2, 4, 5, and 7 address changes to 3.4.17 and 5.5.9) of

that submittal provide the details of the revisions to the DCD to address TSTF-510.

TS and TS Bases of 3.4.17 and [TS] 5.5.9 will be revised as indicated in Enclosure 9 attachments 2, 4, 5, and 7 of KHNP letter MKD/NW-15-0061L, dated August 4, 2015 [ML15216A456].

The staff compared Revision 0 of DCD Tier 2, Section 5.4.2.2 and DCD Tier 2, Chapter 16, GTS Subsections B 3.4.12, 3.4.17, B 3.4.17, 5.5.9, and 5.6.7 to the changes described in TSTF-510, and observed inconsistencies among these documents. Accordingly, the staff prepared RAI 299-8310, Question 5.4.2.2-3, Sub-questions a, b, c, d, e, f, g, h, and i, requesting that the applicant resolve these variations from TSTF-510. Following is a quote of Question 5.4.2.2-3. After the quotation of each sub-question, a description and an assessment of the applicant's response (ML16062A276) is provided. (In the following, note that FSAR is equivalent to DCD Tier 2.):

The [applicant's] response, dated August 4, 2015 (ML15216A456), to [materials and chemical engineering branch (MCB)] Issue 5.4.2.2-9 (KHNP issue AI 5-6.27) proposed numerous changes to the FSAR and the Technical Specifications (TS) to address consistency with the Standard TS and TS Task Force Traveler 510 (TSTF-510). Please address the inconsistencies listed below that remain between the proposed APR1400 FSAR and TS and the STS as modified by TSTF-510.

a) FSAR 5.4.2.2.2.12 ("Reporting"), Item b, delete the word, "Active," or explain the deviation from the STS/TSTF-510. This also applies to TS 5.6.7.b.

   <u>Assessment</u>: KHNP stated it will delete "Active" from FSAR 5.4.2.2.2.12 ("Reporting") Item b and TS 5.6.7.b. The markup of page 5.6-5 in the response letter enclosure's attachment, also showed that in TS 5.6.7.e, the phrase, "for each active degradation mechanism" will be changed to "for each degradation mechanism." The staff finds deletion of the word "active" in these locations acceptable. Therefore, Sub-question "a" is resolved.

b) FSAR 5.4.2.2.2.12 ("Reporting"), Item d, proposed (AI 5-6.21) changing "indications" to "degradation." The STS/TSTF-[510] use "indications" so conditions that are not considered degradation but that could affect tube integrity at some time (e.g., denting) are included in the report. This also applies to TS 5.6.7.d.

   <u>Assessment</u>: KHNP identified that the proposed change of the last word of Item "d" in FSAR Subsection 5.4.2.2.12 ("Reporting") "degradation" is inconsistent with STS (as modified by TSTF-510). Therefore, KHNP will revert to the original word "indications" both in the FSAR statement and in TS 5.6.7.d. The staff finds this acceptable. Therefore, Sub-question "b" is resolved.

c) FSAR 5.4.2.2.2.12 ("Reporting"), Item h should be deleted because no repair methods are being approved for the APR1400 design certification. (Plugs are not repairs.) This also applies to TS 5.6.7.h.

Assessment: KHNP stated it will delete item h ("Repair method utilized and the number of tubes repaired by each repair method") both from FSAR 5.4.2.2.2.12 ("Reporting") and TS 5.6.7.h. The staff finds this acceptable. Therefore, Sub-question "c" is resolved.

d) TS Bases, SR 3.4.17.1, at the end of the last paragraph add the following sentence for consistency with TSTF-510, "If crack indications are found in any SG tube, the maximum inspection interval for all affected and potentially affected SGs is restricted by Specification 5.5.9 until subsequent inspections support extending the inspection interval."

Assessment: KHNP stated it will add the recommended sentence at the end of the last paragraph of TS Bases for SR 3.4.17.1. The staff finds this acceptable. Therefore, Sub-question "d" is resolved.

e) TS Bases 3.4.17, several instances of the word "flaw" or "flaws" were changed to "degradation." Since TS 5.5.9 and TSTF-510 uses "flaw" and "flaws," provide a justification for making these changes or restore the original wording for consistency.

Assessment: KHNP stated that the word "flaw" or "flaws" was changed to "degradation" based on NRC staff's recommendation during the face-to-face meeting held on July 1, 2015. However, KHNP stated that it will restore the original word "flaw" or "flaws" in accordance with TS 5.5.9 and TSTF-510. Affected locations in Subsection B 3.4.17 are (1) first paragraph, sixth sentence of the Bases for Required Actions A.1 and A.2; (2) third paragraph, first sentence of the Bases for SR 3.4.17.1; and (3) first paragraph, second sentence of the Bases for SR 3.4.17.2. The staff finds this acceptable. Therefore, Sub-question "e" is resolved.

f) Change "tube repair criteria" to "tube plugging criteria" for consistency within the APR1400 TS and with the STS/TSTF-510 (e.g., TS 5.5.9.c and 5.5.9.d).

Assessment: KHNP stated that it will change "tube repair criteria" to "tube plugging criteria" in TS 5.5.9.c ("Provisions for SG tube ~~repair~~ plugging criteria. ...") and 5.5.9.d ("....and that may satisfy the applicable tube ~~repair~~ plugging criteria. ..."). The markup of pages B 3.4.17-5, -6, and -7 in the response letter enclosure's attachment also showed that other locations in Subsection B 3.4.17 also received this change: (1) the first paragraph, first and fourth sentences of the Bases for Required Actions A.1 and A.2; (2) third paragraph, first sentence of the Bases for SR 3.4.17.1; and (3) first paragraph, first, second, and third sentences, and third paragraph of the Bases for SR 3.4.17.2. The staff finds this acceptable. Therefore, Sub-question "f" is resolved.

g) TS 5.5.9.d proposes wording similar to TSTF-510, but with some differences. The staff reviewed the wording and found that it is not equivalent to the TSTF-510 wording. This provision in TSTF-510 was carefully worded to allow for prorating of tube/location inspections if the potential for a new degradation mechanism is identified after an inspection period has been partially completed. The wording proposed in the response could be interpreted to allow prorated inspections for all degradation mechanisms. The applicant should modify the proposed wording, making it the same as TSTF-510 or justifying an alternative.

Assessment: KHNP stated it will change paragraphs d.2 and d.3 of GTS Subsection 5.5.9 to be consistent with the STS and TSTF-510; these paragraphs will state:

2. After the first refueling outage following SG installation, inspect each SG at least every 72 effective full power months or at least every third refueling outage (whichever results in more frequent inspections). In addition, the minimum number of tubes inspected at each scheduled inspection shall be the number of tubes in all SGs divided by the number of SG inspection outages scheduled in each inspection period as defined in a, b, c and d below. If a degradation assessment indicates the potential for a type of degradation to occur at a location not previously inspected with a technique capable of detecting this type of degradation at this location and that may satisfy the applicable tube repair criteria, the minimum number of locations inspected with such a capable inspection technique during the remainder of the inspection period may be prorated. The fraction of locations to be inspected for this potential type of degradation at this location at the end of the inspection period shall be no less than the ratio of the number of times the SG is scheduled to be inspected in the inspection period after the determination that a new form of degradation could potentially be occurring at this location divided by the total number of times the SG is scheduled to be inspected in the inspection period. Each inspection period defined below may be extended up to 3 effective full power months to include a SG inspection outage in an inspection period and the subsequent inspection period begins at the conclusion of the included SG inspection outage.

    a) After the first refueling outage following SG installation, inspect 100% of the tubes during the next 144 effective full power months. This constitutes the first inspection period;

    b) During the next 120 effective full power months, inspect 100% of the tubes. This constitutes the second inspection period;

    c) During the next 96 effective full power months, inspect 100% of the tubes. This constitutes the third inspection period; and

d) During the remaining life of the SGs, inspect 100% of the tubes every 72 effective full power months. This constitutes the fourth and subsequent inspection periods.

3. If crack indications are found in any SG tube, then the next inspection for each affected and potentially affected SG for the degradation mechanism that caused the crack indication shall not exceed 24 effective full power months or one refueling outage (whichever results in more frequent inspections). If definitive information, such as from examination of a pulled tube, diagnostic non-destructive testing, or engineering evaluation indicates that a crack-like indication is not associated with a crack(s), then the indication need not be treated as a crack.

The staff determined that the proposed wording exactly matches that of TSTF-510 and STS; therefore, paragraphs d.2 and d.3 of GTS Subsection 5.5.9 are acceptable. Therefore, Sub-question "g" is resolved.

h) A change was proposed to TS B 3.4.17 ("Applicable Safety Analyses") that does not appear to match the intent of the STS. Specifically, in the paragraph in the Bases on Page B 3.4.17-2 beginning with, "The analysis for design basis accidents and transients other than a SGTR," the proposed value is 3.785 L/min (1.0 gpm). The value in this part of the Bases should reflect the value used in the APR1400 safety analyses demonstrating acceptable radiological dose consequences associated with primary-to-secondary leakage during design basis accidents. From the accident analysis in FSAR Chapter 15 (e.g., Table 15.1.5-12), it is not clear to the staff what value is assumed for primary-to-secondary leakage from the steam generators as a result of accident conditions, whether it includes all operational and accident-induced leakage, and how this leakage is apportioned between the two steam generators. It is also not clear that the Chapter 15 analysis is consistent with the statement on Bases page B 3.4.12-2 that the safety analysis for the steam line break accident assumes the entire primary-to-secondary leakage is through the affected generator as an initial condition. Please clarify these issues and provide any proposed FSAR changes to show that the Technical Specification Bases related to the Steam Generator Program are consistent with the APR1400 accident analyses.

<u>Assessment</u>: In response, KHNP stated that

> The value of 1.14 L/min (0.3 gpm) is assumed for primary-to-secondary leakage from one SG in the safety analysis in FSAR Chapter 15. This value includes all operational and accident induced leakage except for the [steam line break (SLB)] accident. KHNP will cancel the change and restore the original value 1.14 L/min (0.3 gpm) in Technical Bases page B 3.4.12-2.
>
> The safety analysis for the SLB accident in FSAR Ch. 15 assumes 2.27 L/min (0.6 gpm). Therefore, KHNP will change

> the leak rate in the fourth paragraph in Technical Bases page B 3.4.12-2 in the APR 1400 FSAR Ch. 16 from 1.14 L/min (0.3 gpm) to 2.27 L/min (0.6 gpm) as shown in the page 10 of the Attachment.

After reviewing the above response, the staff had additional questions, and sent them to KHNP in follow up RAI 494-8620 (ML16160A379), Question 5.4.2.2-6, in Sub-questions a, b, and c. Question 5.4.2.2-6 stated:

> The March 2, 2016 response (ML16062A276) to RAI 299-8310, Question 05.04.02.02-3, Parts (h) and (i), proposes changes to leakage values on Attachment pages 10-13. It is not clear to the staff that the proposed values are consistent with the accident analyses. Please address the following issues and identify any FSAR changes needed to address them. In addition, identify any other FSAR changes that may be necessary for consistency. This information is needed to determine consistency with the Standard Technical Specifications, which provide for the establishment and implementation of a steam generator program to ensure that tube integrity is maintained, which is part of meeting General Design Criterion 32.

In its revised response (ML16208A488) to Sub-question “a” of RAI 494-8620, Question 5.4.2.2-6, the applicant stated that it will retain the phrase (“Except for primary to secondary LEAKAGE, the” safety analyses do not address operational LEAKAGE.), which it had previously proposed to delete from the first sentence of the Applicable Safety Analyses (ASA) section of Subsection B 3.4.12. Since this phrase is consistent with the STS and the APR1400 safety analyses, retaining it is acceptable. Therefore, Question 5.4.2.2-6, Sub-question “a” is resolved.

In its revised response (ML16208A488) to Sub-question “b” of RAI 494-8620, Question 5.4.2.2-6, the applicant stated:

> The 0.3 gpm and 0.6 gpm are the primary to secondary leakage per one SG and two SGs, respectively. Therefore, the last sentence in the first paragraph of page B 3.4.12-2 of FSAR Rev. 0 should be modified as that “an event resulting in steam discharge to the atmosphere assumes 2.27 L/min (0.6 gpm) primary to secondary leakage as the initial condition” as shown on page 1 of the Attachment. Therefore, 0.6 gpm leakage is the assumed leakage from two SGs throughout event in SLB safety analysis for conservatism.

The staff verified that the changes to the last sentence of first paragraph and last sentence of third paragraph of the ASA section of Subsection B 3.4.12, which were indicated on the markup of Bases page B 3.4.12-2 in the response letter enclosure’s attachment, are consistent with the SLB analysis. Also included in the response was a change to the second sentence of the fourth paragraph, as shown, to use the 2.27 L/min leakage value and provide additional detail so that it states (staff suggested edits highlighted in gray): “The safety analysis for the SLB accident assumes

1.13 L/min (0.3 gpm) through each steam generator for the first 30 minutes, and then the entire ~~1.13 L/min (0.3 gpm)~~ 2.27 L/min (0.6 gpm) primary to secondary LEAKAGE is through the affected generator as an initial condition." The staff finds these changes are acceptable. Therefore, Sub-question "b" of RAI 494-8620, Question 5.4.2.2-6 is resolved.

In its revised response (ML16208A488) to Sub-question "c" of RAI 494-8620, Question 5.4.2.2-6, the applicant stated:

> As described in the accident analyses in the FSAR Ch.15, all the accident analyses relevant to the primary-to-secondary leakage assumed the 0.3 gpm leakage for any one SG and 0.6 gpm for all SGs. As stated in the response of above subquestion 'b', the SLB accident assumed 0.6 gpm leakage from total SGs. KHNP will change the 0.3 gpm to 0.6 gpm for consistency with Ch.15 accident analyses.

The staff verified that the changes to the ASA section of Subsection B 3.4.17, which were indicated on the markup of Bases page B 3.4.17-2 in the response letter enclosure's attachment, are consistent with the SLB analysis. These changes are as indicated in the following locations: (a) last sentence of first paragraph ("The accident analysis for an SGTR assumes the contaminated secondary fluid is only briefly released to the atmosphere via safety valves and the majority is discharged to the main condenser ~~relief valves~~."); and (b) second sentence of second paragraph ("In these analyses, the steam discharge to the atmosphere is based on the total primary to secondary leakage from all SGs of ~~1.13 L/min (0.3 gpm)~~ 2.27 L/min (0.6 gpm) or is assumed to increase to 2.27 L/min (0.6 gpm) as a result of accident induced conditions.") The staff concludes these changes are acceptable because they are consistent with the accident analyses. Therefore, Sub-question "c" of RAI 494-8620, Question 5.4.2.2-6 is resolved. Consequently, Sub-question "h" of RAI 494-8610, Question 5.4.2.2-3 is also resolved.

i) The proposed technical specifications include steam generator leakage values that appear to be inconsistent with the standard technical specifications and TSTF-510. For example, page B 3.4.12-2 has three instances where the value of 1.13 L/min (0.3 gpm) is used in paragraphs that refer to the safety analyses for the design. It is the staff's understanding [that] the safety analyses assume 2.27 L/min primary-to-secondary leakage. Another example is on page B 3.4.17-4, in a sentence that states, "… the accident induced leakage does not exceed 0.39 L/min (150 gpd) per SG." This appears to be incorrect because 0.39 L/min is the operational leakage limit.

   Assessment: Changes to Subsections B 3.4.12 and B 3.4.17 made by the applicant in response to Sub-question "h" of RAI 494-8610, Question 5.4.2.2-3, and follow up RAI 494-8620, Question 5.4.2.2-6 also addressed the issues on page B 3.4.12-2 and page B 3.4.17-4 raised by the staff in Sub-question "i"; therefore, Sub-question "i" of Question 5.4.2.2-3 of RAI 494-8610 is resolved.

Based on the above evaluation of the applicant's responses to RAI 299-8310, Question 5.4.2.2-3, Sub-questions a, b, c, d, e, f, g, h, and i; and to follow up RAI 494-8620, Question 5.4.2.2-6, the staff concludes that GTS requirements and Bases for steam generator tube integrity, in Subsections B 3.4.12, 3.4.17, B 3.4.17, and 5.5.9, are acceptable. Therefore, RAI 299-8310, Question 5.4.2.2-3; RAI 494-8620, Question 5.4.2.2-6; and RAI 119-7976, Question 16-23, Sub-question 23 are resolved.

Based on its review and the above evaluation, the staff therefore concludes that Subsection 3.4.17 and Subsection B 3.4.17 are acceptable.

Conclusion for GTS Section 3.4 and Section B 3.4

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.4 and Section B 3.4 are acceptable.

16.4.10 TS Chapter 3.0 LCOs and SRs ─ Section 3.5 Emergency Core Cooling System (ECCS)

GTS Section 3.5 provides requirements for the safety-related equipment designed for emergency core cooling. In general, GTS Section 3.5 is modeled after STS Section 3.5, with differences to reflect APR1400 unique design features. These unique design features include having four high pressure Safety Injection System (SIS) trains that provide the RCS with emergency makeup water from the in-containment refueling water storage tank (IRWST) by way of four direct vessel injection (DVI) lines, instead of the typical CE digital PWR design with two Emergency Core Cooling System (ECCS) trains, each with one high pressure and one low pressure safety injection train connected to the RCS cold legs and initially supplied from a refueling water tank (RWT) outside containment.

The GTS Subsections for the ECCS corresponds to the CE STS Subsections for the ECCS in the following manner:

STS	GTS	Title (*STS Title, if different)
3.5.1	3.5.1	Safety Injection Tanks (SITs)
3.5.2*	3.5.2	Safety Injection System - Operating (*Emergency Core Cooling System - Operating)
3.5.3*	3.5.3	Safety Injection System - Shutdown (*Emergency Core Cooling System - Shutdown)
3.5.4*	3.5.4	In-Containment Refueling Water Storage Tank (*Refueling Water Tank)
3.5.5	3.5.5	Trisodium Phosphate (TSP)

Although GTS Section 3.5 is modeled on STS format and content, the staff noted differences from the STS that warranted technical justification and clarification beyond what was given in GTS Section 3.5 and Section B 3.5, and in the deviation report. The following evaluation summarizes key concerns raised during the staff's review of each of the five subsections in GTS Section 3.5.

Subsection 3.5.1 Safety Injection Tanks (SITs)

GTS Subsection 3.5.1 includes requirements for the four safety injection tanks (SITs), which are to supply water to the reactor vessel during the blowdown phase of a large break loss of coolant accident (LOCA), to provide inventory to help accomplish the lower plenum refill phase, and early core reflood phase that follow thereafter, and to provide RCS makeup for a small break LOCA.

The following table lists the RAI questions concerning Subsection 3.5.1.

Subsection 3.5.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
6.3-6	158-7997 ML15295A497 Response: ML15260B338	3.5.1 SIT atmospheric vent valve position verification SR	CC	
6.3-7	158-7997 ML15295A497 Response: ML16007A083	3.5.1, 3.5.4, need for SR to verify atom percent Boron-10 in boric acid	CU	6.3-10
6.3-10	496-8630 ML16169A366 Responses: ML16202A539 ML17180A454 ML17222A209	APR1400 is keeping boron recycling as an option.	CC	
16-16	106-8069 ML15206A003 Response: ML15246A069	3.5.1 Actions A and B – removed differences from STS by combining them into one Actions table row, and renumbering other Action table rows	CC	
16-17	106-8069 ML15206A003 Response: ML15246A069	SR 3.5.1.4 Frequency revised to say “Once within 6 hours after each solution volume increase of ≥ 1% of tank volume that is not the result of addition from the in-containment refueling water *storage* tank”	CC	
16-46	159-8108 ML15232A657 Responses: ML15341A355 ML16142A053	B 3.5.1 Background section – SIT isolation valve automatic open actuation signals	CC	

Subsection 3.5.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-47	159-8108 ML15232A657 Response: ML15341A355	B 3.5.1 Actions section – Clarified Required Action B.1 discussion	CC	

Status Codes:
CU Closed Unresolved RC Resolved Confirmatory CC Closed Confirmed

See Section 6.3 of this SER for discussion of the applicant's responses to RAI 158-7997, Questions 6.3-6 (ML15260B338) and 6.3-7 (ML16007A083). Also see Section 6.3 of this report for discussion of RAI 496-8630 (ML16169A366), Question 6.3-10, which was tracked as an open item. In its second revised response to Question 6.3-10 (ML17222A209) the applicant added surveillance requirements (and associated Bases) to verify that the isotopic concentration (atomic percent) of the Boron-10 isotope (B-10)—the fraction of boron atoms in the boric acid solution that are B-10—is within the limit specified in the COLR. The response also made appropriate changes to LCO statements and Actions table Conditions. These SRs and related changes are the following:

<u>Subsections 3.5.1 and B 3.5.1, SITs</u>

- Added new Condition statement of "<u>OR</u> One SIT inoperable due to B-10 isotopic concentration not within limits." to Condition A after the first Condition statement
- Added new SR 3.5.1.6: "Verify isotopic concentration of B-10 in each SIT is within the limit specified in the COLR. | 24 months"
- Revised Actions and SRs sections of B 3.5.1 by adding appropriate Bases

<u>Subsections 3.5.4 and B 3.5.4, IRWST</u>

- Added new Condition statement of "<u>OR</u> IRWST B-10 isotopic concentration not within limits." to Condition A after the first Condition statement
- Added new SR 3.5.4.4: "Verify isotopic concentration of B-10 in the IRWST is within the limit specified in the COLR. | 24 months"
- Revised Applicable Safety Analyses, Actions, and SRs sections of B 3.5.4 by adding appropriate Bases

<u>Subsections 3.7.15 and B 3.7.15,</u>

- Revised LCO statement: "The spent fuel pool <u>(SFP)</u> boron concentration shall be ≥ 2,150 ppm<u>, and the SFP B-10 isotopic concentration shall be ≥ 19.9% (atomic percent)</u>."
- Moved the Condition A, Required Action Note to before the Actions table; the Note states "LCO 3.0.3 is not applicable."

- Added new Condition statement of "<u>OR</u> Spent fuel pool B-10 isotopic concentration not within limits." to Condition A after the first Condition statement

- Revised Required Action A.2.1: "Initiate action to restore spent fuel pool boron concentration <u>and B-10 isotopic concentration </u>to within limit<u>s</u>. | Immediately"

- Added new SR 3.7.15.2: "Verify isotopic concentration of B-10 in the SFP is ≥ 19.9% (atomic percent). | 24 months"

- Revised Background, Applicable Safety Analyses, Actions, and SRs sections of B 3.7.15 by adding appropriate Bases

These new requirements will ensure that the B-10 isotopic concentration of the borated water in the SITs, the IRWST, and the SFP are maintained within the specified limits, and therefore, are acceptable. These changes resolve the aspect of RAI 496-8630, Question 6.3-10, related to improving the GTS and Bases.

Although GTS Subsection 3.5.1 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.5.1 and the deviation report.

SRP Section 16.0, Part III.2.A states, in part, "when reviewing a difference between the proposed TS provision and the reference TS provision, verify that the applicant's written technical or administrative reasoning in support of the difference is logical, complete, and clearly written." The staff noted that STS 3.5.1 Condition A has two condition statements, "One SIT inoperable due to boron concentration not within limits. <u>OR</u> One SIT inoperable due to the inability to verify level or pressure." Required Action A.1 ("Restore SIT to OPERABLE status. | 72 hours") applies to both condition statements independently because of the "<u>OR</u>" logical connector. Proposed GTS 3.5.1 places the second condition statement into a new separate Condition B and retains STS Required Action A.1 as Required Action B.1. The first condition statement remains in Condition A; however, Required Action A.1 is changed to say "Restore boron concentration to within limits." Both required actions retain the same 72 hour Completion Time. When in either condition statement, the SIT is considered inoperable; therefore, the two presentations do not alter the operating constraints specified for when one SIT is inoperable for the stated conditions. Therefore, splitting the STS Condition A into two Conditions is not necessary. Since the proposed presentation is not consistent with either the STS or other GTS action requirements, such as Subsection 3.5.4 Action A, it is contrary to the Commission policy on TS standardization and to achieving internal consistency within the GTS. In RAI 106-8069 (ML15206A003), Question 16-16, the staff requested that the applicant either justify this deviation from STS 3.5.1, or conform to the STS presentation. In its response (ML15246A069) the applicant stated that the presentation of proposed GTS 3.5.1 Actions A and B will be revised to conform to the STS 3.5.1 Action A presentation, which is acceptable. Therefore, RAI 106-8069, Question 16-16 is resolved.

The Frequency for GTS SR 3.5.1.4 (verify SIT boron concentration) following addition of borated water to a SIT, states, "Whenever a SIT volume change not from the IRWST exceeds the limits of SR 3.5.1.2, immediately after a boron concentration measurement is ready." The wording in the STS for the equivalent Surveillance Frequency is "Once within 6 hours after each solution volume increase of ≥ [1%] of tank volume that is not the result of addition from the refueling tank." The staff found that the proposed GTS Surveillance Frequency phrasing is confusing and needs to be rewritten. The staff requested in RAI 106-8069 (ML15206A003), Question 16-17, that the applicant justify not using the STS wording and revise the proposed Frequency for clarity. In its response (ML15246A069) the applicant stated that it will revise the Frequency of GTS SR 3.5.1.4 to conform to the STS phrasing, which is acceptable: "Once within 6 hours after each solution volume increase of ≥ 1% of tank volume that is not the result of addition from the in-containment refueling water storage tank." Therefore, RAI 106-8069, Question 16-17 is resolved.

The Background section of the Bases for GTS 3.5.1 states that the SIT "motor operated isolation valves are normally open with power removed from the valve motor to prevent inadvertent closure prior to or during an accident." The next to last paragraph discusses that the isolation valves are interlocked with pressurizer pressure instrumentation channels to ensure the [SIT outlet isolation] valves will automatically open as RCS pressure is increased above SIT pressure and that the SIT isolation valves also receive a signal to open on a safety injection actuation signal (SIAS). In RAI 159-8108 (ML15232A657), Question 16-46, the staff requested that the applicant clarify the discussion to describe when power is and is not removed from the motor operated isolation valves, including at what point during unit startup the power is required to be removed from the valve motors, and to clearly explain the effect of an SIAS signal on the SIT isolation valves.

In its revised response (ML16142A053) to Question 16-46, the applicant stated it will include the following explanation in the Background section of GTS Subsection B 3.5.1:

> At the initial stage of plant heatup, the SIT isolation valves are closed with power available to the valve motors. When RCS pressure increases above 600 psia, the SIT isolation valves are automatically opened through an interlock with the pressurizer pressure channels. When RCS pressure increases above 715 psia, the operators remove power to the SIT isolation valves.
>
> Power is restored to the SIT motor operated isolation valves when RCS pressure decreases below 715 psia during plant cooldown. Before RCS pressure is reduced to 640 psia, operators will lower SIT pressure to 400 psig. An interlock prevents the SIT isolation valves from being closed if RCS pressure is greater than 475 psia. Once RCS pressure is below 475 psia, the SIT isolation valves will be closed and power to the valve actuator is maintained available.

The staff finds the response acceptable, but will confirm that the metric units for pressure are also included for consistency in the final revision to Subsection B 3.5.1. Based on the response, RAI 159-8108, Question 16-46, is resolved.

The staff reviewed Subsection 3.5.1 and Subsection B 3.5.1 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the SITs in Modes 1, 2, and 3 to mitigate events as assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.5.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.5.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.5.1. The staff also verified that Subsections 3.5.1 and B 3.5.1 are consistent with the guidance in STS Subsections 3.5.1 and

B 3.5.1, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff concludes that Subsection 3.5.1 and Subsection B 3.5.1 are acceptable.

Subsection 3.5.2 Safety Injection System (SIS) – Operating

GTS Subsection 3.5.2 includes requirements for the SIS in Modes 1, 2, and 3. The SIS is to provide emergency makeup of borated water to the RCS to ensure core cooling and insertion of negative reactivity to maintain shutdown margin sufficient to ensure that the reactor core is protected after any of the following accidents:

- Loss of coolant accident (LOCA)
- Control element assembly (CEA) ejection accident
- Loss of secondary coolant accident, including uncontrolled steam release
- Steam generator tube rupture (SGTR)

The following table lists the RAI questions concerning Subsection 3.5.2.

Subsection 3.5.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
6.3-9	158-7997 ML15295A497 Responses: ML15260B338 ML16217A298	DCD 6.3.1.4, minimum safety injection flow rate requirements; 3.5.2 Actions; diagonal safety injection pumps (SIPs)	CC	
16-18	106-8069 ML15206A003 Response: ML15246A069	3.5.2 Action A – incorrectly formatted and logically confusing.	CU	16-210
16-19	106-8069 ML15206A003 Response: ML15246A069	SR 3.5.2.1 – revised hot leg injection isolation valve list format to eliminate repetitive tabular content	CC	
16-48	159-8108 ML15232A657 Responses: ML15341A355 ML16142A053	B 3.5.2 Condition A and Condition C – revised Bases to explain diagonal SIS trains	CC	
16-51	162-8055 ML15235A003 Response: ML15301A207	Logical Connector indentation in Actions tables corrected – 3.8.5, 3.5.2, 3.1.7	CC	
16-210	509-8591 ML16214A101 Responses:	3.5.2 Condition A – revise Required Action A.1 to account for second condition	CC	

Subsection 3.5.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16251A532 ML17208B034	statement for two diagonally oriented safety injection trains inoperable – used two separate Condition rows		

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CU Closed Unresolved (has follow up question)

See Section 6.3 of this report for discussion of responses (ML15341A355 and ML16142A053) to RAI 159-8108 (ML15232A657), Question 6.3-9.

Although GTS Subsection 3.5.2 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.5.2 and the deviation report.

The staff noted that Condition A of proposed GTS 3.5.2 actually has two condition statements, which should be stated separately as indicated: "One train inoperable. OR ~~or two~~ Two trains inoperable and diagonally oriented with respect to reactor vessel." Required Action A.1, ("Restore train to OPERABLE status. | 72 hours") is apparently intended to apply to both condition statements independently because of the "OR" logical connector. However, Required Action A.1 needs to be rewritten, because when in the second condition statement both inoperable trains need to be restored to operable status within the 72 hour Completion Time. The staff requested in RAI 106-8069 (ML15206A003), Question 16-18, that the applicant propose new wording for Required Action A.1. In its response (ML15246A069) to Question 16-18 the applicant stated that GTS 3.5.2 Required Action A.1 will be separated into Action A.1 for one train inoperable and Action A.2 for two trains inoperable and diagonally oriented with respect to the reactor vessel. The applicant proposed to connect the two statements with the logical connector "OR"; however, the staff could not accept the response because "OR" means the applicant could choose either action for either condition statement, which is ambiguous. Using "AND" would require both actions to be completed for either condition, which would achieve the intended result of resolving either condition within 72 hours (or in certain scenarios, up to 96 hours). But this result can be achieved with just one action statement that can be phrased various ways:

> "Restore all trains to OPERABLE status."
>
> "Restore four trains to OPERABLE status."
>
> "Restore train(s) to OPERABLE status."
>
> "Restore compliance with the LCO."

The staff notes that because of the design requirement for one SIS division with two diagonally aligned trains to perform the safety function, the presentation of the Actions for STS 3.5.2 is not entirely suitable for the APR1400 SIS. In follow up RAI 509-8591 (ML16214A101), Question 16-210, the staff requested that the applicant consider placing each of the condition statements in separate rows of the Actions table, which would remove all ambiguity in how the completion times for the associated required actions are to be tracked for the condition of one

SIS train inoperable, and for the condition of two diagonal SIS trains inoperable. In its initial response (ML16251A532) to Question 16-210, the applicant presented the previous Condition A as two separate Conditions in the Subsection 3.5.2 Actions table. These are Condition A ("One train inoperable.") and Condition B ("Two trains inoperable and diagonally oriented with respect to the reactor vessel."). Accordingly, the staff observed that Condition D (as relabeled) should refer to Condition B instead of Condition A, so that Condition D states, "Two or more trains inoperable for reasons other than Condition B."

In addition to the correction to Condition D (as relabeled), the staff observed that Condition C (as relabeled) needs to be revised to say, "Required Action and associated Completion Time <u>*of Condition A or B*</u> not met." The Bases for Required Actions C.1 and C.2 also need revising to account for new Required Action B.1 ("Verify two trains diagonally oriented with respect to the reactor vessel are OPERABLE. | 1 hour").

Pending correction of these apparent oversights in Conditions C and D, and in the Bases for Required Action D.1, and the needed change to the Bases for Required Actions C.1 and C.2, RAI 509-8591, Question 16-210, was tracked as an open item.

In Subsection 3.5.2, Condition A (relabeled as Condition B, as noted previously) applies when two SIS trains are inoperable if the trains are diagonal and Required Action A.1 appears intended to allow 72 hours to restore the two trains to operable status (as discussed above). If two adjacent SIS trains are inoperable, Condition C applies and requires an immediate unit shutdown. As noted in RAI 159-8108 (ML15232A657), Question 16-48, the Bases for Subsection 3.5.2 do not explain the significance of "diagonal trains"; presumably two operable safety injection trains injecting on opposite sides of the reactor vessel is acceptable, but injecting on one side of the reactor vessel is not, possibly because a balanced or symmetric flow into the reactor vessel is necessary to satisfy safety analysis assumptions. The applicant stated that full flow from two diagonal SIS trains is credited in the APR1400 LOCA safety analysis. If only two adjacent SIS trains are available, the safety analysis criteria cannot be satisfied should a cold leg break occur [next to] one of the two adjacent DVI nozzles due to core bypass flow that could occur. In its (revised) response (ML16142A053) to RAI 159-8108, Question 16-48, the applicant agreed to include the following discussion of the significance of diagonal SIS trains in the Bases for Required Action A.1 (relabeled as Required Action B.1, as noted previously) of Subsection 3.5.2.

> <u>A.1</u>
>
> ... An event accompanied by a loss of offsite power and the failure of an emergency diesel generator can disable one SIS train until power is restored. ~~Full flow from two diagonally oriented SI pumps is credited for a break in an RCP discharge leg and flow is initially directed to the associated DVI and later a portion of the flow is directed to the hot leg via one of the available trains (Train 3 or 4).~~
>
> <u>B.1 and B.2</u>
>
> <u>Full flow from two diagonal SIS trains is credited because the safety analysis acceptance criteria cannot be satisfied should a cold leg break occur with the only two OPERABLE DVI nozzles being adjacent to the faulted cold leg due to core bypass flow that could occur.</u> Hence, continued operation for 72 hours is justified.

The staff finds the response acceptable because the Bases state the significance of having diagonal SIS trains operable. Therefore, RAI 150-8108, Question 16-48 is resolved.

In its supplemental response (ML17208B034) to RAI 509-8591, Question 16-210, the applicant revised Subsection 3.5.2 and the Actions section of Subsection B 3.5.2, as follows:

- Action A – removed Required Action A.2, which states "OR A.2 Restore two trains diagonally oriented with respect to the reactor vessel to OPERABLE status. | 72 hours" because Conditions B and D address two or more trains inoperable.

- Bases for Required Action A.1 – Retained the first sentence of the last paragraph of the original Bases for Required Action A.1, as shown in the discussion of Question 16-48 above, since it describes how one SIS train can be made inoperable by loss of multiple ac power sources.

- Action B – revised Condition B for clarity to state "B. Two trains inoperable and diagonally oriented with respect to the reactor vessel (Trains 1 and 3, or Trains 2 and 4)";

- Bases for Required Actions B.1 and B.2 – revised first paragraph for accuracy to state "If two trains are inoperable, it should be verified within 1 hour whether the inoperable trains are diagonally oriented with respect to the reactor vessel (Trains 1 and 3, or Trains 2 and 4~~; trains associated with the same emergency diesel generator~~) or not.

- Bases for Required Actions B.1 and B.2 – revised third paragraph for accuracy to state "Full flow from two diagonal SIS trains ~~diagonally oriented SI pumps~~ is credited because the safety analysis acceptance criteria *cannot* be satisfied should a cold leg break occur with the only two operable DVI nozzles being adjacent to the faulted cold leg due to core bypass flow that could occur. ~~for a break in an RCP discharge leg and flow is initially directed to the associated DVI and later a portion of the flow is directed to the hot leg via one of the available trains (Train 3 or 4).~~ Hence, continued operation for 72 hours is justified."

- Action C – revised Condition C for clarity to state "C. Required Action and associated Completion Time of Condition A or B not met."

- Bases for Required Actions C.1 and C.2 – revised first sentence for accuracy to state "If the inoperable train cannot be restored to OPERABLE status or the two operable diagonal trains cannot be verified within the associated Completion Time, the plant must be brought to a MODE in which the LCO does not apply."

- Action D – revised Condition D for accuracy to state "D. Two or more trains inoperable for reasons other than Condition ~~A~~ B."

- Bases for Required Action D.1 – revised first sentence for accuracy to state "If two or more trains are inoperable for reasons other than Condition ~~A~~ B, the unit is in a condition outside the accident analysis."

Since these changes clarify the phrasing and therefore the accuracy and useability of the action requirements and associated Bases, the staff finds the revised Actions table acceptable. Therefore, RAI 509-8591, Question 16-210, is resolved.

The staff reviewed Subsection 3.5.2 and Subsection B 3.5.2 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the SI System in Modes 1, 2, and 3 to mitigate events as assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.5.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.5.2 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.5.2. The staff also verified that Subsections 3.5.2 and B 3.5.2 are consistent with the guidance in STS Subsections 3.5.2 and B 3.5.2, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open item, the staff concludes that Subsection 3.5.2 and Subsection B 3.5.2 are acceptable.

Subsection 3.5.3 Safety Injection System (SIS) – Shutdown

GTS Subsection 3.5.3 includes requirements for the SIS in Modes 4 and 5, and in Mode 6 with reactor vessel level 0.25 inches below the top of the reactor vessel flange (< 130 ft 0 in elevation). The SIS is to provide emergency makeup of borated water to the RCS to ensure core cooling and insertion of negative reactivity to maintain shutdown margin sufficient to ensure that the reactor core is protected after any of the following accidents:

- Loss of coolant accident (LOCA)
- Control element assembly (CEA) ejection accident
- Loss of shutdown cooling
- Inadvertent reactor vessel drain down

The following table lists the RAI questions concerning Subsection 3.5.3.

Subsection 3.5.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-20	106-8069 ML15206A003 Response: ML15246A069	3.5.3 LCO statement – Revised; 3.5.3 Action B – Removed unnecessary Required Action B.1.1, and renumbered Required Action B.1.2 as B.1; B 3.5.3 Actions section - Revised Bases for Required Action B.1	CC	16-149.2H
16-21	106-8069 ML15206A003 Response: ML15246A069	3.5.3 Required Action B.2 – Justified 24 hour Completion Time; B 3.5.3 Actions section – Revised Bases for Required Action B.2	CC	16-149.2I
16-149.2H	481-8546 ML16133A271	Revise 3.5.3 Applicability in Mode 6 to "MODE 6 with	CR	

Subsection 3.5.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Responses: ML16312A528 ML17262A353 ML17291A634	~~RCS level < 39.7 m (130 ft 0 in)~~ water level < 7.0 m (23 ft) above the top of reactor vessel flange."		
16-149.2l	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	3.5.3 Actions and B 3.5.3 Actions section – Revise to account for staff proposed change in Applicability	CR	
16-153.3h	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Explained why automatic SIAS is not needed to meet LCO 3.5.3 SIS train operability requirements	CR	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CR Closed Resolved with no DCD changes

Although GTS Subsection 3.5.3 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.5.3 and the deviation report.

The staff noted in RAI 106-8069 (ML15206A003), Question 16-20, that proposed GTS 3.5.3 Condition B states "Required Action and associated Completion Time of Condition A not met." Required Action B.1.1 is to "Verify RCS level > 39.7 m (130 ft 0 in)," which is unnecessary because Required Action B.1.2 is to 'Initiate actions to restore "RCS level > 39.7 m (130 ft 0 in)," and the TS Applicability is "… MODE 6 with RCS level < 39.7 m (130 ft 0 in)." The applicant was requested to justify the need for Required Action B.1.1, or remove it and renumber Required Action B.1.2 as B.1. In its response (ML15246A069) to RAI 106-8069, Question 16-20, the applicant stated that TS 3.5.3 Required Action B.1.1 will be removed and Required Action B.1.2 will be renumbered as B.1. The staff finds the response acceptable. Therefore, RAI 106-8069, Question 16-20 is resolved.

The staff noted in RAI 106-8069 (ML15206A003), Question 16-21, that proposed GTS 3.5.3 Required Action B.2 is to "Reduce RCS cold leg temperature to < 57.2 °C (135 °F)" within 24 hours. Required Action B.2 and the associated Completion Time are not adequately justified or explained in the Bases or elsewhere. Question 16-21 requested that the applicant justify and explain Required Action B.2 and the associated 24 hour Completion Time in the Bases for Subsection 3.5.3. The staff notes that in the Bases for Required Action B.2, the last sentence says "The 24-hour Completion Time limits the time the plant is subject to conditions where the LCO is applicable." The purpose of this statement is not apparent when the unit is in Mode 6 because the Applicability for Mode 6 has no lower temperature range limit in its definition. In its response (ML15246A069) to RAI 106-8069, Question 16-21, the applicant stated that APR1400 requires operability of two SIS trains not only during Mode 4, but also in Mode 5, and in Mode 6 with RCS level < 39.7 m (130 ft 0 in) based on insights from the shutdown risk evaluation.

When no SIS trains are available during Mode 5, Action B requires immediately initiating action to raise reactor vessel level to 130 ft. Cooldown to the refueling temperature (135°F) is selected as an additional action requirement because it will place the unit in a safer status. Considering that the possibility of a pipe break during Mode 4 or Mode 5 is extremely low, this action is considered acceptable. It is possible to reduce RCS cold leg temperature from any shutdown condition to < 57.2°C (135°F) within 24 hours. Thus, the associated completion time is reasonable. The applicant proposed to enhance the Bases for Required Action B.2 to clarify these points. The staff finds the response acceptable. Therefore, RAI 106-8069, Question 16-21 is resolved.

The staff issued RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2H, to request that the applicant consider expanding the DCD Revision 0, Mode 6 Applicability of Subsection 3.5.3 from "Mode 6 with RCS level < 130 ft" to "Mode 6 with RCS level < 23 ft above the top of the reactor vessel (RV) flange." For consistency with this suggestion, the staff requested that Required Actions B.1.1 and B.1.2 be revised to also specify the higher water level, instead of 130 ft. The staff reasoned that requiring two SIS trains when RCS level is below the refueling water level (elevation 153 ft 1/4 in) instead of 0.25 inches below the reactor vessel flange (elevation 130 ft 0 in) affords significantly greater coolant inventory to mitigate a loss of decay heat removal or loss of coolant event, allowing operators more time before needing to manually initiate safety injection.

The staff also issued RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2I, to request the applicant to consider an edit to the Subsection 3.5.3 LCO statement and a suggestion for Mode-specific action requirements. Pending completion of the staff's review of the applicant's response (ML16195A559) to RAI 481-8546, Question 16-149, Sub-questions 2H and 2I, were tracked as open items.

However, the staff determined that the existing Applicability and Actions are adequate to address shutdown risk concerns, by considering each applicable mode of operation, as follows:

In GTS Subsection 3.5.3 of DCD Revision 0, Condition B must be entered if both diagonally oriented SIS trains, required by LCO 3.5.3, are not made operable within 1 hour, in accordance with Required Action A.1.

- If the unit is in Mode 6 with RCS level below the RV flange, Required Action B.1 (immediately verify RCS level is ≥ 130 ft, or immediately initiate actions to restore RCS level to ≥ 130 ft) would result in exiting the mode of applicability. If Required Action B.1 is completed in less than 24 hours, reducing cold leg temperature to < 135°F per Required Action B.2, and restoring the SIS trains to operable status, would then not be required because the LCO would no longer have to be met.

- If the unit is in Mode 6, but with RCS level below 127 ft 1/4 in (> 3 ft below the RV flange), LCO 3.9.5, in addition to two operable SC trains, would also require the containment spray pump in the same electrical division as the SC train in operation to be operable. Given the above failure to restore two SIS trains, this affords additional capability to restore RV level, and decay heat removal using the SC System.

- If the unit is in Mode 5 with RCS loops filled, RCS level must be above 134 ft elevation; which is about 4 ft above the RV flange. (See evaluations of Subsections 3.4.7 and 3.4.8 in Section 16.4.9 of this report.) Since LCO 3.5.3 applies in all of Mode 5, two diagonally oriented operable SIS trains would be required. In addition, LCO 3.4.7 would require:

- ○ Two operable SC trains, and one operable SC train to be in operation; or
- ○ One operable SC train to be in operation, and both SGs with secondary side water level ≥ 25% wide range indication (minimum level to support natural circulation secondary heat transfer; all reactor coolant pumps are idle)

In this situation, given the above failure to restore two SIS trains, completing Subsection 3.5.3 Required Action B.1 would not result in additional coolant inventory; neither would it result in exiting the mode of applicability of LCO 3.5.3. Therefore, reducing cold leg temperature to < 135°F must be completed within the 24 hour Completion Time of Required Action B.2.

- If the unit is in Mode 5 with RCS loops not filled, with RCS level below the RV flange, but ≥ 119 ft 1 in elevation, LCO 3.5.3 would require two diagonally oriented operable SIS trains. LCO 3.4.8 would require two operable SC trains, and one operable SC train to be in operation; and the containment spray pump in the same electrical division as the SC train in operation to be operable. Given the above failure to restore two SIS trains, this affords additional capability to restore RV level, and decay heat removal using the SC System.

  In this situation, given the above failure to restore two SIS trains, completing Subsection 3.5.3 Required Action B.1 would result in significant additional coolant inventory; but would not result in exiting the mode of applicability of LCO 3.5.3. Therefore, reducing cold leg temperature to < 135°F must be completed within the 24 hour Completion Time of Required Action B.2.

- If the unit is in Mode 5 with RCS loops not filled, with RCS level ≤ 119 ft 1 in (mid-loop operation), LCO 3.5.3 would require two diagonally oriented operable SIS trains. LCO 3.4.8 would require two operable SC trains, and one operable SC train to be in operation; and the containment spray pump in the same electrical division as the SC train in operation to be operable. Given the above failure to restore two SIS trains, this affords additional capability to restore RV level, and decay heat removal using the SC System.

  In this situation, completing Subsection 3.5.3 Required Action B.1 would result in significant additional coolant inventory; but would not result in exiting the mode of applicability of LCO 3.5.3. Since LCO Note 4 of Subsection 3.4.8 requires core exit temperature to be maintained ≤ 135°F during mid-loop operation, the requirement to reduce cold leg temperature to < 135°F within the 24 hour Completion Time of Required Action B.2 would already be met.

- If the unit is in Mode 4, LCO 3.5.3 would require two diagonally oriented operable SIS trains. LCO 3.4.6 would require two loops or trains consisting of any combination of RCS loops and shutdown cooling (SC) trains to be OPERABLE and at least one loop or train to be in operation.

  In this situation, given the above failure to restore two SIS trains, completing Subsection 3.5.3 Required Action B.1 would not result in additional coolant inventory; neither would it result in exiting the mode of applicability of LCO 3.5.3. And reducing cold leg temperature to < 135°F from Mode 4 conditions, within the 24 hour Completion Time of Required Action B.2, would necessarily require entering Mode 5, in which case the above discussion of LCO 3.4.7 would apply.

Based on the above evaluation, the staff concludes that the Actions table of Subsection 3.5.3 is acceptable, and that requiring two diagonally oriented operable SIS trains according to the Applicability of LCO 3.5.3 is an improvement over CE STS because it may reduce the core damage risk in Modes 4, 5, and 6 and during reduced RCS inventory conditions in Modes 5 and 6. Therefore, RAI 481-8546, Question 16-149, Sub-questions 2H and 2I, are resolved and closed, with no DCD changes. Note that Question 16-149 also addresses applicability and action requirements in Subsections 3.4.8, 3.5.4, 3.6.7, and 3.9.5.

The staff reviewed Subsection 3.5.3 and Subsection B 3.5.3 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the SI System in Modes 4 and 5, and in Mode 6 with RCS level below 130 ft elevation, to mitigate events as assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.5.3 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.5.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.5.3. The staff also verified that Subsections 3.5.3 and B 3.5.3 are consistent with the guidance in STS Subsections 3.5.3 and B 3.5.3, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.5.3 and Subsection B 3.5.3 are acceptable.

Subsection 3.5.4 In-Containment Refueling Water Storage Tank (IRWST)

Subsection 3.5.4 includes requirements for the IRWST in support of the SIS and the containment spray system (CSS) as a source of borated water for engineered safety feature (ESF) pump operation.

The following table lists the RAI questions concerning Subsection 3.5.4.

Subsection 3.5.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
6.3-7	158-7997 ML15295A497 Response: ML16007A083	3.5.1, 3.5.4, Added SR to verify atom percent Boron-10 in boric acid	CU	6.3-10
6.3-10	496-8630 ML16169A366 Responses: ML16202A539 ML17180A454 ML17222A209	APR1400 is keeping boron recycling as an option.	CC	
6.3-8	158-7997 ML15295A497 Response: ML15260B338	3.5.4 IRWST – added HVT trash rack to SR 3.5.2.8.	CC	
16-22	106-8069 ML15206A003	3.5.4 and B 3.5.4 – removed term “borated” to modify	CC	

Subsection 3.5.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML15246A069	IRWST water temperature and volume		
16-149.2L	481-8546 ML16133A271 Response: ML16312A528 ML17262A353 ML17291A634	Revised 3.5.4, IRWST, consistent with 3.5.3 suggested changes	CR	

Status Codes:
RC Resolved Confirmatory
CU Closed Unresolved (has follow up question)
CR Closed Resolved with no DCD changes
CC Closed Confirmed

Although Subsection 3.5.4 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.5.4 and the deviation report.

See Section 6.3 of this SER for discussion of RAI 496-8630 (ML16169A366), Question 6.3-10, which was tracked as an open item. The resolution of the technical specification aspect of Question 6.3-10 is described in the evaluation of Subsection 3.5.1 in Section 16.4.10 of this SER.

The staff noted that the proposed wording referring to IRWST water temperature and water volume uses “borated water temperature,” and “borated water volume” in generic TS 3.5.4 (Conditions A and B; SR 3.5.4.1 and SR 3.5.4.2; and associated Bases). Since there is a Condition addressing boron concentration, the need to use the adjective “borated” prior to the word water is questioned. In RAI 106-8069 (ML15206A003), Question 16-22, the staff requested that the applicant justify using the term “borated” before “water temperature” and “water volume” or revise the wording appropriately. In its response (ML15246A069) to Question 16-22, the applicant stated that the word “borated” before “water temperature” and “water volume” will be deleted to be a concise statement. The staff finds the response acceptable. Therefore, RAI 106-8069, Question 16-22 is resolved.

The staff issued RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2L, to request that the applicant consider expanding the Mode 6 Applicability of Subsection 3.5.4 from “Mode 6 with RCS level < 39.7 m (130 ft 0 in)” to “Mode 6 with RCS level < 23 ft above the top of the reactor vessel flange” to be consistent with a similar suggestion for the Mode 6 Applicability of Subsection 3.5.3. In its response (ML16195A559) to Question 16-149, regarding Sub-question 2L, the applicant stated the IRWST Mode 6 Applicability requirements are dictated by the Mode 6 SIS operability requirements of Subsection 3.5.3. Pending completion of its review, the response to Sub-question 2L was tracked as an open item.

In the evaluation of Subsection 3.5.3, the staff concluded that the SIS operability and action requirements, which apply in Modes 4 and 5, and in Mode 6 with RCS level at or below 130 ft elevation (1/4 in below top of the reactor vessel flange), are acceptable. Since the IRWST operability requirements in these shutdown Modes are needed to support the LCO 3.5.3 required operability of two diagonally oriented SIS trains, the staff evaluated the Actions table of Subsection 3.5.4 and verified that it is consistent with the Subsection 3.5.3 Actions table; in particular, Subsection 3.5.4 Condition D, which applies in Mode 5, and also in Mode 6 with RCS level below 130 ft elevation, when one or more IRWST parameters have not been restored to within limits within the specified completion time of Required Action A.1 or B.1. The required actions to immediately initiate action to restore RCS level to an elevation of 130 ft or greater, and within 24 hours reduce RCS cold leg temperature to less than 135°F are the same as Subsection 3.5.3 Required Actions B.1 and B.2, for the condition of having not restored the required diagonally oriented SIS trains to operable status within the specified completion time of Subsection 3.5.3 Required Action A.1. Therefore, the staff concludes that the Actions table of Subsection 3.5.4 is also acceptable. Therefore, RAI 481-8546, Question 16-149, Sub-question 2L, is resolved and closed. Note that Question 16-149 also addresses applicability and action requirements in Subsections 3.4.8, 3.5.3, 3.6.7, and 3.9.5.

The staff reviewed Subsection 3.5.4 and Subsection B 3.5.4 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the IRWST in Modes 1, 2, 3, 4 and 5, and in Mode 6 with RCS level below 130 ft elevation, to support the SIS and the CSS to mitigate events as assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.5.4 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.5.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.5.4. The staff also verified that Subsections 3.5.3 and B 3.5.4 are consistent with the guidance in STS Subsections 3.5.4 and B 3.5.4, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.5.4 and Subsection B 3.5.4 are acceptable.

Subsection 3.5.5 Trisodium Phosphate (TSP)

Subsection 3.5.5 includes requirements for TSP which is employed as a passive form of pH control for post LOCA containment spray and core cooling water.

There were no RAI questions concerning Subsection 3.5.5.

Subsection 3.5.5 is identical to STS Subsection 3.5.5, and is consistent with the APR1400 design for pH control of recirculated water in containment during a design basis event. Therefore, the staff concludes that Subsection 3.5.5 and Subsection B 3.5.5 are acceptable.

Conclusion for GTS Section 3.5 and Section B 3.5

The applicant adhered to the ECCS information as provided in the CE STS (digital), with some differences to reflect APR1400 unique design features. With respect to these unique design features, the GTS are sufficient to ensure operation of these features within the bounds of the safety analyses. Therefore, based on the above evaluation, the staff concludes that Section 3.5 and Section B 3.5 are acceptable.

16.4.11 TS Chapter 3.0 LCOs and SRs ─ Section 3.6 Containment Systems

GTS Section 3.6 provides requirements for the containment systems, which are designed to contain fission products that may exist in the containment atmosphere following accident conditions.

The GTS Subsections for the containment systems correspond to the CE STS Subsections in the following manner:

STS	GTS	Title (*STS Title, if different)
3.6.1	3.6.1	Containment
3.6.2	3.6.2	Containment Air Locks
3.6.3	3.6.3	Containment Isolation Valves
3.6.4	3.6.4	Containment Pressure
3.6.5	3.6.5	Containment Air Temperature
3.6.6*	3.6.6	Containment Spray System (*Containment Spray and Cooling Systems)
3.6.7*	–	(*Spray Additive System)
3.6.8*	–	(*Shield Building Exhaust Air Cleanup System)
3.6.9*	–	(*Hydrogen Mixing System)
3.6.10*	–	(*Iodine Cleanup System)
3.6.11*	–	(*Shield Building)
3.6.12*	–	(*Vacuum Relief Valves)
–	3.6.7	Containment Penetrations - Shutdown Operations

Unlike the typical CE digital PWR design currently in operation in the United States, the APR1400 containment design does not require a spray additive system, a safety-related hydrogen mixing system (HMS), a safety-related iodine cleanup system (ICS), a shield building, and containment vacuum relief valves. Accordingly, the GTS include no requirements comparable to the requirements in STS Subsections 3.6.7, 3.6.8, 3.6.9, 3.6.10, 3.6.11 and 3.6.12 for these structures, systems, and components. In the APR1400 design, (1) the pH adjustment baskets, which are required by LCO 3.5.5, perform the function of maintaining the post-accident pH level of the water inventory inside containment, instead of the spray additive system included in a typical CE digital PWR design, (2) the nonsafety-related combustible gas control system, which includes the HMS, is not covered by an LCO because it is designed to only mitigate severe accident events, (3) the DBA analyses, as described in DCD Tier 2, Sections 6.5.3 and 15.6.5, do not credit removal of gaseous iodine by a safety-related filtration system similar to the one used in the typical CE digital PWR design, and (4) the containment external pressure analysis of an inadvertent spray actuation event, as described in DCD Tier 2, Section 6.2.1, does not credit operation of vacuum relief valves, which is credited in the inadvertent spray actuation event analysis for the typical CE digital PWR design. Therefore, the staff concludes that the omission in GTS Section 3.6 of Subsections equivalent to CE STS Subsections 3.6.7, 3.6.8, 3.6.9, 3.6.10, 3.6.11 and 3.6.12 is acceptable.

Subsection 3.6.1 Containment

Subsection 3.6.1 includes requirements for the containment, which consists of the concrete reactor building (RB), its steel liner, and the penetrations through this structure. The structure is designed to contain radioactive material that could be released from the reactor core following a design basis LOCA. Additionally, this structure provides shielding of radiation from radioactive fission products that could be present in the containment atmosphere following accident conditions.

The following table lists the RAI questions concerning Subsection 3.6.1.

Subsection 3.6.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.1	125-7975 ML15216A651 Response: ML16032A596	B 3.6.1 ASA section and B 3.6.2 ASA section – replaced “allowable leakage rate of 0.1% of the containment volume per day” with “allowable leakage rate of 0.1% of containment air weight per day” for consistency with DCD Tier 2, Section 6.2 assumption.	CC	
16-25.2	125-7975 ML15216A651 Response: ML16032A596	B 3.6.1 SR section – removed duplicate paragraph from Bases for SR 3.6.1.1	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsection 3.6.1 provisions match those in STS Subsection 3.6.1. There is no significant difference between the APR1400 design and the CE PWR design with respect to maintaining containment integrity and containment leak tightness. Therefore Subsection 3.6.1 and Subsection B 3.6.1 are acceptable.

Subsection 3.6.2 Containment Air Locks

Subsection 3.6.2 includes requirements for the containment airlocks which form part of the containment pressure boundary and provide a means for personnel access during all Modes.

The following table lists the RAI questions concerning Subsection 3.6.2.

Subsection 3.6.2 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.1	125-7975 ML15216A651 Response: ML16032A596	B 3.6.2 Background ─ Revised to replace ”air volume” with “air weight”	CC	
16-50	162-8055 ML15235A003 Response: ML15301A207	3.6.2 Actions table Notes 1, 2, and 3, Required Action Notes 1 and 2 of Actions A and B, and surveillance column Notes 1 and 2 of SR 3.6.3.1 ─ Re-labeled as “NOTES” instead of “NOTE”	CC	
16-132	444-8530	SR 3.6.2.1 ─ Removed test	CC	

Subsection 3.6.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16076A028 Response: ML16152A263	acceptance criteria		

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although Subsection 3.6.2 closely follows the STS in format and content, the staff noted the following differences that warranted clarification beyond what was given in Subsection 3.6.2 and the deviation report.

In RAI 444-8530 (ML16076A028), Question 16-132, the staff requested the applicant to clarify the differences between STS SR 3.6.2.1 and GTS SR 3.6.2.1 as described in the deviation report. The main difference is that the GTS includes the acceptance criteria for air lock testing:

a. Overall air lock leakage rate is ≤ 0.05 L_a when tested at ≥ P_a [3.592 kg/cm^{2}G (51.09 psig)].

b. For each door seal, leak rate is ≤ 0.01 L_a when tested at ≥ P_a [3.592 kg/cm^{2}G (51.09 psig)].

The NRC staff also pointed out an inconsistency between the above listed test acceptance criteria and those provided in Specification 5.5.16, “Containment Leak Rate Testing Program,” which states the following:

b. The calculated peak containment internal pressure for the design basis loss of coolant accident, P_a is 51.77 psig. The containment design pressure is 60 psig.

d. Leakage rate acceptance criteria are:

  2. Air lock testing acceptance criteria are:

    i. Overall air lock leakage rate is ≤ 0.05 L_a when tested at ≥ P_a.

    ii. For each door, leakage rate is ≤ 0.01 L_a when pressurized to ≥ 10 psig.

In its response (ML16152A263) to Question 16-132, the applicant stated that the “Deviation Report [Revision 1) has some incorrect information on page 90. The acceptance criteria for air lock testing specified in TS SR 3.6.2.1 will be removed to coincide with TS 5.5.16.d acceptance criteria and STS format. Also, the P_a value (51.77 psig) in Subsection 5.5.16.b will be changed to 3.59 kg/cm^{2}G (51.09 psig).” The staff finds this response acceptable because the revised SR 3.6.2.1 and Subsection 5.5.16 conform to guidance in the STS and are consistent with the safety analyses described in DCD Tier 2, Section 6.2.1. Therefore, RAI 444-8530, Question 16-132, is resolved. Note that in Revision 2 of the DCA, the P_a value was revised to 3.60 kg/cm^{2}G (51.21 psig).

Based on its review, the staff concludes that Subsection 3.6.2 and Subsection B 3.6.2 are acceptable.

Subsections 3.6.3 Containment Isolation Valves, 3.6.4 Containment Pressure, and 3.6.5 Containment Air Temperature

Subsection 3.6.3 provisions match those in STS Subsection 3.6.3. There is no difference between the APR1400 design and the CE PWR design with respect to Type C testing of containment isolation valves in accordance with 10 CFR Part 50, Appendix J, Option B requirements.

Subsection 3.6.4 provisions match those in STS Subsection 3.6.4. There is no difference between the APR1400 design and the CE PWR design with respect to containment pressure requirements other than the design-specific pressure limits to reflect the assumed initial containment atmosphere conditions in the safety analyses that are applicable to the APR1400 design. There were no RAI questions concerning Subsection 3.6.4.

The following table lists the RAI question concerning Subsection 3.6.3.

Subsection 3.6.3 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-50	162-8055 ML15235A003 Response: ML15301A207	3.6.2 Actions table Notes 1, 2, and 3, Required Action Notes 1 and 2 of Actions A and B, and surveillance column Notes 1 and 2 of SR 3.6.3.1 ─ Re-labeled as “NOTES” instead of “NOTE”	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsection 3.6.5 provisions match those in STS Subsection 3.6.5. There is no difference between the APR1400 design and the CE PWR design with respect to containment temperature requirements other than the design-specific temperature limits to reflect the assumed initial containment atmosphere conditions in the safety analyses that are applicable to the APR1400 design. There were no RAI questions concerning Subsection 3.6.5.

Subsections 3.6.3, 3.6.4, and 3.6.5 closely follow STS Subsections 3.6.3, 3.6.4, and 3.6.5 in format and content, with only minor editorial differences. Therefore, the staff concludes that Subsections 3.6.3, 3.6.4, and 3.6.5 and Subsections B 3.6.3, B 3.6.4, and B 3.6.5 are acceptable.

Subsection 3.6.6 Containment Spray System

Subsection 3.6.6 includes requirements for the containment spray system (CSS), which cools containment atmosphere to limit post-accident pressure and temperature to less than the design values. The containment pressure reducing and the iodine removal capability of the spray reduce the release of fission product radioactivity from containment to the environment, in the event of a design basis accident (DBA), to within regulatory limits.

The APR1400 design has two 100 percent capacity containment spray (CS) divisions [trains] in contrast to the two 50 percent capacity CS trains and two 50 percent capacity containment air cooling trains in the typical CE digital plant design. The APR1400 shutdown cooling (SC) pumps and the CS pumps are designed to be interchangeable (within the same ESF Class 1E AC electrical division) so that the SC pumps can be used to perform the containment spray safety function during Modes 1, 2, 3, and 4; likewise, the CS pumps can be aligned to function as SC pumps for decay heat removal during Modes 4, 5, and 6.

The following table lists the RAI questions concerning Subsection 3.6.6.

Subsection 3.6.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.3	125-7975 ML15216A651 Response: ML16032A596	B 3.6.6 SR section – Added Bases for 31 day Frequency of SR 3.6.6.1	CC	
16-140.1	478-8568 ML16131A614 Responses: ML16182A594 ML17241A147	B 3.6.6 ASA section – Clarified how the SC pump is used as back-up to the CS pump regarding power supplies from different safety-related trains in Class 1E AC electrical power system	CC	
16-140.2	478-8568 ML16131A614 Responses: ML16182A594 ML17241A147	B 3.6.6 Applicability section – Clarified use of CS pump to support reduced RCS inventory activities in Modes 5 and 6	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Although Subsection 3.6.6 closely follows the STS in format and content, the staff noted the following items that warranted clarification beyond what was given in Subsection 3.6.6 and the deviation report.

In RAI 125-7975 (ML15216A651), Question 16-25, Sub-question 3, the staff requested that the applicant revise the Subsection B 3.3.6 SR section by adding a basis for the 31 day Frequency of SR 3.6.6.1. In its response (ML16032A596) to Question 16-25, regarding Sub-question 3, the applicant revised the Bases of SR 3.6.6.1 by inserting the following paragraph:

> The 31 day Frequency is based on engineering judgment, is consistent with the procedural controls governing valve operation, and ensures correct valve positions.

The staff finds this response acceptable. Therefore, RAI 125-7975, Question 16-25, Sub-question 3, is resolved.

In RAI 478-8568 (ML16131A614), Question 16-140, Sub-question 1, the staff requested the applicant to clarify how the SC pump is designed to back up the CS pump in Modes 1, 2 and 3, with respect to their respective power supplies from different trains in the Class 1E AC electrical system. In its response (ML16182A594) to Question 16-140, Sub-question 1, the applicant proposed to revise the Applicable Safety Analyses section of the Bases for Subsection 3.6.6 to add the following clarifying details; staff suggested editorial improvements are in italics highlighted in gray:

> The *~~associated~~ shutdown cooling pump in the same* electrical division *~~of shutdown cooling pump~~* can be aligned *to serve* as *~~backup for~~* the containment spray pump in MODES 1, 2, and 3 when the containment spray pump is not available.

Pending incorporation of the suggested changes, RAI 478-8568, Question 16-140, Sub-question 1, was tracked as an open item. In its revised response (ML17241A147), the applicant incorporated the suggested edits. Therefore Sub-question 1 is resolved.

In RAI 478-8568, Question 16-140, Sub-question 2, the staff requested the applicant to clarify the use of the CS pump to support reduced RCS inventory activities in Mode 6. In its response (ML16182A594) to Question 16-140, regarding Sub-question 2, the applicant proposed to revise the Applicability section of the Bases for Subsection 3.6.6 to add the following clarifying details; staff suggested editorial improvements are in italics highlighted in gray:

> When the unit is in MODE 6 with *RCS water level ≤ 127 ft 1/4 in ~~REDUCED RCS INVENTORY~~*, LCO 3.9.5.b requires the containment spray (CS) pump, which is in the same *~~Electrical Division~~ electrical division* as the SC*~~S~~* train in operation, to be OPERABLE.

Pending incorporation of the suggested changes, RAI 478-8568, Question 16-140, Sub-question 2, was tracked as an open item. In its revised response (ML17241A147), the applicant incorporated the suggested edits. Therefore Sub-question 2 is resolved.

Pending an explanation of why the new Note to STS SR 3.6.6.1, which was introduced by TSTF-523, as discussed in the evaluation of Subsection 3.4.6 in Section 16.4.9 of this SER, was not included with GTS SR 3.6.6.1, and why Subsection 3.6.6 did not include new STS SR 3.3.6.5, TSTF-523 was tracked as an open item. As discussed in the evaluation of Subsection 3.4.6 in Section 16.4.9 of this SER, the open item related to the missing provisions of TSTF-523 is resolved.

The staff reviewed Subsection 3.6.6 and Subsection B 3.6.6 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the CS System in Modes 1, 2, and 3 to mitigate design basis events as assumed in the accident analyses. Accordingly, the staff concludes that Subsection 3.6.6 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.6.6 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.6.6. The staff also verified that Subsections 3.6.6 and B 3.6.6 are consistent with the guidance in STS Subsections 3.6.6 and B 3.6.6, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.6.6 and Subsection B 3.6.6 are acceptable.

Subsection 3.6.7 Containment Penetrations – Shutdown [including Reduced RCS Inventory] Operations

Subsection 3.6.7 requirements are established to address safety issues related to operational experience with shutdown events during reduced RCS inventory conditions, with reactor vessel water level ranging from at or below the reactor vessel flange down to the level of the RCS hot leg connection to the reactor vessel, commonly referred to as mid-loop operation. This operational experience with shutdown events, such as a loss of core decay heat removal or inadvertent draining of the reactor vessel, is described in Generic Letter (GL) 88-17, "Loss of Decay Heat Removal," and is based on past events at pressurized water reactor (PWR) electrical power generation facilities in the United States. The STS does not include a subsection equivalent to Subsection 3.6.7.

The following table lists the RAI questions concerning Subsection 3.6.7.

Subsection 3.6.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.4	125-7975 ML15216A651 Responses: ML16032A596 ML17235B291	• LCO 3.6.7.c.1 and B 3.6.7 comparison to LCO 3.9.3.c.1 and B 3.9.3; • LCO 3.6.7.c.1 – verified omission of the term "equivalent" from LCO 3.6.7.c.1 statement; • B 3.6.7 – Background section – added discussion of safety issues in GL 88-17; last paragraph – removed content related to use of phrase "equivalent isolation method" as used in B 3.9.3	CC	16-149.1
16-25.5	125-7975 ML15216A651 Response: ML16032A596	• 1.1, B 3.6.2 Applicability section, 3.6.7, 3.9.3, 3.9.5 – removed definition of "REDUCED RCS INVENTORY"; used "< 127 ft 1/4 in" instead (change to B 3.6.2 subsequently obviated by change in Applicability of LCO 3.6.7); • B 3.6.7 Actions section – deleted brackets from Completion Times of Required Actions A.1 and B.1; • B 3.6.7 SR section– provided basis for 12 hour Frequency of SR 3.6.7.1	CC	16-149.2A 16-149.2B

Subsection 3.6.7 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-149.1	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634 ML17362A080	B 3.6.7 Background section ─ Revised to address GL 88-17 safety issues associated with requirements for containment closure in Modes 5 and 6; – last paragraph – removed content related to use of term “equivalent isolation method” as used in B 3.9.3 • 3.3.8 Applicability and Condition C – revised to account for reliance on LCO 3.6.7.c.2 and LCO 3.9.3.c.2 B 3.3.8 LCO and Applicability sections – made conforming changes	CC	
16-149.2A	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Shutdown risk mitigation features applicability. • Removed definition for “REDUCED RCS INVENTORY”	CC	
16-149.2B	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	• 3.6.7 – Replaced “REDUCED RCS INVENTORY” with “RCS level < 127 ft 1/4 in” • 3.6.7 – Revised title to “Containment Penetrations – Shutdown Operations” • B 3.6.1 Applicability section – Made conforming title change to reference to LCO 3.6.7 • B 3.6.2 Applicability section – Made conforming title change to reference to LCO 3.6.7 • 3.6.7 – Revised Required Action B.1 by replacing “> [EL 127’ 0” (38.7 m)]” with “> 38.72 m (127 ft 1/4 in)” • B 3.6.7 Actions section – Made conforming change to discussion of Action B.1	CC	

Subsection 3.6.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-149.2G	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	• 3.6.7 – Revised title to “Containment Penetrations – Shutdown Operations” • 3.6.7 - Revised Mode 5 Applicability to “MODE 5 with RCS loops not filled,” • 3.6.7 - Revised Mode 6 Applicability to “MODE 6 with the water level < 7.0 m (23 ft) above the top of the reactor vessel flange.” • 3.6.7 - Revised Applicability statement to add a new Note • B 3.6.7 – Changed title to “Containment Penetrations – Shutdown Operations” • B 3.6.7 ASA section – Revised LCO selection criterion statement • B 3.6.7 Applicability section – Revised to conform with Applicability changes; – Appended new paragraph about keeping equipment hatch closed when LCO 3.6.7 is required to be met	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Even though the proposed requirements in Subsection 3.6.7 are formulated in accordance with guidance in the STS, the staff determined that the supporting information provided in the Bases for Subsection 3.6.7 is incomplete. For example, the basis for this specification would be clearer if it included a discussion of GL 88-17 safety issues. In RAI 125-7975 (ML15216A651), Question 16-25, Sub-question 4, the applicant was requested to address this lack of detail in the Bases for Subsection 3.6.7:

> The TS 3.6.7 Bases do not provide sufficient supporting information with regard to the need for LCO 3.6.7 requirements. The LCO 3.6.7 statement reads almost the same as the one for LCO 3.9.3. Since the scope of "Applicability" for LCO 3.6.7 is different from the one for LCO 3.9.3, the staff expects to see a change to LCO 3.6.7.c.1 with respect to the term "equivalent " used in LCO 3.9.3 to mean "a HVAC or vapor barrier" which is not capable to prevent the release of fission products or support a pressurized containment condition as shown in the low-power-and-shutdown (LPSD) risk analysis. The applicant is requested to address the above staff's concerns and revise TS 3.6.7 and its associated bases accordingly.

In its response (ML16032A596) to Question 16-25, regarding Sub-question 4, the applicant stated (emphasis added):

> The closure of a containment penetration during reduced inventory operations requires different design criteria than during refueling operations. Since *the explained term of equivalent in LCO 3.9.3* for refueling operations may not be adequate for reduced inventory operations, that alternative for isolation *will be deleted from Technical Specification 3.6.7 as indicated in Attachment 4*. Unlike the Bases for LCO 3.9.3, the Bases for 3.6.7 does not include clarification for the term 'equivalent' and, therefore, no change to the Bases for 3.6.7 is necessary.

The staff noted that the applicant did not propose to revise the Subsection 3.6.7 Bases as requested, although the applicant did agree with removing the term "equivalent" from LCO 3.6.7.c.1 (see response letter enclosure, Attachment 4) instead of providing a suitable definition in the Subsection 3.6.7 Bases. Since provisions to fully address GL 88-17 safety issues are needed in various GTS Subsections, the staff issued follow up RAI 481-8546 (ML16133A271), Question 16-149, requesting that the applicant consider changes to these provisions in Section 1.1 and Subsections 3.4.7, 3.4.8, 3.5.3, 3.6.7, 3.9.4 and 3.9.5 and associated Bases.

In RAI 481-8546, Question 16-149, Sub-question 1, staff requested that the applicant revise the Background section of the Bases for TS 3.6.7 to include a discussion of operating experiences of currently operating PWR plants during mid-loop operations as documented in GL 88-17.

In its response (ML16312A528), to Question 16-149, Sub-question 1, the applicant revised the Background section of the Bases for Subsection 3.6.7 by replacing the existing discussion with a more detailed discussion addressing the reasons for requiring containment closure capability during shutdown operations in Mode 5 with the RCS loops not filled, and in Mode 6 with the refueling pool water level < 7.0 m (23 ft) above the top of the reactor vessel flange. The discussion covered the following safety issues associated with requiring containment closure during a loss of core decay heat removal event:

- steaming of reactor coolant into containment as a result of RCS heatup and direct venting;
- maintaining capability to close the containment equipment hatch within 1 hour without AC power and to hold it in place with at least [four bolts] approximately equally spaced;
- maintaining capability to close one door of the containment personnel access airlock;
- maintaining operable containment purge isolation actuation signal (CPIAS) and containment isolation actuation signal (CIAS) ESFAS functions.
- maintaining isolation, or the capability for manual isolation, on at least one side for containment penetrations that provide direct access from containment atmosphere to outside atmosphere; isolation may be achieved by an OPERABLE automatic isolation valve, a manual isolation valve, or a blind flange.

The staff finds the proposed change acceptable because it highlights the reasons for requiring containment closure capability during shutdown operations in Mode 5 with the RCS loops not filled, and in Mode 6 with the refueling pool water level < 7.0 m (23 ft) above the top of the reactor vessel flange. Therefore, RAI 481-8546, Question 16-149, Sub-question 1, is resolved. However, it is unclear from the provided markup (response letter enclosure Attachment 1, page 2) whether the applicant still intends to remove the term “equivalent” from LCO 3.6.7.c.1, since the Background section of the Subsection 3.6.7 Bases provides a definition identical to that provided in the Bases for Subsection 3.9.3; in addition, Subsection 3.9.4 Required Action A.4 and Subsection 3.9.5 Required Action B.4 (both of which are the result of the applicant’s response (ML16036A378) to RAI 133-7978, Question 16-31) require placing the containment building penetrations in the required status within 4 hours as specified in LCO 3.6.7. Therefore, this part of RAI 125-7975, Question 16-25, Sub-question 4, was tracked as an open item. In its revised response (ML17235B291) to RAI 125-7975, Question 16-25, Sub-question 4, the applicant maintained the term “equivalent” in LCO 3.6.7.c.1 and noted that Revision 1 of Subsection B 3.6.7, Background section, already includes the following passage regarding equivalent containment penetration isolation methods:

> The containment penetrations that provide direct access from containment atmosphere to outside atmosphere must be isolated on at least one side. Isolation may be achieved by an OPERABLE automatic isolation valve, or by a manual isolation valve, blind flange, or equivalent. Equivalent isolation methods must be approved and may include use of a material that can provide a temporary, atmospheric pressure ventilation barrier for the other containment penetrations during fuel movements.

However, the staff could not consider RAI 125-7975, Question 16-25, Sub-question 4, to be resolved because the use of “equivalent isolation methods” for containment penetrations that provide direct access from containment atmosphere to outside atmosphere is contrary to the shutdown risk evaluation assumptions for containment closure should a loss of decay heat removal event occur during a condition of reduced RCS inventory, including mid-loop operation.

In its second revised response (ML17291A634) to RAI 481-8546, Question 16-149, in the markup of affected pages of Subsections 3.6.7 and B 3.6.7, the applicant omitted the phrase “, or equivalent” from LCO 3.6.7.c.1, but inadvertently retained the associated discussion, which is quoted above, in the last paragraph of the Background section of the Bases. Since the staff’s acceptance of the shutdown PRA is based in part on the exclusion from LCO 3.6.7.c.1 of any allowance for use of an equivalent method to isolate containment penetrations that provide direct access from containment atmosphere to outside atmosphere, the applicant subsequently submitted a third revised response (ML17362A080) to RAI 481-8546, Question 16-149. In that response, the applicant revised the last paragraph of the Background section of Subsection B 3.6.7 as indicated by the following mark up:

> The containment penetrations that provide direct access from containment atmosphere to outside atmosphere must be isolated on at least one side. Isolation may be achieved by an OPERABLE automatic isolation valve, ~~or by~~ a manual isolation valve, or a blind flange~~, or equivalent. Equivalent isolation methods must be approved and may include use of a material that can provide a temporary, atmospheric pressure ventilation barrier for the other containment penetrations during fuel movements~~.

In the response, the applicant also states that this third revised response supersedes previous RAI question responses, such as for RAI 125-7975, Question 16-25, Sub-question 4, regarding LCO 3.6.7.c.1. Since this third revised response is consistent with the resolution of RAI 440-8551 (ML16074A286), Question 19-95, as documented in Chapter 19 of this SER (also see Question 19-95 responses at ML16113A413 and ML16250A866), the staff concludes that LCO 3.6.7.c.1 and the last paragraph of the Background section of Subsection B 3.6.7 are acceptable. Therefore, the resolution of RAI 481-8546, Question 16-149, Sub-question 1 is confirmed; in addition, the staff concludes that RAI 125-7975, Question 16-25, Sub-question 4, is resolved.

In RAI 125-7975 (ML15216A651), Question 16-25, Sub-question 5, the applicant was requested to provide a discussion of the basis for the bracketed 6 hour Completion Time associated with Subsection 3.6.7 Actions A and B and the basis for the 12 hour Frequency of SR 3.6.7.1; these requirements, as initially proposed in DCD Revision 0, are as follows with metric units omitted. Editorial changes related to the responses (ML16312A528, ML17262A353, ML17291A634) to RAI 481-8546, Question 16-149, Sub-question 2B, are indicated by markup. The staff also suggests an additional edit, which is indicated by italics, to conform to standard phrasing of such Condition statements in the STS:

> A. One or more containment penetrations not in required status. | A.1 Restore containment penetration to required status. | [4 ~~6~~ hours]
>
> B. Required Action and *associated* Completion Time not met. | B.1 Restore RCS level to > 127 ft 1/4 in. ~~>[EL 127' 0" (38.7 m)].~~ | [6 hours]
>
> SR 3.6.7.1 Verify each required containment building penetration is in its required status. | [12 hours]

In its response (ML16032A596) to Question 16-25, regarding Sub-question 5, the applicant proposed to revise the bracketed 6 hour Completion Time of Required Action A.1 to 4 hours for consistency with the equivalent condition in STS Subsection 3.9.5; the applicant also revised the Actions section of the Bases for Subsection 3.6.7 as follows:

> A.1
>
> If one or more containment penetrations are not in the required status, restoration must be accomplished within [4 ~~6~~] hours. This will ensure that the plant will be within the assumptions of the safety analysis.
>
> B.1
>
> If Action A.1 has not been completed within the [4 ~~6~~] hours, then the RCS level must be restored to > 127 ft 1/4 in ~~>[EL 127' 0" (38.7 m)]~~ within [6] hours of Action A.1 not being met.

The staff accepts the proposed basis for the completion times and surveillance frequencies of Subsection 3.6.7 because of the short time intervals during which an event requiring containment closure is unlikely to occur. However, pending a final resolution of RAI 481-8546, Question 16-149, which may result in additional changes to Subsection 3.6.7, RAI 125-7975, Question 16-25, Sub-question 5, was tracked as an open item. The applicant provided a revised response (ML17262A353) to RAI 481-8546, Question 16-149. Since this revised response did not affect the above indicated changes, the staff finds the response to Sub-question 5 acceptable. Therefore, RAI 125-7975, Question 16-25, Sub-question 5, is resolved.

In its response (ML16312A528) to RAI 481-8546, Question 16-149, regarding Sub-question 2G, the applicant agreed to revise the title of Subsection 3.6.7 to "Containment Penetrations –

Shutdown Operations”; however the related proposed change in the ASA section of Bases for Subsection 3.6.7 needs clarification, as indicated in the following markup.

> *Containment penetration status during* ~~Shutdown~~ *shutdown* operations ~~*satisfy*~~ *satisfies* ~~LCO Selection~~ Criterion 3 *of 10 CFR 50.36(c)(2)(ii)*.

In response to Sub-question 2G, the applicant also proposed to revise the Subsection 3.6.7 Applicability and to add an Applicability Note, regarding closure of the equipment hatch before removing the pressurizer manway; the applicant also made conforming changes to the Applicability section of the Bases for Subsection 3.6.7, as follows; additional staff suggested clarifications are indicated by italics highlighted in gray.

APPLICABILITY:

MODE 5 with *any* Reactor Coolant System (RCS) loop~~s~~ not filled ~~REDUCED RCS INVENTORY~~,
MODE 6 with the water level < 23 ft above the top of *the* reactor vessel flange ~~REDUCED RCS INVENTORY~~.

--------------------------------NOTE--------------------------------
The equipment hatch ~~*is*~~ *shall be* closed *and held in place by a minimum of [four bolts]* before *opening* the ~~*manway of*~~ pressurizer ~~*(PZR) opens*~~ *manway* in MODE 5.

APPLICABILITY

The LCO is applicable ~~*during*~~ *in* MODE 5 with *any* RCS loop~~s~~ not filled ~~REDUCED RCS INVENTORY~~ ~~*or*~~ *and in* MODE 6 with the *refueling pool* water level < 23 ft above the top of the reactor vessel flange ~~REDUCED RCS INVENTORY~~.

The equipment hatch ~~*keeps*~~ *is administratively required to be* closed *before opening the pressurizer manway in MODE 5, and is kept closed* during ~~*these MODEs*~~ *MODE 5 in the RCS loops not filled condition and during MODE 6 with water level below the level required by LCO 3.9.6, “Refueling Water Level.”* ~~*, because the equipment hatch is administratively closed before the manway of the pressurizer opens.*~~ *This ensures that all containment penetrations will be in the status required by LCO 3.6.7 before the onset of reactor coolant boiling and steaming into containment in the event of a loss of shutdown cooling during reduced RCS inventory conditions.*

Pending incorporation of the above staff-proposed clarifying changes to the LCO 3.6.7 Applicability statement, and to the ASA and Applicability sections of the Bases for Subsection 3.6.7, RAI 481-8546, Question 16-149, Sub-question 2G was tracked as an open item. In its revised responses (ML17262A353 and ML17362A080) to Question 16-149, regarding Sub-question 2G, the applicant incorporated the suggested clarifications to the LCO 3.6.7 Applicability statement and the associated Bases. In addition, the applicant removed the brackets from the 4 hour Completion Time for Required Action A.1 and the 6 hour Completion Time of Required Action B.1, consistent with the final response (ML17290B218) to RAI 154-8064, Question 16-44. Therefore, RAI 481-8546, Question 16-149, Sub-question 2G is resolved.

The staff concludes that Subsection 3.6.7 and Subsection B 3.6.7 are acceptable based on the above evaluation, and because they are an improvement over the STS. The additional operational limitations they provide will reduce the risk of operation while shutdown in a reduced RCS inventory condition.

Conclusion for Section 3.6 and Section B 3.6

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.6 and Section B 3.6 are acceptable.

16.4.12 TS Chapter 3.0 LCOs and SRs ─ Section 3.7 Plant Systems

GTS Section 3.7 provides requirements for plant systems and components on (1) the secondary-side of the steam generators such as the main steam safety valves (MSSVs), the main steam isolation valves (MSIVs), the main feedwater isolation valves (MFIVs), the main steam atmospheric dump valves (MSADVs); and the Auxiliary Feedwater System (AFWS); (2) the balance-of-plant cooling water supply such as the Component Cooling Water System (CCWS), the Essential Service Water System (ESWS), and the Essential Chilled Water System (ECWS); (3) the various plant heating, ventilation and air conditioning (HVAC) systems; and (4) requirements for controlling parameters such as specific activity in the secondary side coolant, or boron concentration and water level in the spent fuel storage pool.

The GTS for the plant systems correspond to the CE STS in the following manner:

STS	GTS	Title (*STS Title, if different)
3.7.1	3.7.1	Main Steam Safety Valves
3.7.2	3.7.2	Main Steam Isolation Valves
3.7.3	3.7.3	Main Feedwater Isolation Valves
3.7.4*	3.7.4	Main Steam Atmospheric Dump Valves (*Atmospheric Dump Valves)
3.7.5	3.7.5	Auxiliary Feedwater (AFW) System
3.7.6*	3.7.6	Auxiliary Feedwater Storage Tank (*Condensate Storage Tank)
3.7.7	3.7.7	Component Cooling Water (CCW) System
3.7.8*	3.7.8	Essential Service Water System (*Service Water System)
3.7.9	3.7.9	Ultimate Heat Sink
3.7.10*	3.7.10	Essential Chilled Water System (*Essential Chilled Water System)
3.7.11*	3.7.11	Control Room Heating, Ventilation, and Air Conditioning (HVAC) System (*Control Room Emergency Air Cleanup System)
3.7.12*	3.7.11	Control Room HVAC System (*Control Room Emergency Air Temperature Control System)

3.7.13*	3.7.12	Auxiliary Building Controlled Area Emergency Exhaust System (*ECCS Pump Room Exhaust Air Cleanup System)
3.7.14*	3.7.13	Fuel Handling Area Emergency Exhaust System (*Fuel Building Air Cleanup System)
3.7.15*	3.7.12	Auxiliary Building Controlled Area Emergency Exhaust System (*Penetration Room Exhaust Air Cleanup System)
3.7.16*	3.7.14	Spent Fuel Pool Water Level (*Fuel Storage Pool Water Level)
3.7.17*	3.7.15	Spent Fuel Pool Boron Concentration (*Fuel Storage Pool Boron Concentration)
3.7.18*	3.7.16	Spent Fuel Assembly Storage (*Spent Fuel Pool Storage)
3.7.19	3.7.17	Secondary Specific Activity

Although GTS Section 3.7 is modeled on STS format and content, the staff noted differences from the STS that warranted technical justification and clarification beyond what was given in GTS Section 3.7 and Section B 3.7, and in the deviation report. The following evaluation summarizes key concerns raised during the staff's review of each of the seventeen subsections in GTS Section 3.7.

Subsection 3.7.1 Main Steam Safety Valves (MSSVs)

Subsection 3.7.1 includes requirements for the MSSVs, which provide overpressure protection for the secondary system, and protection against overpressurizing the reactor coolant pressure boundary (RCPB) by providing a heat sink for the removal of energy from the RCS if the preferred heat sink, provided by the Condenser and Circulating Water System, is not available.

The following table lists the RAI questions concerning Subsection 3.7.1.

Subsection 3.7.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.1	120-7977 ML15209A000 Responses: ML16050A530 ML17191B261	Table 3.7.1-2 Note regarding MSSV setting tolerances and lack of references to ASME Code in B 3.7.1	CU	16-150.1
16-130.2B1	439-8524 ML16074A284 Response: ML16187A196	SR 3.7.1.1, SR 3.7.2.1, and SR 3.7.2.2 have incorrect Note for when a surveillance is required to "be performed" – Note revised to say "Only required to be performed in MODES 1 and 2."	CC	
16-130.2B2	439-8524 ML16074A284 Response:	SR 3.7.1.1 – Removed unnecessary Note excepting SR 3.0.4	CC	

Subsection 3.7.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16187A196			
16-150.1	481-8546 ML16133A271 Responses: ML16187A207 ML16237A360 ML16323A495 ML17222A186	Table 3.7.1-2 Note and SR 3.7.1.1 – Revised to clarify appropriate use of "as-found" and "as-left" setting tolerances	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Although Subsection 3.7.1 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.7.1 and the deviation report.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 1, and in follow up RAI 481-8546 (ML16133A271), Question 16-150, Sub-question 1, the applicant was requested to clarify the application of the ±3% tolerance for the "As-Found" value of the MSSV lift setpoint. In the CE STS, this allowance is discussed in the Bases for SR 3.7.1.1, with the ±3% placed in brackets, which indicate a need for further supporting information to meet ASME Code, Section III, NC 7000 requirements. A set pressure tolerance of ±1% must be applied to the "As-Found" value unless a greater tolerance is established as permissible in the Overpressure Protection Report (NC 7200). In its second revised response (ML16323A495) to Question 16-150, regarding Sub-question 1, the applicant stated the following:

> Table 3.7.1-2 allows a ±3% setpoint tolerance for OPERABILITY. Therefore further testing for the valves is unnecessary in the case where the lift setting is within OPERABILITY limit. If the lift setting does not meet the OPERABILITY limit, two additional valves (maximum of the total number of MSSV) per valve with unsatisfactory result are required to be tested according to the ANSI/ASME OM-1987 requirements.
>
> Generic TS 3.7.1, Table 3.7.1-2 and, Bases 3.7.1 will be revised as indicated in the attachment.

The Table 3.7.1-2 Note is being revised as follows (deleted text is lined-out and added text is underlined):

> -- NOTE --
> ~~Table 3.7.1-2 allows a ± 3 % setpoint tolerance for OPERABILITY; however, the valves are reset to ± 1 % during the Surveillance to allow for drift~~ <u>Each MSSV's as-found lift setting shall be within ±3% of the lift setting value stated in Table 3.7.1-2 for the valve to be considered OPERABLE. The valve's lift setting shall be reset to within the calibration tolerance of ±1% of the lift setting value stated in Table 3.7.1-2 if the lift setting is found to be outside the calibration tolerance.</u>

The SR 3.7.1.1 surveillance statement is being revised as follows (deleted text is lined-out and added text is underlined):

> Verify each required MSSV ~~lift setpoint per Table 3.7.1- 2~~ is within ±3% of the lift setting value stated in Table 3.7.1-2, in accordance with the Inservice Testing Program. ~~Following testing, lift settings shall be within ± 1 %~~ If the lift setting is found to be outside the calibration tolerance of ±1% of the lift setting value stated in Table 3.7.1-2, the valve lift setting shall be reset to within the calibration tolerance.

The Applicable Safety Analyses (ASA) section of Subsection B 3.7.1 is revised by adding the following at the end of the section (staff suggested clarifications are denoted in italics with gray highlight):

> In *the* safety analysis, the lift setpoint of MSSV is considered *to have a* total *uncertainty of* ±4% ~~uncertainty~~ that includes ±3% setpoint uncertainty with long term drift and ±1% instrument error *uncertainty for additional conservatism* ~~*conservatively*~~.

The discussion SR 3.7.1.1 in Subsection B 3.7.1 is also revised as follows:

> … Table 3.7.1-2 allows a ±3 % setpoint tolerance for OPERABILITY~~; however, the valves are reset to ± 1 % during the Surveillance to allow for drift~~. Therefore, further testing for the valves is unnecessary in the case where the lift setting is within *the* OPERABILITY limit. If the lift setting does not meet the OPERABILITY limit, two additional valves ~~*(maximum of the total number of MSSV)*~~ per valve showing an unsatisfactory result*, up to the total number of remaining valves,* are required to be tested according to the ANSI/ASME OM-1987 requirements. In case that the lift setting is not within ±1% even though it is within the OPERABILITY limit, the valves ~~are~~ *must be* reset within ±1%.

The staff noted that the applicant had provided a document titled "Overpressure Protection for APR1400" in its response (ML15348A085) to RAI 233-8244, Question 5.2.2-1; see Section 5.2.2 of this SER for discussion of this RAI response. In this document, the applicant states, in part, regarding MSSVs, "[T]he first, second, and third banks of MSSVs are assumed to lift at 1,235.7, 1,267.9 and 1,293.9 psia and to close at 1,112.1, 1,141.1 and 1,164.5 psia, respectively." When compared to the lift setpoints of 1174, 1205, and 1230 psig for the respective MSSVs in Table 3.7.1-2, the assumed values in the overpressure protection report exceed the +3% allowance listed in GTS Subsection 3.7.1. For example, the assumed lift setting of the first bank of MSSVs, converted to psig, is 1235.7 psia minus 14.7 psi, or 1221 psig, which is greater than the Table 3.7.1-2 value of 1174 psig by a factor of 1.04, or 4%. This 4% difference includes a 3% uncertainty that accounts for long term drift and a 1% instrument error uncertainty, as stated in the proposed change to the ASA section of the Bases.

Based on the above discussion, the staff finds this response acceptable because the revised Note to Table 3.7.1-2 and related Bases for Subsection 3.7.1 clearly provide the basis for the cited operability tolerance of ±3%. Pending incorporation of the suggested clarifications in the ASA and SR sections of the Bases for Subsection 3.7.1, RAI 481-8546, Question 16-150, Sub-question 1, was tracked as an open item. In its third revised response (ML17222A186) to Question 16-150, Sub question 1, the applicant revised Subsection B 3.7.1, as follows:

- Replace last two paragraphs of ASA section with:

  > In the safety analysis, the lift setpoint of [an] MSSV is considered to have a total uncertainty of ±4% that includes ±3% setpoint uncertainty with long term drift and ±1% instrument error uncertainty for additional conservatism.
  >
  > The MSSVs satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

- Revise second paragraph of Surveillance Requirements section for SR 3.7.1.1, as indicated:

  > The ANSI/ASME Standard requires that all valves be tested every 5 years, and a minimum of 20% of the valves be tested every 24 months. The ASME Code specifies the activities and frequencies necessary to satisfy the requirements. Table 3.7.1-2 allows a ±3% setpoint tolerance for OPERABILITY. Therefore, further testing for the valves is unnecessary in the case where the lift setting is within the OPERABILITY limit. If the lift setting does not meet the OPERABILITY limit, two additional valves ~~(maximum of the total number of MSSV) per valve showing an unsatisfactory result~~ per valve showing an unsatisfactory result, up to the total number of remaining valves, are required to be tested according to the ANSI/ASME OM-1987 requirements. In case that the lift setting is not within ±1% even though it is within the OPERABILITY limit, the valves ~~are~~ must be reset within ±1%.

These changes provide the requested clarification of the Bases for Subsection 3.7.1. Therefore, RAI 481-8546, Question 16-150, Sub-question 1, is resolved.

In RAI 439-8524 (ML16074A284), Question 16-130, Sub-question 2B1, the applicant was requested to conform the surveillance column Note for SR 3.7.1.1 to the STS SR 3.7.1.1 version of the Note so that the first sentence of the Note states “Only required to be performed in MODES 1 and 2.” In Question 16-130, Sub-question 2B2, the applicant was requested to remove the second sentence of the surveillance column Note because there is no need to explicitly state that the Note is an exception to the SR 3.0.4 restriction on operational Mode entry. In its response (ML16187A196) to Question 16-130, the applicant made the requested changes to the surveillance column Note for SR 3.7.1.1 (first sentence), and also for SR 3.7.2.1 and SR 3.7.2.2 to state “Only required to be performed in MODES 1 and 2.” The second sentence of the Note for SR 3.7.1.1 was deleted. Conforming changes to the Bases for these SRs were also made. Therefore, Sub-questions 2B1 and 2B2 of Question 16-130 of RAI 439-8524 are resolved.

The staff reviewed Subsection 3.7.1 and Subsection B 3.7.1 and verified that the MSSV LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure overpressure protection for the secondary system, and also for the RCPB for events initiating in Mode 1, 2 or 3 that are characterized in the transient and accident analyses as decreased heat removal events. These include the full power loss of condenser vacuum event, which is the limiting anticipated operational occurrence, and the full power feedwater line break inside containment, which is the limiting design basis accident for peak RCS pressure. Accordingly, the staff concludes that Subsection 3.7.1 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.1. The staff also verified that Subsections 3.7.1 and B 3.7.1 are consistent with the guidance in CE STS Subsections 3.7.1 and B 3.7.1, and the APR1400 design as described in the DCD. Therefore, based on its review and resolution of the identified open item, the staff concludes that Subsection 3.7.1 and Subsection B 3.7.1 are acceptable.

Subsection 3.7.2 Main Steam Isolation Valves (MSIVs)

Subsection 3.7.2 includes requirements for the MSIVs, which isolate steam flow from the secondary side of the steam generators following a high energy line break (HELB). MSIV closure terminates flow from the unaffected (intact) steam generator.

The following table lists the RAI question concerning Subsection 3.7.2.

Subsection 3.7.2 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-130.2B1	439-8524 ML16074A284 Response: ML16187A196	SR 3.7.1.1, SR 3.7.2.1, & SR 3.7.2.2 have incorrect Note for when a surveillance is required to "be performed"; – Note revised to say "Only required to be performed in MODES 1 and 2."	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

As previously described in the evaluation of Subsection 3.7.1, the applicant made the requested changes to the surveillance column Note in SR 3.7.2.1 and SR 3.7.2.2. Therefore, Sub-question 2B1 of Question 16-130 of RAI 439-8524 is resolved.

The staff reviewed Subsection 3.7.2 and Subsection B 3.7.2 and verified that the MSIV LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the MSIVs will perform their design safety function to mitigate the radiological consequences of accidents initiating in Mode 1, 2, or 3. Accordingly, the staff concludes that Subsection 3.7.2 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.1 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.1. The staff also verified that Subsections 3.7.2 and B 3.7.2 are consistent with the guidance in CE STS Subsections 3.7.2 and B 3.7.2, and the APR1400 MSIV design as described in the DCD. Therefore, based on its review and the resolution of the identified open item, the staff concludes that Subsection 3.7.2 and Subsection B 3.7.2 are acceptable.

Subsection 3.7.3 Main Feedwater Isolation Valves (MFIVs)

Subsection 3.7.3 includes requirements for the MFIVs, which isolate main feedwater (MFW) flow to the secondary side of the steam generators following a high energy line break (HELB).

Each steam generator has two in-series MFIVs in the economizer flow path and two in-series MFIVs in the downcomer flow path.

There were no RAI questions concerning Subsection 3.7.3.

The staff reviewed Subsection 3.7.3 and Subsection B 3.7.3 and verified that the MFIV LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the eight MFIVs will perform their design safety function as assumed in the safety analyses for events initiating in Mode 1, 2, or 3. Accordingly, the staff concludes that Subsection 3.7.3 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.3 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.3. The staff also verified that Subsections 3.7.3 and B 3.7.3 are consistent with the guidance in CE STS Subsections 3.7.3 and B 3.7.3, and the APR1400 MFIV design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.7.3 and Subsection B 3.7.3 are acceptable.

Subsection 3.7.4 Main Steam Atmospheric Dump Valves (MSADVs)

Subsection 3.7.4 includes requirements for the MSADVs, which provide a safety grade method for cooling the unit to shutdown cooling system (SCS) entry conditions, should the preferred heat sink via the Steam Bypass System to the condenser not be available.

The following table lists the RAI questions concerning Subsection 3.7.4.

Subsection 3.7.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-108.9	289-8215 ML15307A004 Response: ML16027A196	3.7.4 - Revised LCO and Condition A to reflect that the specified two operable MSADVs are "per steam generator"	CC	
16-108.10	289-8215 ML15307A004 Response: ML16027A196	3.7.4 – Revised Condition B to reflect that the specified two operable MSADVs are "per steam generator"	CC	
16-130.2A	439-8524 ML16074A284 Response: ML16187A196	3.7.4 Required Action A.1 – Added Note excepting LCO 3.0.4 consistent with STS 3.7.4 Rev 2.2	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The APR1400 design has four main steam lines with two for each of the two steam generators (SGs) in contrast to the two main steam lines, one per SG, in the digital CE PWR design. As a result, each SG has two MSADVs, one on each main steam line, which the control room operator may use to cool down the RCS from Mode 3, the hot standby condition ($T_{cold} \geq 350^{\circ}F$), to Mode 4, the hot shutdown condition (350˚F > T_{cold} > 210˚F), following an event in which the condenser is unavailable for use with the Steam Bypass System.

Although Subsection 3.7.4 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.7.4 and the deviation report.

In RAI 289-8215 (ML15307A004), Question 16-108, Sub-questions 9 and 10, the staff requested the applicant to modify Subsection 3.7.4 and its associated Bases to more clearly reflect the two-MSADVs-per-SG design. In its response (ML16027A196) to Question 16-108, regarding Sub-questions 9 and 10, the applicant proposed to revise the LCO 3.7.4 statement, Actions A and B as follows:

LCO 3.7.4 Two MSADV lines per steam generator shall be OPERABLE.

A. One ~~required~~ MSADV line inoperable. | A.1 Restore MSADV line to OPERABLE status. | 7 days

B. Two ~~or more~~ MSADV lines inoperable. | B.1 Restore ~~all but~~ one MSADV line to OPERABLE status. | 24 hours

The staff finds this response acceptable because the revised LCO 3.7.4 statement and applicable Actions table entries are consistent with guidance in the STS, and reflect the main steam system design regarding MSADVs as described in DCD Section 10.3, "Main Steam System." Therefore, RAI 289-8215, Question 16-108, Sub-questions 9 and 10, are resolved.

The staff reviewed Subsection 3.7.4 and Subsection B 3.7.4 and verified that the MSADV LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the MSADVs will perform their RCS heat removal safety function to provide, along with the auxiliary feedwater system, a safety grade means of cooling the unit to SCS temperature and pressure entry conditions for events initiating in Mode 1, 2, or 3, or in Mode 4 with a steam generator being relied upon for RCS heat removal, and the preferred heat sink is not available. Accordingly, the staff concludes that Subsection 3.7.4 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.4 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.4. The staff also verified that Subsections 3.7.4 and B 3.7.4 are consistent with the guidance in CE STS Subsections 3.7.4 and B 3.7.4, and the APR1400 MSADV design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.7.4 and Subsection B 3.7.4 are acceptable.

Subsection 3.7.5 Auxiliary Feedwater System (AFWS)

Subsection 3.7.5 includes requirements for the AFWS, which automatically supplies feedwater to the SGs to remove decay heat from the RCS upon the loss of normal feedwater supply.

The APR1400 AFWS design is unusual in that each SG is associated with two dedicated AFWS trains, one motor driven train, and one turbine driven train with steam supplied from the associated SG. There is no provision for the AFWS trains for one SG to supply feedwater to the other SG. Consequently, with all four AFWS trains operable, if the limiting accident requiring AFW includes faulting one SG accompanied by a loss of offsite power, and a single failure that disables one AFWS train associated with the unfaulted SG, only one AFWS train will remain available to perform the safety function. Clearly, if just one train is inoperable, the ability to withstand a single failure of an operable train is lost for the scenario described. Therefore, there is no justification for more than 72 hours to restore an inoperable AFWS train in one SG or in two SGs. Specifying an immediate shutdown would seem to be warranted if two AFWS trains for the same SG are inoperable, or if any three AFWS trains are inoperable; should all four AFWS trains be unavailable, action to restore a train to operable status must be initiated immediately.

The following table lists the RAI questions concerning Subsection 3.7.5.

Subsection 3.7.5 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.2	120-7977 ML15209A000 Responses: ML16050A530 ML17191B261	3.7.5 Actions - Revise to reflect AFWS unique design features	CU	16-131
16-24.3	120-7977 ML15209A000 Response: ML16050A530 ML17191B261	B 3.7.5 Background section - Resolve inconsistencies between TS Bases and DCD Tier 2, Section 10.4.9, Figure 10.4.9-1, Figure 10.4.9-2, and Table 10.4.9-2	CU	16-150.2
16-24.4	120-7977 ML15209A000 Response: ML16050A530	SR 3.7.5.4 - Removed redundant surveillance column Note b	CC	
16-24.5	120-7977 ML15209A000 Response: ML16050A530	B 3.7.5 Background section - Revised eighth paragraph by deleting incorrect information about the SGTR event crediting operator action to isolate AFW flow to the affected SG 30 minutes after event detection.	CC	
16-24.6	120-7977 ML15209A000 Response: ML16050A530	B 3.7.5 Background section - Made editorial corrections regarding FSAR 10.4.9 and consistent use of AFWS instead of AF System or AFW System	CC	
16-24.7	120-7977 ML15209A000 Response: ML16050A530 ML17191B261	B 3.7.5 LCO section – Revise to more clearly explain why four 100% capacity AFWS trains are required to be operable	CU	16-150.3

Subsection 3.7.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-131	444-8530 ML16076A028 Response: ML16142A042	• 3.7.5 LCO statement – Revised as indicated: “Four independent auxiliary feedwater (AFW) ~~trains~~ flow paths shall be OPERABLE.” • 3.7.5 Action A – with one AFWS train (or AFW flow path) inoperable, AFWS redundancy is lost for certain accident scenarios. Therefore, the proposed Completion Time of 7 days is not acceptable.	CU	16-154.1 16-154.1a 16-154.1b
16-150.2	481-8546 ML16133A271 Responses: ML16187A207 ML16237A360 ML16323A495 ML17222A186	B 3.7.5 Background section – Corrected technical errors	CC	
16-150.3	481-8546 ML16133A271 Responses: ML16187A207 ML16237A360 ML16323A495 ML17222A186	B 3.7.5 LCO section – Revised to further explain why four 100% capacity AFWS trains are required to be operable	CC	
16-153.3g	498-8595 ML16182A332 Responses: ML16295A249 ML17233A389	Expanded Applicability of AFAS instrument functions and associated ESF logic functions to include Mode 4.	CC	See 16-154.2
16-154.1	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 and B 3.7.5 – replaced ‘flow path’ with ‘train’	CC	
16-154.1a	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 LCO statement – Revised to state: “Two auxiliary feedwater (AFW) divisions, each with one motor driven train and one turbine driven train, shall be OPERABLE.”	CC	

Subsection 3.7.5 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		3.7.5 LCO Note – Revised to state: "Only the motor driven train of one AFW division is required to be OPERABLE in MODE 4."		
16-154.1b	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action A – Revised to state: "A. One AFW division with one train inoperable in MODE 1, 2, or 3. | A.1 Restore train to OPERABLE status. | [72 hours]"; Justified 72 hour Completion Time	CC	
16-154.1c	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action B – Relabeled as Action C and revised to state "C. One AFW division with two trains inoperable in MODE 1, 2, or 3. | C.1 Restore one train of affected AFW division to OPERABLE status. | [24] hours"; justified 24 hour Completion Time	CC	
16-154.1d	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action C – Relabeled as Action B and revised to state "B. Two AFW divisions with one train inoperable in MODE 1, 2, or 3. | B.1 Restore two trains of an AFW division to OPERABLE status. | 72 hours"	CC	
16-154.1e	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action D – Revised to state "D. Required Action and associated Completion Time of Condition A, B, or C not met. OR ~~One~~ Three AFW ~~division with both~~ trains inoperable ~~and a train of other AFW division inoperable~~ in MODE 1, 2, or 3. | D.1 Be in MODE 3 | 6 hours AND D.2 Be in MODE 4. | 18 hours"	CC	
16-154.1f	498-8595 ML16182A332 Responses: ML16257A574	3.7.5 – Added new Action E: "E. ~~Two~~ Four AFW ~~divisions with two~~ trains inoperable in MODE 1, 2, or 3. | E.1 NOTE–	CC	

Subsection 3.7.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML17271A050 ML17291A660	LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW train is restored to OPERABLE status. Initiate action to restore one AFW train ~~of an AFW division~~ to OPERABLE status. | Immediately”		
16-154.1.g	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action E – Relabeled as Action F and revised to state “Two AFW ~~trains, each of which includes a~~ motor driven trains inoperable in MODE 4. | F.1 NOTE– LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW motor driven train is restored to OPERABLE status. Initiate action to restore one AFW motor driven train to OPERABLE status. | Immediately”	CC	
16-154.1.h	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.5 Action F – Relabeled as Action G and deleted	CR	
16-154.1.i	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	SR 3.7.5.1 – Revised for clarity	CC	
16-154.1.j	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	SR 3.7.5.2 Note – Revised for clarity	CC	

Subsection 3.7.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-154.1.k	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	SR 3.7.5.3 Note and SR 3.7.5.4 Note 1 – Revised for clarity	CC	
16-154.1.l	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	SR 3.7.5.3 – Revised for consistent phrasing	CC	
16-154.1.m	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	SR 3.7.5.5 – Revised for clarity and consistent phrasing	CC	
16-154.3	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	B 3.7.5 Revision 0 - revised to be consistent with the changes stated in the response to 16-154.1	CC	

Status Codes:
CR Closed Resolved with no DCD changes
CU Closed Unresolved (has follow up question)
RC Resolved Confirmatory
CC Closed Confirmed

Although Subsection 3.7.5 appears to follow the STS in format and content, the staff noted that it should have been modified compared to STS Subsection 3.7.5 to reflect unique features of the APR1400 AFWS design. In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 2, the staff requested that the applicant modify the Subsection 3.7.5 Actions table to properly capture these unique features. In its response (ML16050A530) to Question 16-24, regarding Sub-question 2, the applicant stated the following:

> In the APR1400, the AFW system consists of two mechanical divisions. Each mechanical division consists of one 100 percent capacity motor-driven pump, one 100 percent capacity turbine-driven pump, one 100 percent auxiliary feedwater storage tank, associated valves, a cavitating flow-limiting venturi, and instrumentation. There is no cross-connection between the two mechanical divisions, except for the cross-connection capability of the auxiliary feedwater storage tanks. Thus, two AFW pumps are configured into each mechanical division.
>
> Therefore, Condition A for turbine-driven pumps is needed in the APR1400 Standard Design.

The staff noted that no change was proposed to Subsection 3.7.5 as part of this response and found the stated position unacceptable in that Action A, as written, could not be used given the major difference in the design of the steam supply piping to the turbine-driven pumps. Further, with clarifying details presented above on the system mechanical portion that is configured only as two independent divisions, not four independent trains, the staff found that other Actions in Subsection 3.7.5 needed modification as well.

In follow up RAI 444-8530 (ML16076A028), Question 16-131, the staff requested the applicant to consider the following changes to fully address the staff's original concerns:

- Revise LCO 3.7.5 to state: "The turbine-driven AFW pump train and the motor-driven AFW pump train associated with each steam generator shall be OPERABLE."
- Revise LCO 3.7.6 so that it requires two AFW storage tanks to be operable, because each AFW storage tank is designed to only support the operability of its associated AFW division, to meet the single failure criterion.
- Revise Subsection 3.7.5 Condition A to remove the first Condition statement regarding an inoperable AFW turbine-driven pump steam admission valve.
- Revise Subsection 3.7.5 Actions table to address different combinations of AFWS degradation.

In its response (ML16142A042) to Question 16-131, the applicant proposed to revise the LCO statement and Actions table of Subsection 3.7.5. These proposed changes, however, did not fully address the concerns raised by RAI 120-7977, Question 16-24, in Sub-question 2, or RAI 444-8530 in follow up Question 16-131. Therefore, in RAI 498-8595 (ML16182A332), Question 16-154, the staff issued additional follow up Sub-questions 1, 2 and 3, requesting that the applicant consider further modifications to various provisions of Subsection 3.7.5. Details of the staff's evaluation of the applicant's response to RAI 498-8595, Question 16-154, Sub-question 1, is provided within the below discussion of other issues raised by the staff concerning Subsection 3.7.5 and Subsection 3.7.6. Question 16-154, Sub-question 2 is resolved as part of the evaluation of Subsection 3.3.5 in Section 16.4.8 of this SER. In its responses (ML16257A574, ML17271A050, and ML17291A660) to Question 16-154, Sub-question 3, the applicant proposed changes to Subsection B 3.7.5 to conform to the changes it made to Subsection 3.7.5 in response to Question 16-154, Sub-question 1. Finding these Bases changes consistent with the revised Specification, the staff concludes that Question 16-154, Sub-question 3 is resolved.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 3, the staff requested that the applicant clarify the description of the four AFW trains as independent trains in the Background section of the Bases for Subsection 3.7.5. In its response (ML16050A530) to Question 16-24, regarding Sub-question 3, the applicant proposed to revise the Bases to reflect the system design as two independent mechanical divisions. However, the staff noted several editorial errors during the review of this response, and in follow up RAI 481-8546 (ML16133A271), Question 16-150, Sub-question 2, the applicant was requested to correct these errors by revising the second sentence of the first paragraph of the Subsection B 3.7.5 Background section as shown in the following markup:

> The <u>two </u>auxiliary feedwater (AFW) pumps <u>in each mechanical division</u> take suction ~~through separate and independent suction lines~~ from ~~the~~ <u>a</u>

> respective common auxiliary feedwater storage tank~~s~~ (AFWST~~s~~) (LCO 3.7.6), ~~and~~ each pump with a respective discharge header, and ~~pump~~ discharge ~~each~~ to *the* ~~a~~ respective steam generator secondary side through a common AFW discharge header, ~~via a separate and independent connection~~ which connects to the steam generator downcomer main feedwater (MFW) piping inside containment.

In the Attachment to the applicant's revised response letter (ML16187A207) to Question 16-150, regarding Sub-question 2, the markup of this sentence matched the suggested changes with one exception; the applicant included the word "pump" before the verb "discharge"; this word should be removed, as indicated by double lineout and gray highlight. In addition, replacing the article 'a' with 'the' in the same line is suggested (as indicated with italics and gray highlight) to clarify that each AFWS division only supplies water to its respective SG.

The revised sentence needs the additional recommended clarifications for the sentence to adequately reflect the AFWS design as described in DCD Section 10.4.9. Therefore, RAI 481-8546, Question 16-150, Sub-question 2, was tracked as an open item. In the response (ML16257A574) to RAI 498-8595, Question 16-154, on Attachment page 17, the applicant proposed that the first paragraph, second sentence of the Background section of Subsection B 3.7.5 match the requested changes by stating, in part:

> ...The two auxiliary feedwater (AFW) pumps in each mechanical division take suction from a respective common auxiliary feedwater storage tank (AFWST) (LCO 3.7.6), each pump with a respective discharge header, and discharge to ~~a~~ the respective steam generator secondary side through a common AFW discharge header, which connects to the steam generator downcomer main feedwater (MFW) piping inside containment....

Therefore, RAI 481-8546, Question 16-150, Sub-question 2, is resolved.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 4, the staff requested that the applicant remove the redundant surveillance column Note b of SR 3.7.5.4. In its response (ML16050A530) to Question 16-24, regarding Sub-question 4, the applicant agreed to delete this redundant information. Even though the staff found this response acceptable, the deleted Note b was reinstated in the applicant's response (ML16257A574) to RAI 498-8595, Question 16-154, Sub-question 1j. Details of the staff's evaluation of the response to RAI 498-8595, Question 16-154, Sub-question 1, are provided below.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 7, the staff requested that the applicant revise the Subsection B 3.7.5 LCO section by adding a discussion to explain why all four 100% capacity AFW pumps are required to be OPERABLE, for the purpose of enhancing the plant operator's understanding of Subsection 3.7.5 requirements. In its response (ML16050A530) to Question 16-24, regarding Sub-question 7, the applicant stated:

> Assuming a postulated pipe failure concurrent with a single active component failure, four 100 percent capacity pumps are required to be OPERABLE for the AFW system. If one steam generator is not OPERABLE for reactor cooling on an initiating event, the turbine-driven pump and the motor-driven pump in that mechanical division are also not OPERABLE due to the respective steam generator. Concurrent with the initiating event, a single active component failure

is considered for the turbine-driven pump or the motor-driven pump in the other mechanical division. This is accomplished by powering two 100 percent capacity motor-driven pumps from independent emergency buses and by a diverse means of steam supply for the two 100 percent capacity turbine-driven pumps.

The staff found that these clarifying details provide a clear basis for the LCO requirements, but noted that the applicant did not propose any changes to the Bases to capture them. Therefore, the staff issued follow up RAI 481-8546 (ML16133A271), Question 16-150, Sub-question 3, requesting the applicant to add the details in this paragraph to the Bases. In its response (ML16187A207) to Question 16-150, regarding Sub-question 3, the applicant proposed to insert a third paragraph in the Subsection B 3.7.5 LCO section as indicated by the following markup of the above paragraph (with staff suggested clarifications shown in italics with gray highlight):

> Assuming a postulated pipe failure concurrent with a single active component failure, four 100 percent capacity pumps are required to be OPERABLE for the AFW system. If one steam generator is not OPERABLE for reactor cooling on an initiating event, the turbine driven pump and the motor driven pump in that mechanical division are also not OPERABLE due to the respective inoperable steam generator. Concurrent with the initiating event, a single active component failure is considered for the turbine driven pump or the motor driven pump in the other mechanical division. One AFW pump and the associated SG would remain OPERABLE to provide reactor cooling because of the AFW System design that provides redundant capacity, and motive power that is both independent and diverse. The two *~~100 percent capacity~~* motor driven pumps are powered from independent emergency buses and each of the two *~~100 percent capacity~~* turbine driven pumps is powered from steam supplied by the respective SG, which provides diversity. *The capability to withstand a single failure* ~~This~~ is accomplished by powering two 100 percent capacity motor driven pumps from independent emergency buses and *by two 100 percent capacity turbine driven pumps* each powered by an independent *steam supply, which is a diverse means of motive power.* *~~by a diverse means of steam supply for the two 100 percent capacity turbine-driven pumps.~~*

The staff finds that the proposed response needs the suggested clarifications. Pending incorporation of these clarifications, RAI 481-8546, Question 16-150, Sub-question 3, was tracked as an open item. In its third revised response (ML17222A188) to Question 16-150, regarding Sub-question 3, the applicant incorporated the suggested changes in the LCO section of Subsection B 3.7.5. Therefore, RAI 481-8546, Question 16-150, Sub-question 3, is resolved.

As noted previously, the staff issued follow up RAI 498-8595 (ML16182A332), Question 16-154, Sub-questions 1, 2 and 3, to request the applicant to consider additional suggested changes to Subsections 3.7.5 and B 3.7.5 for more consistency with the unique features of the AFW system design. In its response (ML16257A574) to RAI 498-8595, Question 16-154, Sub-questions 1.a through 1.m, the applicant proposed to revise Revision 0 of GTS Subsection 3.7.5, partially consistent with the staff's suggested changes, as follows:

Question 16-154, Sub-question 1.a

- LCO 3.7.5 ~~Four independent~~ Two auxiliary feedwater (AFW) ~~trains~~ divisions, each with one motor driven train and one turbine driven train, shall be OPERABLE.

- LCO 3.7.5 Note   Only ~~one AFW train, which includes a~~ the motor driven ~~pump,~~ train of one AFW division is required to be OPERABLE in MODE 4.

These changes are acceptable because they improve the LCO statement and the modifying Note by highlighting the distinguishing design details of the AFW system, and by use of consistent phrasing, they enable stating the action requirements unambiguously. Therefore, Sub-question 1.a is resolved.

Question 16-154, Sub-question 1.b (GTS Rev. 0, 3.7.5 Action A revised as shown)

- 3.7.5 Action A   A. ~~One turbine driven AFW train inoperable due to associated inoperable steam supply. OR NOTE - Only applicable if MODE 2 has not been entered following refueling. One turbine driven AFW pump inoperable in Mode 3 following refueling~~ One AFW train inoperable in MODE 1, 2, or 3. | A.1 Restore ~~affected equipment~~ train to OPERABLE status. | 7 days

The proposed Completion Time of 7 days cannot be justified deterministically, because for a steam line break (SLB) event or a feedwater line break (FLB) event, the two AFW trains in the mechanical division, which feeds the affected SG, will not be available to fulfill their safety functions. In this case, a single failure of the remaining AFW train results in a loss of AFW safety function; for a loss of redundancy, the STS typically allow no more than a 72 hour Completion Time to restore redundancy. Therefore, Sub-question 1.b was tracked as an open item. The staff believes Condition A, in the context of other Condition statements, is more clearly stated as “One AFW division with one train inoperable in MODE 1, 2, or 3.”

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.b, the applicant revised Condition A as suggested, and elected to designate the 72 hour Completion Time for Required Action A.1 as a COL action item, along with the addition of an associated reviewer’s note in the Bases for Action A. This note states:

> [------------------------------------REVIEWER’S NOTE--------------------------------
> The COL applicant should use the stated Completion Time for Required Action A.1 unless a longer Completion Time can be justified using risk insights in accordance with RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis” and RG 1.177, “An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications.”
> ---]

Designating the 72 hour Completion Time is this way ensures that absent an acceptable justification for a longer time by a COL applicant, the plant-specific TS will specify the standard deterministically based time for correcting a loss of redundancy condition. Therefore, Question 16-154, Sub-question 1.b, is resolved.

Question 16-154, Sub-question 1.c (GTS Rev. 0, 3.7.5 Action B revised as shown)

- 3.7.5 Action ~~B~~C   ~~B~~C. One AFW ~~train~~ division with two trains inoperable in MODE 1, 2, or 3 ~~for reasons other than Condition A~~. **|** ~~B~~C.1 Restore one

train of affected AFW ~~train~~ division to OPERABLE status. |
72 hours

The revised Action B, relabeled as Action C, constitutes a vulnerability to the accident scenario discussed above. For a steam line break (SLB) event or a feedwater line break (FLB) event that disables the SG associated with the two operable AFW trains, the AFW function would be lost. Therefore, at least one of the two inoperable AFW trains must be restored to operable status within a short time period, perhaps as short as 1 hour. Pending resolution of this completion time issue, Sub-question 1.c was tracked as an open item.

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.c, the applicant relabeled Action B as Action C, and revised Action C as suggested. In addition, the applicant elected to replace the 72 hour Completion Time for Required Action C.1 with a 24 hour time, and also designate it as a COL action item. As done for Action A, an associated reviewer's note is added to the Bases for Action C. This note is identical to the note for Action A, except that it refers to Required Action C.1 instead of A.1. The proposed Bases for Action C and the 24 hour Completion Time states:

> With both AFW trains inoperable in one AFW division, the AFW function would be lost for events that render both trains of the unaffected AFW division inoperable. Action must be taken to restore one train of the affected AFW division to OPERABLE status within [24] hours. The [24 hour] Completion Time is based on the redundancy and diversity of the two OPERABLE AFW trains in the remaining AFW division, the time needed for repairs, and the low probability of such an event occurring during this period.
>
> In addition, during the Completion Time period, for most events, two OPERABLE AFW trains would remain available to supply feedwater to the associated SG.

The staff concludes that this is an acceptable deterministic justification for allowing a 24 hour period of vulnerability to an accident scenario that could result in having no AFW trains to support core decay heat removal using a SG post accident. Designating the 24 hour Completion Time as a COL action item ensures that absent an acceptable justification for a longer time by a COL applicant, the plant-specific TS will specify an appropriate deterministically based time for correcting a potential loss of function condition. Therefore, Question 16-154, Sub-question 1.c, is resolved.

Question 16-154, Sub-question 1.d (GTS Rev. 0, 3.7.5 Action C revised as shown)

- 3.7.5 Action ~~C~~B — ~~C~~B. ~~One turbine driven AFW train inoperable due to associated inoperable steam supply. AND One motor driven AFW train inoperable~~ A train of each AFW division inoperable in MODE 1, 2, or 3. | ~~C~~B.1 Restore ~~steam supply to turbine driven train~~ two trains of an AFW division to OPERABLE status. | ~~48 hours~~ 72 hours ~~OR C.2 Restore motor driven AFW train to OPERABLE status. | 48 hours~~

The revised Action C, relabeled as Action B, also constitutes a loss of redundancy, given the accident scenario discussed above; therefore, the 72 hour Completion Time is appropriate. The staff believes Condition B, in the context of other Condition statements, is more clearly stated as “Two AFW divisions with one train inoperable in MODE 1, 2, or 3.” Pending resolution of this phrasing issue, Sub-question 1.d was tracked as an open item.

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.d, the applicant relabeled Action C as Action B, and revised Action B as suggested. Therefore, Question 16-154, Sub-question 1.d, is resolved.

<u>Question 16-154, Sub-question 1.e</u> (GTS Rev. 0, 3.7.5 Action D revised as shown)

- 3.7.5 Action D — D. Required Action and associated Completion Time of Condition A, B, or C not met. <u>OR</u> ~~Three AFW trains~~ <u>One AFW division with both trains inoperable and a train of other AFW division</u> inoperable in MODE 1, 2, or 3. | D.1 Be in MODE 3 | 6 hours <u>AND</u> D.2 Be in MODE 4 <u>without reliance upon SGs for heat removal</u>. | 18 hours

The staff noted a need to change this proposed Action D, based on the final resolution of the issues discussed above on Actions A, B, and C. But requiring a unit shutdown is the appropriate action. When entering Mode 4 as part of a unit shutdown, core decay heat and reactor coolant pump heat input should be adequate to support operation of a turbine driven AFW pump until the shutdown cooling system can be put into service. Thus, there is not an issue with entering Mode 4 from Mode 3 with only one turbine driven AFW pump train operable. The staff believes the second Condition statement would be more clearly stated as “Three AFW trains inoperable in MODE 1, 2, or 3.” Pending resolution of this phrasing issue, Sub-question 1.e was tracked as an open item.

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.e, the applicant revised Condition D and Required Actions D.1 and D.2 as suggested. Therefore, Question 16-154, Sub-question 1.e, is resolved.

<u>Question 16-154, Sub-question 1.f</u>

- 3.7.5 Action E — <u>E.</u> <u>Two AFW divisions with two trains inoperable in MODE 1, 2, or 3</u>. | NOTE–LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW train is restored to OPERABLE status. <u>E.1</u> <u>Initiate action to restore one train of an AFW division to OPERABLE status.</u> | <u>Immediately</u>

This new action requirement is appropriate if no AFW trains are operable because a unit cooldown without AFW supply to a SG is impractical, and is consistent with the STS. The staff believes that Condition E would be more clearly stated as “Four AFW trains inoperable in MODE 1, 2, or 3. Likewise, Required Action E.1 could be stated more concisely as “Initiate action to restore one AFW train to OPERABLE status. | Immediately”. Pending resolution of this phrasing issue, Sub-question 1.f was tracked as an open item.

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.f, the applicant revised Condition E and Required Action E.1 as suggested. Therefore, Question 16-154, Sub question 1.f, is resolved.

Question 16-154, Sub-question 1.g

- 3.7.5 Action ~~E~~F ~~E~~F. Two AFW trains, each of which includes a motor driven train inoperable in MODE 4. | NOTE–LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW motor driven train is restored to OPERABLE status. F.1 Initiate action to restore one AFW motor driven train to OPERABLE status. | Immediately

The staff concludes that the proposed Action F (as relabeled) is appropriate for when there may be insufficient steam pressure in Mode 4 to maintain the necessary SG water level with a turbine driven AFW pump alone. However, the condition statement appears to be unclear. The staff believes the condition statement is easier to understand if written as, "Two AFW motor driven trains inoperable in MODE 4." Therefore, Sub-question 1.g was tracked as an open item.

In its second revised response (ML17291A660) to Question 16-154, regarding Sub-question 1.g, the applicant revised Condition F as suggested. Therefore, Question 16-154, Sub-question 1.g, is resolved.

Question 16-154, Sub-question 1.h

The staff requested that the applicant provide an Action G, which states:

- 3.7.5 Action G G. NOTE–LCO 3.0.3 and all other LCO Required Actions requiring MODE changes are suspended until one AFW motor driven train is restored to OPERABLE status. Required AFW motor driven train inoperable in MODE 4. | G.1 Initiate action to restore one AFW motor driven train to OPERABLE status. | Immediately

Since this action is equivalent to the above proposed Action F, which is acceptable, the suggested Action G is not needed. Therefore, Question 16-154, Sub-question 1.h is resolved.

Question 16-154, Sub-questions 1.i, 1.j, 1.k, 1.l, and 1.m

- SR 3.7.5.1 Verify each ~~AFW~~ manual, power-operated, and automatic valve in the flow path of each AFW train and in ~~each~~ the steam supply flow path ~~to the~~ of each AFW turbine driven pump, that is not locked, sealed, or otherwise secured in position, is in the correct position. | 31 days

- SR 3.7.5.2 NOTE - Not required to be performed for AFW turbine driven ~~AFW~~ pumps until 24 hours after reaching 69.25 kg/cm^{2}G (985 psig) in steam generators. Verify developed head of each AFW pump at flow test point is greater than or equal to required developed head. | In accordance with Inservice Testing Program

- SR 3.7.5.3 NOTE - a. ~~Not required to be performed for turbine driven AFW pumps until 24 hours after reaching 69.25 kg/cm2G (985 psig) in steam generators. b.~~ Not required to be met in MODE 4 when steam generator is relied upon for heat removal. Verify each AFW automatic valve that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal. | 18 months

- SR 3.7.5.4 — NOTES – ~~a~~1. Not required to be performed for AFW turbine driven ~~AFW~~ pumps until 24 hours after reaching 69.25 kg/cm^{2}G (985 psig) in steam generators. ~~b~~2. Not required to be met in MODE 4 when steam generator is relied upon for heat removal. Verify each AFW pump starts automatically on an actual or simulated actuation signal ~~when in MODE 1, 2, or 3~~. | 18 months

- SR 3.7.5.5 — Verify proper alignment of required ~~AFW~~ flow paths of each train of each AFW division by verifying flow from the associated auxiliary feedwater storage tank to the associated steam generator. | Prior to entering MODE 2 whenever ~~a~~ the unit has been in MODE 5~~, 6,~~ or 6, or defueled for a cumulative period of > 30 days

The staff finds the above revised Surveillance requirements acceptable because they conform to the phrasing convention of the STS and are consistent with the AFWS design. In particular, removal of surveillance column Note “a” of SR 3.7.5.3 is acceptable because it is not a precondition for performing this surveillance. Therefore, Question 16-154, Sub-questions 1.i, 1.j, 1.k, 1.l, and 1.m are resolved.

The staff reviewed Subsection 3.7.5 and Subsection B 3.7.5 and verified that the AFW System LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the AFW System will perform its RCS heat removal safety function to provide, along with the MSADVs, a safety grade means of cooling the unit to SCS temperature and pressure entry conditions for events initiating in Mode 1, 2, or 3, or in Mode 4 with a steam generator being relied upon for RCS heat removal, and the preferred heat sink is not available. Accordingly, the staff concludes that Subsection 3.7.5 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.7.5. The staff also verified that Subsections 3.7.5 and B 3.7.5 are consistent with the guidance in CE STS Subsections 3.7.5 and B 3.7.5, and the APR1400 AFW System design as described in the DCD. Therefore, based on its review and the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.7.5 and Subsection B 3.7.5 are acceptable.

Subsection 3.7.6 Auxiliary Feedwater Storage Tank (AFWST)

Subsection 3.7.6 includes requirements for the two AFWSTs, each of which provide a safety grade source of water to the respective SG for removing decay and sensible heat from the RCS.

The following table lists the RAI questions concerning Subsection 3.7.6.

Subsection 3.7.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-131	444-8530 ML16076A028 Response: ML16142A042	3.7.6 LCO statement – Revised to state that "Each AFWST shall be OPERABLE."	CU	16-154.4
16-154.4	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.6 LCO statement – Revised to state that "Two AFWSTs shall be OPERABLE."; B 3.7.6 SR section – Revised Bases for SR 3.7.6.1	CC	
16-154.5	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.6 Action A – Justified Completion Time of 7 days to restore AFWST to operable status based on verifying capability to manually connect AFWSTs in both AFW divisions, and availability of condensate storage tank water volume in affected division.	CR	
16-154.6	498-8595 ML16182A332 Responses: ML16257A574 ML17271A050 ML17291A660	3.7.6 Action B – Justified Completion Time of 24 hours to be in Mode 4 (with SC in service)	CR	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

In the APR1400 design, there are two 100 percent capacity AFWSTs, each supporting its respective independent division of the AFWS (one turbine-driven AFW train and one motor-driven AFW train) as opposed to the one common safety-related condensate storage tank (CST) in the CE PWR design.

Subsection 3.7.6 provisions generally, match those in STS Subsection 3.7.6. However, in conjunction with the review of Subsection 3.7.5 above, the staff noted that requirements as shown in STS Subsection 3.7.6 should also be modified to reflect the differences between the APR1400 design and the CE PWR design for the AFWS. In RAI 444-8530 (ML16076A028), Question 16-131, the applicant was requested to revise both Subsections 3.7.5 and 3.7.6 to reflect the noted differences. In its response (ML16142A042) to Question 16-131, the applicant proposed to revise the LCO 3.7.6 statement to state "~~One~~ Each AFWST shall be OPERABLE" which the staff found to be inadequate to support the operability of the two independent divisions of the AFWS covered under Subsection 3.7.5. Therefore, in follow-up RAI 498-8595

(ML16182A332), Question 16-154, in Sub-questions 4 and 5, the applicant was requested to consider suggested changes to the 3.7.6 LCO statement and Action A as indicated below:

> ~~One~~Two AFWSTs shall be OPERABLE.
>
> A. One AFWST inoperable. | A.1 Verify OPERABILITY of backup water supply for affected AFW division. | 4 hours AND Once per 12 hours thereafter AND A.~~1~~2 Verify OPERABILITY of other AFWST. | 4 hours AND Once per 12 hours thereafter AND A.~~2~~3 Restore AFWST to OPERABLE status. | 7 days

In its response (ML16257A574) to Question 16-154, regarding Sub-questions 4 and 5, the applicant agreed to adopt the staff's suggested change to the LCO 3.7.6 statement, however the "s" in "AFWSTs" was missing in the mark-up page attached to the response. Further, the applicant justified not adopting the staff's suggested changes to Action A by stating that either tank can manually supply either division of the AFWS. The staff disagrees with this statement because of check valves installed on the cross-connect piping between the division suction headers, as shown on DCD Figure 10.4.9-1 (Sheet 1 of 4). Pending a satisfactory resolution of these issues, RAI 498-8595, Question 16-154, Sub-questions 4 and 5, were tracked as open items.

In its second revised response (ML17291A660) to Question 16-154 regarding Sub-questions 4 and 5, the applicant corrected the LCO statement of Subsection 3.7.6, and changed Action A to state:

> A. One AFWST inoperable. | A.1 Verify OPERABILITY of backup water supply and the other AFWST. | 4 hours AND Once per 12 hours thereafter AND
> A.2 Restore AFWST to OPERABLE status. | 7 days

The staff finds the proposed Action A acceptable because it is consistent with STS 3.7.6 Action A, which also requires verifying OPERABILITY of the backup water supply. As described in the proposed associated change to the Actions section of Subsection B 3.7.6, the backup water supply is the affected AFW division's nonsafety-related condensate storage tank. This verification provides adequate assurance that if called upon, the affected AFW division will have a supply of water to support secondary heat removal after a reactor trip. Verifying that the unaffected division's AFWST water volume is available for supplying makeup water to the inoperable AFWST, through a normally closed manual valve in the pipe connecting the two tanks, provides additional assurance. With the water supply capability verification required by Required Action A.1, the staff concludes that the 7 day Completion Time of Required Action A.2 is justified and acceptable. Therefore, RAI 498-8595, Question 16-154, Sub-questions 4 and 5, are resolved.

In RAI 498-8595 (ML16182A332), Question 16-154, Sub-question 6, the staff requested that the applicant explain why the 24 hour Completion Time of Subsection 3.7.6 Required Action B.2 is an appropriate time period, given the APR1400 design, to place the unit in MODE 4 without reliance on a steam generator for heat removal in the event a Required Action and associated Completion Time of Condition A are not met. The staff noted that this unit cool down would appear to be based on one AFW division with two operable trains and one steam generator. Pending a satisfactory resolution of this issue, RAI 498-8595, Question 16-154, Sub-question 6, was tracked as an open item.

In its initial revised response (ML17271A050) to Question 16-154, regarding Sub-question 6, the applicant stated:

6. This condition B means the failure to restore the affected AFWST to operable status within 7 days. APR1400 consists of one 100% AFWST of each division and also a cross connection is provided between the AFWSTs so that either tank can manually supply either division of the AFWS. The 24 hour completion time is reasonable based on operating experience in Korea by KHNP, to transit from Mode 1, 2 or 3 to Mode 4 in an orderly manner and without challenging the safety function.

Since the unit normally relies on a nonsafety startup feedwater pump to cool down the RCS to the Shutdown Cooling System temperature and pressure entry conditions in Mode 4, and in Condition B, one AFWST remains OPERABLE to support one division of safety related emergency secondary heat removal, the staff finds that 24 hours is an acceptable time to accomplish Required Action B.2. In the event both AFWSTs are inoperable, placing the unit in MODE 4 within 13 hours, as required by LCO 3.0.3, is within the capability of the plant systems normally used for going from Mode 1 to Mode 4. For these reasons, and the applicant's above response, the staff concludes that RAI 498-8595, Question 16-154, Sub-question 6, is resolved.

The staff reviewed Subsection 3.7.6 and Subsection B 3.7.6 and verified that the AFWST LCO, and associated applicability, action, and surveillance requirements are sufficient to ensure the AFWSTs will perform their support function of the AFW System, which provides along with the MSADVs a safety grade means of cooling the unit to SCS temperature and pressure entry conditions for events initiating in Mode 1, 2, or 3, or in Mode 4 with a steam generator being relied upon for RCS heat removal, and the preferred heat sink is not available. Accordingly, the staff concludes that Subsection 3.7.6 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.6 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.6. The staff also verified that Subsections 3.7.6 and B 3.7.6 are consistent with the guidance in CE STS Subsections 3.7.6 and B 3.7.6, and the design of the APR1400 AFWST and AFW System as described in the DCD. Therefore, based on its review and the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.7.6 and Subsection B 3.7.6 are acceptable.

Subsection 3.7.7 Component Cooling Water System, and Subsection 3.7.8 Essential Service Water System

Subsection 3.7.7 includes requirements for the Component Cooling Water System (CCWS) which is a closed loop cooling water system that conducts heat from connected components, such as the emergency diesel generators, and heat exchangers, such as the SC heat exchangers, and transfers that heat to the Essential Service Water System (ESWS) in the CCWS heat exchangers. The CCWS consists of two separate, independent, redundant, closed loop, safety related, 100 percent capacity divisions. Each division includes three CCW heat exchangers, two CCW pumps, and a surge tank. LCO 3.7.7 requires two CCW divisions to be operable. The CCWS serves as an intermediate cooling water system between radioactive systems it cools and the ESWS.

Subsection 3.7.8 includes requirements for the ESWS, which consists of two separate, redundant, open loop, safety related, and 100 percent capacity divisions. Each division includes two pumps that circulate water from the ultimate heat sink (UHS) to the CCW heat exchanger and back to the UHS. LCO 3.7.8 requires two ESWS divisions to be operable.

The following table lists the RAI questions concerning Subsections 3.7.7 and 3.7.8.

Subsections 3.7.7 and 3.7.8 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.8	120-7977 ML15209A000 Response: ML16050A530	SR 3.7.8.1 - Replaced "CCW" with "ESW" in the surveillance column Note	CC	
16-50	162-8055 ML15235A003 Response: ML15301A207	3.7.7 Required Action Notes 1 and 2 of Action A should be labeled “NOTES” instead of “NOTE”	CC	
16-50	162-8055 ML15235A003 Response: ML15301A207	3.7.8 Required Action Notes 1 and 2 of Action A should be labeled “NOTES” instead of “NOTE”	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

The staff reviewed Subsections 3.7.7 and 3.7.8 and Subsections B 3.7.7 and B 3.7.8 and verified that the CCWS and ESWS LCOs, and associated applicability, action, and surveillance requirements are sufficient to ensure that these systems will perform their function to remove heat from the RCS by way of the SCS heat exchangers and from safety related components and transfer the heat to the ultimate heat sink (UHS), thereby achieving and maintaining safe shutdown of the unit for events initiating in Mode 1, 2, 3 or 4. Accordingly, the staff concludes that Subsections 3.7.7 and 3.7.8 satisfy paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsections B 3.7.7 and B 3.7.8 satisfy paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsections 3.7.7 and 3.7.8. The staff also verified that Subsections 3.7.7 and 3.7.8 and Subsections B 3.7.7 and B 3.7.8 are consistent with the guidance in CE STS Subsections 3.7.7 and 3.7.8 and Subsections B 3.7.7 and B 3.7.8, and the design of the APR1400 CCWS and ESWS as described in the DCD. Therefore, based on its review, the staff concludes that Subsections 3.7.7 and 3.7.8, and Subsections B 3.7.7 and B 3.7.8 are acceptable

Subsection 3.7.9 Ultimate Heat Sink (UHS)

Subsection 3.7.9 includes requirements for the UHS, which provides a heat sink for process and operating heat from safety related components during a DBA or transient, as well as during normal operation.

In the APR1400 design, the UHS is configured into two independent mechanical divisions, to be in line with the two independent mechanical divisions of the ESWS and CCWS discussed above, as opposed to a single UHS water source in the CE PWR design. Each division of the UHS includes one basin, a two-cell mechanical draft cooling tower and its own makeup water supply source that will ensure a 30-day water inventory in support of an LOCA.

The following table lists the RAI question for Subsection 3.7.9.

Subsection 3.7.9 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-44	154-8064 ML15295A495 Responses: ML16187A252 ML17180A444 ML17236A374 ML17290B218	Use of brackets and identification / enumeration of COL Action Items	CC	

Subsection 3.7.9 provisions are established as shown below:

- LCO statement: [[Two]] UHS [[divisions]] shall be OPERABLE.

- Applicability statement: MODES 1, 2, 3, and 4.

- Action A: A. [[One UHS cooling tower inoperable.]] | A.1 [[Restore UHS cooling tower to OPERABLE status.]] | [[72 hours]]

- Action B: B. [[Required Action and associated Completion Time of Condition A not met. <u>OR</u>]] UHS inoperable [[for reasons other than condition A.]] | B.1 Be in MODE 3. | 6 hours <u>AND</u> B.2 Be in MODE 5. | 36 hours

- SR 3.7.9.1: Verify water level of UHS is ≥ [[7.90 m (25.93 ft) from the bottom of the basin]]. | 24 hours

- SR 3.7.9.2: Verify water temperature of UHS [[basin]] is ≤ [[33.2 °C (91.8 °F)]]. | 24 hours

- SR 3.7.9.3: [[Operate each UHS cooling tower fan for ≥ 15 minutes.]] | [[31 days]]

- SR 3.7.9.4: [[Verify each UHS manual, power-operated, and automatic valve in the flow path servicing safety related equipment, that is not locked, sealed, or otherwise secured in position, is in correct position.]] | [[31 days]]

- SR 3.7.9.5: [[Verify each UHS automatic valve and each control valve in the flow path that is not locked, sealed, or otherwise secured in position, actuates to correct position on an actual or simulated actuation signal.]] | [[18 months]]

- SR 3.7.9.6: [[Verify each cooling tower fan starts automatically on an actual or simulated actuation signal.]] | [[18 months]]

Except for the use of the double bracket to indicate conceptual design information for the UHS, the staff finds the proposed TS requirements acceptable because they conform to the guidance of the STS and reflect the UHS design as described in DCD Section 9.2.5.

The staff tracked RAI 154-8064, Question 16-44 as an open item pending receipt and confirmation of a comprehensive and accurate revised response from the applicant, as stated in the beginning of Section 16.4 in the discussion of general matters relevant to one or more DCD Tier 2, Chapter 16 sections. Question 16-44 is resolved as described therein; the resolution included the replacement of double brackets with single brackets to indicate that the bracketed information constitutes COL action item COL 16-3.7(2).

Since the issue of Question 16-44 concerns the accuracy and completeness of the list of COL action items in proposed DCD Tier 2, Table 16-1, as stated in the beginning of Section 16.4, and not the bracketed placeholders for plant-specific requirements for the UHS, and since Subsection 3.7.9 and Subsection B 3.7.9 are consistent with CE STS Subsection 3.7.9 and Subsection B 3.7.9 and therefore satisfy paragraphs (2) and (3) of 10 CFR 50.36(c) and paragraphs (1) and (2) of 10 CFR 50.36(a), the staff concludes that Subsection 3.7.9 and Subsection B 3.7.9 are acceptable, subject to satisfactory completion of COL 16-2.7(2) by the COL applicant.

Subsection 3.7.10 Essential Chilled Water System

Subsection 3.7.10 includes requirements for the Essential Chilled Water System (ECWS), which provides a heat sink for the removal of operating heat from selected safety related air handling systems during a DBA or transient, as well as during normal operation.

There were no RAI questions concerning Subsection 3.7.10.

Subsection 3.7.10 provisions match those in STS Subsection 3.7.10. There is no difference between the APR1400 design and the CE PWR design for this system. Since the requirements in Subsection 3.7.10 and the Bases in Subsection B 3.7.10 are consistent with the APR1400 ECWS design, the staff concludes that these Subsections are acceptable.

Subsection 3.7.11 Control Room HVAC System

Subsection 3.7.11 includes requirements for the Control Room HVAC System (CRHS), which consists of two divisions of the Control Room Emergency Makeup Air Cleaning System (CREACS); each CREACS division includes one Air Cleaning Unit (ACU) for air filtration with two ACU fan trains with separate flow paths and isolation dampers for each ACU fan train; and two divisions of the Control Room Supply and Return System (CRSRS); each CRSRS division includes two Air Handling Unit (AHU) fan trains for temperature and humidity control with separate flow paths and isolation dampers for each AHU fan train.

The following table lists the RAI questions concerning Subsection 3.7.11.

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.9	120-7977 ML15209A000 Response: ML16050A530 ML17191B261	3.7.11 • Remove title Note describing CRHS design • LCO statement – Revise to reflect that the air cleaning units (ACUs) are separate from the air handling units (AHUs); • Actions table - Revise to reflect combining the	CU	16-144.1 16-223.2 16-223.10

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		Specification for the HVAC temperature and humidity control function with the Specification for the air filtration and control room isolation function		
16-24.10	120-7977 ML15209A000 Response: ML16050A530	3.7.11 – Clarified the use of the term "division" and "train" in Subsection 3.7.11 and Bases	CR	
16-24.11	120-7977 ML15209A000 Response: ML16050A530	3.7.11 Applicability – designate Modes 5 and 6 as a COL action item with brackets	CU	16-223.16
16-24.12	120-7977 ML15209A000 Responses: ML16050A530 ML17191B261	3.7.11 – Designated toxic gas protection as a COL action item with brackets in Required Action Note for Action E	CC	See 16-223.4
16-24.13	120-7977 ML15209A000 Response: ML16050A530	SR 3.7.11.5 – Clarified that all four AHUs are tested each refueling outage	CR	
16-144.1	481-8546 ML16133A271 Response: ML16166A435	3.7.11 – Delete title Note	CU	16-223.2
16-144.2	481-8546 ML16133A271 Response: ML16166A435	3.7.11 – define HVAC on first use within a subsection	CU	16-223.1
16-144.3	481-8546 ML16133A271 Response: ML16166A435	Deviation report LCO statement quote mismatch with GTS LCO 3.7.11	CU	16-223.2
16-144.5	481-8546 ML16133A271 Response: ML16166A435	3.7.11 Required Action B.3 Completion Time – Changed to 90 days to match STS	CC	
16-223.1	526-8651 ML16291A395	3.7.11 title – Defined HVAC at first use in a subsection	CC	

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16335A460	B 3.7.11 title – Defined HVAC at first use in a subsection		
16-223.2	526-8651 ML16291A395 Response: ML16335A460	3.7.11 • title – Deleted Note • LCO statement - Revised to state, “Two Control Room Emergency Makeup Air Cleaning System (CREACS) divisions and two Control Room Supply and Return System (CRSRS) divisions of the CRHS shall be OPERABLE.” B 3.7.11 LCO section – Revise to state, “An OPERABLE CRSRS division requires just one of the two air handling units (AHUs).”	CC	See 16-223.9
16-223.3a	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	3.7.11 Action B – Revised previously proposed new Action B by replacing the Condition of “Three AHUs inoperable.” with “One CRSRS division inoperable.” with a 7 day operability restoration Completion Time, based on the LCO requiring just one of the two AHU fan trains per CRSRS division	CC	
16-223.3b	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	3.7.11 – Addressed dependency of the two AHU fan trains in a division on a common division of the essential chilled water system	CC	
16-223.4a	526-8651 ML16291A395 Response: ML16335A460	3.7.11 – Relabeled previously proposed Action D as Action E and added a bracketed remedial action for a gaseous radwaste system leak; also revised it for clarity; and	CR	See 16-44 regarding COL action items See COL action item 6.4(3)

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		B 3.7.11 - made conforming Bases changes. In addition: 1. Pointed out location of toxic gas detectors on DCD Tier 1, Figure 2.7.3.1-1, and in DCD Tier 2, Figure 9.4.1-1; and 2. Added a DCD discussion of CRHS automatic switchover from both normal and emergency modes to the CRHS isolation mode of operation on detection of toxic gas		
16-223.4b	526-8651 ML16291A395 Response: ML16335A460	3.7.11 - Stated role of toxic gas detection and mitigation features on operability of the CRHS	CR	
16-223.4c	526-8651 ML16291A395 Response: ML16335A460	3.7.11 - Stated role of smoke detection and mitigation features on operability of the CRHS	CR	
16-223.4d	526-8651 ML16291A395 Response: ML16335A460	3.7.11 - Add toxic gas detectors to DCD Tier 1 Table 2.7.3.1-2	CR	
16-223.4e	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	3.7.11 - Stated role of automatic start interlock between CRHS trains on CRHS operability, and how the interlock is tested as part of SR 3.7.11.3	CC	See 16-223.7 and 16-223.14
16-223.5a	526-8651 ML16291A395 Response: ML16335A460	3.7.11 – Relabeled previously proposed Action E as Action F and revised Action F for clarity	CC	
16-223.5b	526-8651 ML16291A395 Responses: ML16335A460	B 3.7.11 – Revised third paragraph of the LCO section of B 3.7.11 regarding	CC	

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML17255A101	operability of a CREACS division		
16-223.5c	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	3.7.11 – Action E relabeled as Action F - Added a bracketed remedial action for a gaseous radwaste system leak as Required Action F.2 with conforming changes to Bases	CC	
16-223.6	526-8651 ML16291A395 Response: ML16335A460	3.7.11 - Revised Action F, relabeled as Action G. for clarity and consistency with other suggested changes and conforming changes to B 3.7.11 Actions section	CC	
16-223.7	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	SR 3.7.11.3 - Revised for consistency with other suggested changes and for clarity with conforming changes to Bases	CC	
16-223.8	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 LCO section – Revise first original paragraph to improve clarity regarding what a CRHS division needs to be operable	CC	
16-223.9	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 LCO section – Revised second original paragraph to improve clarity regarding the features and components a CRSRS division needs to be operable	CC	
16-223.10	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Actions section – Revised Bases for Required Actions A.1 and B.1 for improved clarity	CC	
16-223.11	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Actions section – Revised Bases for relabeled Required Actions D.1 and D.2 for improved clarity	CC	

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-223.12	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Actions section – Revised Bases for relabeled Required Action F.1 for improved clarity; applicant declined to add an explicit Bases discussion for bracketed Required Action F.2 concerning the Gaseous Radwaste System	CC	
16-223.13	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Actions section – Revised Bases for relabeled Required Action G.1 for improved clarity	CC	
16-223.14	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 SR section – Revised Bases for SR 3.7.11.3 for improved clarity	CC	
16-223.15	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Actions section – Revised Bases for relabeled Required Actions E.1 and E.2[.1] and [E.2.2] for improved clarity	CC	
16-223.16	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	B 3.7.11 Applicability section – Revised to improve clarity	CC	
16-223.17.a.i 16-223.17.a.ii 16-223.17.a.iii 16-223.17.a.iv	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	3.7.11 – Clarified aspects of CRHS design, such as electrical power division trains supporting a train of components in a CRHS division; and outside air intake damper actuation functions required for CRHS division operability	CR	
16-223.17.a.iv.A	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	State whether the instrumentation control logic to isolate the damper pair, which corresponds to the higher radiation signal, is	CR	

Subsection 3.7.11 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		required for operability of CREACS		
16-223.17.a.iv.B	526-8651 ML16291A395 Responses: ML16335A460 ML17255A101	Explained how the CRSRS division with the operating AHU determines which CREACS train initiates ACU filtering of makeup air and MCR recirculated air upon trip of one outside air intake radiation monitor.	CR	
16-223.17.b	526-8651 ML16291A395 Responses: ML16335A460	Added a Note to DCD Tier 1 Table 2.7.3.1-1 to list the four ACU fans, and state the Class 1E electrical power source and distribution that powers each fan.	CC	
16-223.17.c	526-8651 ML16291A395 Responses: ML16335A460	Described how the ACU fan air flow control damper and the AHU fan air flow control damper are tested to ensure they will maintain air flow within design limits during normal, emergency, and isolation modes of operation of the CRHS.	CC	
16-223.17.d	526-8651 ML16291A395 Responses: ML16335A460	Stated that operability of the four CRHS tornado dampers is required for CRHS operability.	CC	

Status Codes:

CU	Closed Unresolved (has follow up question)	RC	Resolved Confirmatory
CR	Closed Resolved with no DCD changes	CC	Closed Confirmed

The CREACS provides a protected environment from which occupants can control the unit following an uncontrolled released of radioactivity, toxic gas, or smoke. The CRSRS provides air temperature and humidity control for the MCR.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 9, the staff requested that the applicant revise Subsection 3.7.11 to address controls of the two separate systems (the CREACS and the CRSRS) within the CRHS, based on their respective safety functions to be consistent with guidance in the STS. In its response (ML16050A530) to Question 16-24, regarding Sub-question 9, the applicant proposed the following changes:

- Revised the LCO statement;

- Revised Condition A to address only degradation of the CREACS;
- Added new Condition B to address degradation of the CRSRS;
- Renumbered and revised the remaining Conditions to reflect the above three changes and to improve clarity; and
- Revised Subsection B 3.7.11 to reflect the revised Subsection 3.7.11 requirements.

The staff reviewed these proposed changes and found the need for further modifications. In follow up RAI 526-8651 (ML16291A395), Question 16-223, the staff requested that the applicant consider additional changes to Subsection 3.7.11 and associated Subsection B 3.7.11. Detailed discussion of these changes are provided below.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 10, the staff requested that the applicant clarify the use of the term "division" as it is applied to the two subsystems (the CREACS and the CRSRS) within the CRHS. In its response (ML16050A530) to Question 16-24, regarding Sub-question 10, the applicant explained the use of the terms "division" and "train" throughout the APR1400 design and licensing documents to represent redundant equipment in a system. The staff finds this response acceptable based on the consistent use of the term "division" as it is applied to a two independent mechanical equipment lay-out within a system, and the term "train" as it is applied to a two redundant equipment within a division throughout various GTS Subsections. Also, their use in Subsection 3.7.11 reflects the CRHS design as described in DCD Section 9.4.1. Therefore, RAI 120-7977, Question 16-24, Sub-question 10, is resolved.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 11, the staff requested that the applicant provide a discussion of the basis for requiring LCO 3.7.11 during Modes 5 and 6. In its response (ML16050A530) to Question 16-24, regarding Sub-question 11, the applicant proposed to revise the Bases to include the requested supporting information, as well as revising the Applicability statement to identify the phrase "Modes 5 and 6" as a COL action item, which must be fully addressed by a COL applicant, by use of square brackets. The staff found the proposed changes were incomplete, and issued follow up RAI 526-8651 (ML16291A395), Question 16-223, requesting the applicant to consider additional changes. Detailed discussions of these changes are provided below.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 12, the staff requested that the applicant provide mitigation provisions regarding a "toxic gas release event" because such provisions are included as part of STS Subsection 3.7.10. In its response (ML16050A530) to Question 16-24, regarding Sub-question 12, the applicant proposed to revise Subsection 3.7.11 and Subsection B 3.7.11 to add these toxic gas mitigation provisions while identifying them as a COL action item using square brackets, as indicated below.

The applicant also proposed the following changes to Subsection 3.7.11 Required Actions C.2 and E.1:

- C.2 Verify mitigating actions to ensure CRE occupant exposures to radiological, ~~chemical,~~ <u>[toxic gas,]</u> and smoke hazards will not exceed limits. | Immediately
- E.1 <u>[Note: Place CRHS in toxic gas isolation mode if automatic transfer to toxic gas isolation mode is inoperable.]</u> Place OPERABLE CRHS division in emergency mode. | Immediately

The applicant also proposed the following changes to the Bases for Subsection 3.7.11.

- In the Background section, the second paragraph is revised as indicated below:

  The CREACS provides a protected environment from which occupants can control the unit following an uncontrolled released of radioactivity, ~~hazardous chemicals,~~ [toxic gas,] or smoke. The CRSRS provides air temperature control for the control room.

- In the Background section, the ninth paragraph is revised as indicated below (Additional staff suggested clarifying edits are indicated in italics with gray highlight):

  [-----------------------------REVIEWER'S NOTE------------------------------------
  The need for toxic gas isolation mode will be determined by the COL applicant.
  --]

  *Actuation of t*he CRHS places the system into ~~either of two separate of operation mode (emergency mode for protection for radiation, or recirculation mode for protection from smoke)~~ the emergency mode for protection from radiation [or the toxic gas isolation mode for protection from toxic gas, depending on the initiation signal]. Upon receipt of *an* actuation signal ~~*of*~~ *for* the emergency mode of operation, the unfiltered normal makeup air path is isolated, ~~*closes*~~ exhaust *isolation* dampers *are closed*, and *the* CREACS of the operating division is automatically started. The emergency mode initiates pressurization and filtered ventilation of the air supply to the CRE.

- In the Background section, a new paragraph is added after the tenth paragraph as indicated below:

  [Upon detection of a toxic gas, the toxic gas detector will initiate complete closure of outside intake isolation dampers to the CRE.]

- In the Background section, the eleventh paragraph is revised as indicated below:

  The air entering the CRE is continuously monitored by radiation [and toxic gas] detectors. One detector output above the setpoint causes actuation of the emergency ~~radiation state~~ mode [or the toxic gas isolation mode] as required. [The actions of the toxic gas isolation mode take precedence, and will override the action of the emergency mode.]

- In the Applicable Safety Analyses section, the third paragraph is revised as indicated below (Additional staff suggested clarifying edits are indicated in italics with gray highlight):

  The CRHS provides protection from smoke ~~and hazardous chemicals~~ [and toxic gas] to the CRE occupants. [The analysis of ~~hazardous chemicals~~ toxic gase*s* releases demonstrates that the toxicity limits are not exceeded in the CRE following a ~~hazardous chemical~~ toxic gas release (~~*Reference 1*~~ *Ref. 2*)]. The evaluation of a smoke challenge demonstrates that it will not result in the inability of the CRE occupants to control the reactor either from the control room or from the remote shutdown room (~~*Reference 3*~~ *Ref. 4*)

- In the LCO section, the fourth paragraph is revised as indicated below:

    In order for the CREACS divisions to be considered OPERABLE, the CRE boundary must be maintained such that the CRE occupant dose from a large radioactive release does not exceed the calculated dose in the licensing basis consequence analyses for DBAs, and that CRE occupants are protected from ~~hazardous chemicals and~~ [toxic gas and] smoke.

- In the Actions section, the discussion of Actions C.1, C.2 and C.3 is revised as indicated below (Additional staff suggested clarifying edits are indicated in italics with gray highlight):

    If the unfiltered inleakage of potentially contaminated air past the CRE boundary and into the CRE can result in CRE occupant radiological dose greater than the calculated dose of the licensing basis analyses of DBA consequences (allowed to be up to 50 mSv *(5 rem)* whole body or its equivalent to any part of the body), or inadequate protection of CRE occupants from ~~hazardous chemicals or~~ [toxic gas or] smoke, the CRE boundary is inoperable. Actions must be taken to restore an OPERABLE CRE boundary within ~~*92*~~ *90* days.

    During the period that the CRE boundary is considered inoperable, action must be initiated to implement mitigating actions to lessen the effect on CRE occupants from the potential hazards of a radiological ~~or chemical~~ [or toxic gas] event or challenge from ~~*the*~~ smoke. Actions must be taken within 24 hours to verify that in the event of a DBA, the mitigating actions will ensure that CRE occupant radiological exposures will not exceed the calculated dose of the licensing basis analyses of DBA consequences, and that CRE occupants are protected from ~~hazardous chemical and~~ [toxic gas and] smoke. …

- In the Actions section, a discussion of the new Action E.1 Note is added at the end of the discussion of Actions E.1 and E.2 as indicated below (Additional staff suggested clarifying edits are indicated in italics with gray highlight):

    [-------------------------------REVIEWER'S NOTE-------------------------------------
    The need for toxic gas isolation mode will be determined by the COL applicant.
    ---]

    [Required Action E.1 is modified by a Note ~~*indicating to*~~ *that requires placing* ~~*place*~~ the CRHS in the toxic gas isolation mode if the automatic toxic gas isolation mode is inoperable.]

- In the Surveillance Requirements section, the first sentence of the second paragraph of the discussion of SR 3.7.11.4 is revised as indicated below

(Additional staff suggested clarifying edits are indicated in italics with gray highlight):

> The CRE is considered habitable when the radiological dose to CRE occupants calculated in the licensing basis analyses of DBA consequences is no more than 50 mSv *(5 rem)* whole body or its equivalent to any part of the body and the CRE occupants are protected from ~~hazardous chemicals and~~ [toxic gas and] smoke.

The staff finds the above proposed changes are consistent with guidance in the STS and reflect the CRHS design described in DCD Sections 6.4 and 9.4.1. However, pending incorporation of the needed additional clarifications recommended by the staff, which are denoted by italics and gray highlights in the above markup, RAI 120-7977, Question 16-24, Sub-question 12, was tracked as an open item. In its revised response7 (ML17191B261) to Sub-question 12, the applicant incorporated the suggested edits. Therefore, RAI 120-7977, Question 16-24, Sub-question 12, is resolved.

In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 13, the staff requested that the applicant clarify how all four AHUs will be tested as specified in SR 3.7.11.5, given that only one AHU in each of the two CRSRS division is required to be operable. In its response (ML16050A530) to Question 16 24, regarding Sub-question 13, the applicant explained that all four AHU are tested one at a time within the 18-month Frequency to verify each CRSRS division has the capacity to remove the design heat load, and since each AHU is tested individually, the remaining three AHUs are available to support the CRSRS operability. The staff finds this response acceptable because it confirms that all AHUs are tested, not just the one AHU required in each division by LCO 3.7.11. Therefore, RAI 120-7977, Question 16-24, Sub-question 13, is resolved.

In RAI 481-8546 (ML16133A271), Question 16-144, the applicant was requested to address the following observations regarding Subsection 3.7.11:

1. The use of a Note under the Subsection 3.7.11 title to provide system design details;

2. The use of an acronym “HVAC” on its first use within a Subsection of the GTS;

3. LCO 3.7.11 statement cited in the Deviation Report is different from those in Revision 0 of the GTS; and

4. The use of “92-day” Completion Time (CT) in the GTS in place of “90-day” CT in the STS for restoring an inoperable control room envelope boundary to operable status.

In its response (ML16166A435) to Question 16-144, the applicant did not completely address the staff’s concerns about observations 1, 2, and 3. Therefore, in follow up RAI 526-8651 (ML16291A395), Question 16-223, Sub-questions 1 and 2, the staff reiterated these concerns as discussed below.

As mentioned above, during its review of proposed changes in response to RAI 120-7977, Question 16-24, the staff found the need for additional changes in Subsection 3.7.11. In addition, the staff noted that in DCD Section 9.4.1.2, Control Room HVAC System Description, the applicant states, in part, the following:

Emergency Mode

> Upon receipt of an engineered safety feature actuation signal … The emergency makeup ACU of the operating division starts automatically … Upon failure of the designated ACU, the standby AHU and ACU of the redundant division start automatically.

For clarity and consistency with the design of the control room emergency air cleanup system (CREACS) and the control room supply and return system (CRSRS), and in conformance with the STS conventions on the use of notes, in follow-up RAI 526-8651, Question 16-223, the staff requested the applicant consider additional modifications of Subsection 3.7.11 and its associated Bases as detailed below.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 1, the staff requested that the applicant define the acronym “HVAC” on its first use in the Subsection title as indicated below:

> Control Room Heating, Ventilation, and Air Conditioning (HVAC) System (CRHS)

In its response (ML16335A460) to Question 16 223, Sub-question 1, the applicant adopted the above suggested change. Therefore, RAI 526-8651, Question 16-223, Sub-question 1, is resolved.

In RAI 526-8651, Question 16-223, Sub-question 2, the staff requested that the applicant remove the note that was proposed for beneath the title of Subsection 3.7.11. In its response (ML16050A530) to RAI 120-7977, Question 16-24, regarding Sub-question 9, the applicant had previously revised this note, as indicated, to state:

> The CRHS consists of two divisions of control room emergency makeup air cleaning system (CREACS) and control room supply and return system (CRSRS). Each division of CREACS consists of one air cleaning unit (ACU) and each division of CRSRS consists of two air handling units (AHUs).

In the response to Sub-question 9, the applicant also revised the LCO statement of Subsection 3.7.11, as indicated, to incorporate the design details (redundantly) provided in the Note:

> ~~Two CRHS divisions shall be OPERABLE~~ Two Control Room Emergency Makeup Air Cleaning System (CREACS) divisions and two Control Room Supply and Return System (CRSRS) divisions of the CRHS shall be OPERABLE.

In its response (ML16335A460) to RAI 526-8651, Question 16-223, regarding Sub-question 2, the applicant agreed to delete the title Note, and adopted the above revised LCO statement. Therefore, RAI 526-8651, Question 16-223, Sub-question 2, is resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 3 (subsequently tracked as Sub-question 3a), the staff requested that the applicant consider additional modification of new Action B to reflect the STS phrasing convention and the CRSRS design, as described in DCD Section 9.4.1, as indicated, to state:

> B. One CRSRS division ~~Three AHUs~~ inoperable. | B.1 Restore ~~one inoperable AHU~~ CRSRS division to OPERABLE status. | 7 days

In its response (ML16335A460) to Question 16-223 regarding Sub-question 3, the applicant adopted the suggested change. In addition, as shown in the markup of Subsection B 3.7.11 on pages 4 and 5 of the response's Attachment, the applicant revised the LCO section of the Bases to include the following statements (with one correction noted by the staff in gray highlight):

> ... An OPERABLE CRHS division requires the emergency makeup air cleaning unit (ACU) in the associated ~~CRSRS~~ CREACS division and one of the two air handling units (AHUs) in the associated CRSRS division to be OPERABLE. The outside air intake isolation dampers, the ACU inlet isolation damper, the ACU return air isolation damper, the emergency makeup ACU fan, and the ACU discharge airflow control damper, which are associated with the required AHU flow path, are also required to be OPERABLE for OPERABILITY of the CRHS division.

The revised discussion in the Bases LCO section makes clear that an operable CRHS division requires the ACU fan and associated dampers that are powered by the same electrical division and train as the required AHU supply fan and its associated dampers. Therefore, RAI 526-8651, Question 16-223, Sub-question 3a, is resolved. In its revised response (ML17255A101) to Question 16-223, regarding Sub-question 3a, the applicant corrected the above indicated error in the LCO section of Subsection B 3.7.11, by replacing "CRSRS division and one of two air handling units" with "CREACS division and one of the two air handling units"; the staff finds this change acceptable.

In RAI 526-8651 (ML16291A395), Question 16-223, the last paragraph of Sub-question 3 (subsequently tracked as Sub-question 3b), stated:

> Staff noted an inaccuracy in the response to RAI 120-7977, Question 16-24. Because of the interlock feature to automatically start the standby AHU and ACU in the opposite CRHS division upon failure of the running AHU or ACU, when the CRHS is in the emergency mode of operation, and because each CRSRS division's two AHUs are supported by the same essential chilled water division, each AHU is completely independent only from the two AHUs in the opposite division, but is not completely independent from the other AHU in the same division, as asserted by KHNP in the response to RAI 120-7977, Question 16-24.

In its response (ML16335A460) to RAI 526-8651, Question 16-223, regarding Sub-question 3b, the applicant did not address correction of the noted inaccuracy in the response to RAI 120-7977, Question 16-24. The staff had expected that the applicant would clarify the dependency of the two AHU fan trains in the same division on a common division of the essential chilled water system. Sub-question 3b was tracked as an open item pending this clarification from the applicant. In its revised response (ML17255A101) to Question 16-223, regarding Sub-question 3b, the applicant added the following statement to the Background section of Subsection B 3.7.11:

> Two AHUs are provided per division and the cooling coils of the two AHUs in a division receive chilled water from the same division of the essential chilled water system.

Since this statement clarifies that the two AHUs in a division depend on a common division of the essential chilled water system, RAI 526-8651, Question 16-223, Sub-question 3b, is resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-questions 4a, 5a, 5c, and 15, the staff requested that the applicant consider additional modification to the revised Action D (renumbered as Action E), and Action E (renumbered as Action F), as indicated, to state:

> ~~D~~E. Required Action and associated Completion Time of Condition A or B not met [in ~~MODES 5 and 6~~ MODE 5 or 6, or] during movement of irradiated fuel assemblies. | ~~D~~E.1 [NOTE– Place CRHS in toxic gas isolation mode if automatic transfer to toxic gas isolation mode is inoperable.] Place CREACS and CRSRS of an OPERABLE CRHS division in emergency mode. | Immediately OR ~~D~~E.2[.1] Suspend movement of irradiated fuel assemblies. | Immediately AND [E.2.2 Suspend operations with a potential for releasing radioactivity from the Gaseous Radwaste System. | Immediately]
>
> ~~E~~F. Two ~~CRHS~~ CREACS divisions inoperable [in ~~MODES 5 and 6~~ MODE 5 or 6, or] during movement of irradiated fuel assemblies. OR One or two CREACS divisions inoperable due to inoperable CRE boundary [in ~~MODES 5 and 6~~ MODE 5 or 6, or] during movement of irradiated fuel assemblies. | ~~E~~F.1 Suspend movement of irradiated fuel assemblies. | Immediately AND [F.2 Suspend operations with a potential for releasing radioactivity from the Gaseous Radwaste System. | Immediately]

In addition, the staff requested that the applicant clarify operability requirements for toxic gas detectors (Sub-questions 4b and 4d), smoke detectors (Sub-question 4c) and the interlock feature that initiates an automatic start of the standby AHU and ACU in the opposite CRHS division (Sub-question 4e).

In its response (ML16335A460) to Question 16-223, the applicant adopted the above suggested changes; therefore Action E and Action F are acceptable, and Sub-questions 4a, 5a, 5c, and 15 are resolved. (The staff observed that the response to Sub-question 4 stated the revised Action E (as relabeled) *without the bracketed Required Action E.2.2*, which was suggested by the staff in Sub-question 15. However, on page 2 of the response's Attachment, a markup of the Subsection 3.7.11 Actions table does show the *bracketed Required Action E.2.2*.) In addition, the applicant provided justification to not include *explicit* operability requirements for:

(1) Toxic gas detectors. The applicant stated that the COL applicant will fully address these requirements based on a plant-specific evaluation of toxic gas release events, according to COL Item 6.4(3). For this reason, the applicant will not revise:

- DCD Tier 1, Table 2.7.3.1-2 to list the toxic gas detectors,
- DCD Tier 1, Figure 2.7.3.1-1 and DCD Tier 2, Figure 9.4.1-1, to include the [CRHS flow path] locations of the toxic gas detectors, or
- DCD Tier 2, Section 9.4.1 to discuss CRHS automatic switchover, from both normal and emergency modes to the isolation mode of CRHS operation on detection of toxic gas.

(2) Smoke detectors. The applicant stated that because the smoke detectors only perform nonsafety-related functions, an explicit LCO for them is not required.

(3) Interlock to automatically start the standby CRHS division upon failure of the operating division. The applicant stated this interlock feature is not required for standby CRHS division operability because the affected components can be manually started by the control room operator if the interlock fails to perform its function.

The staff agrees with the applicant's position on the toxic gas detectors, for the reasons stated above, and smoke detectors because "CRE occupants can be protected from smoke by using self-contained breathing apparatus inside the CRE as stated in DCD, Tier 2, Subsection 6.4.1.e"; therefore, RAI 526-8651, Question 16-223, Sub-questions 4b, 4c, and 4d are resolved. However, the staff disagrees with the applicant's position on the interlock. Pending resolution of the interlock operability issue, RAI 526-8651, Question 16-223, Sub-question 4e, was tracked as an open item. In its revised response (ML17255A101) to Question 16-223, regarding Sub-question 4e, the applicant stated:

> KHNP will revise the Bases for SR 3.7.11.3 to explain that the automatic functions of the individual components necessary for OPERABILITY of the emergency mode of CRHS operation such as ACUs, AHUs, and dampers, which are described in FSAR, Subsection 9.4.1 (Ref. 1), are verified by this SR. KHNP will also revise the Bases for SR 3.7.11.3 to include a statement that this SR verifies the interlock feature-to automatically start the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the same division and realign to emergency mode when the running CRHS train in a division fails to operate in emergency mode, and to automatically start the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the other division and realign to emergency mode when a CRHS division fails to operate in emergency mode is operable.

Based on the above, the staff concludes that SR 3.7.11.3 will verify the operability of all automatic actuation functions of the fans and dampers of each CRHS division initiated upon receipt of a CREVAS signal, with the CRHS initially in the normal mode of operation or initially already in the emergency mode of operation, including actuation from a standby condition, and damper realignment upon failure of the initially actuated or running CRHS train. The applicant also improved the Bases for SR 3.7.11.3 by inserting "a bracketed phrase, 'or toxic gas isolation mode' after each of the phrases, 'emergency mode' in the markup [of the] Bases for SR 3.7.11.3 to allow [a] COL applicant to use the bracketed phrases [with brackets removed] in case it is determined that automatic transfer to toxic gas isolation mode [upon] receiving a toxic gas detection signal is needed [to protect control room occupants as required by GDC 19]." The applicant also revised the resolution column for toxic gas protection[,] regarding Subsection 3.7.11[, in DCD, Tier 2, Chapter 16,] Table 16-1, "List of COL Action Items," to include the phrase, "toxic gas isolation mode." Based on finding these changes to Subsection B 3.7.11 and DCD, Tier 2, Chapter 16, Table 16-1 acceptable, the staff concludes that RAI 526-8651, Question 16-223, Sub-question 4e, is resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 5, the staff requested that the applicant consider additional modification of revised Action E (relabeled as Action F) for clarity and consistency with other proposed changes, as indicated:

~~E~~F. Two ~~CRHS~~ CREACS divisions inoperable [in ~~Mode~~ MODE 5 or 6, or] during movement of irradiated fuel assemblies. OR One or two CREACS divisions inoperable due to inoperable CRE boundary [in ~~Mode~~ MODE 5 or 6, or] during movement of irradiated fuel assemblies. | ~~E~~F.1 Suspend movement of irradiated fuel assemblies. | Immediately AND [F.2 Suspend operations with a potential for releasing radioactivity from the Gaseous Radwaste System. | Immediately]

The staff also requested that the applicant revise the third paragraph of the LCO section of the associated Bases to describe the automatic start logic of the CREACS ACU fans.

In its response (ML16335A460) to Question 16-223, regarding Sub-question 5, the applicant adopted the above suggested change to Action E (relabeled as Action F), and provided justification for not revising the LCO section of the associated bases by citing an earlier proposed change, as part of the response to RAI 304-8361, Question 6.4-2, to clearly state that "each CREACS division is considered operable when one of the two fans and one of the two electric heating coils are operable." Although this statement is accurate, failure of the Bases to describe the automatic start logic of the CREACS ACU fans remains an issue, because staff considers it an operability criterion for a CREACS train. Therefore, RAI 526-8651, Question 16-223, Sub-question 5b, was tracked as an open item. In its revised response (ML17255A101) to Question 16-223, for Sub-question 5b, the applicant replaced the fourth paragraph of the LCO section of Subsection B 3.7.11 "to account for the necessary individual components regarding an operable CRHS division in the emergency mode and the isolation mode." The new paragraphs state:

> Each CRHS division is considered OPERABLE in the emergency mode when the individual components necessary to limit CRE occupant exposure are OPERABLE. A CRHS division is considered OPERABLE in the emergency mode when the associated:
>
> a. One of two fans in the ACU is OPERABLE.
>
> b. One of two electric heating coils in the ACU is OPERABLE.
>
> c. HEPA filter and carbon adsorber are not excessively restricting flow and are capable of performing their filtration functions.
>
> d. One of two AHUs with associated AHU fan, AHU heating coil, AHU cooling coil, and AHU discharge flow control damper is OPERABLE.
>
> e. One of two outside air intake isolation dampers in each of two outside air intake paths is OPERABLE.
>
> f. One of two AHU inlet isolation dampers in each of the two normal makeup paths to the AHU inlet is OPERABLE.
>
> g. One of two ACU inlet isolation dampers is OPERABLE.
>
> h. One of two ACU return air isolation dampers is OPERABLE.
>
> i. One of two ACU discharge flow control dampers is OPERABLE.
>
> j. One of two kitchen and toilet exhaust isolation dampers is OPERABLE.

k. One of two smoke removal isolation dampers is OPERABLE.

A CRHS division is considered OPERABLE in the isolation mode when the above components, with the exception of the individual components associated with the ACU, are OPERABLE.

The normal and isolation modes of CRHS operation do not include using the ACU function, but regardless of whether the CRHS is operating in the normal, emergency, or isolation mode, two CREACS divisions (each with its ACU and associated required fan and dampers) must still be OPERABLE when the unit is in the Applicability of LCO 3.7.11.

The staff concludes that the above list of CRHS components, which are necessary for CRHS operability in the emergency, normal, and isolation modes of operation, is consistent with the CRHS design. Where operability of a listed component requires its automatic capabilities to actuate or realign, the Bases for SR 3.7.11.3 clarifies that this SR verifies each such capability. As noted in the discussion of the resolution of Sub-question 4e above, the Bases for SR 3.7.11.3 is revised as indicated:

> This SR verifies active components in each ~~CREACS~~ CRHS division start and operate on an actual or simulated actuation signal. The automatic functions of the individual components necessary for OPERABILITY of the emergency mode of CRHS operation such as ACUs, AHUs, and dampers, which are described in FSAR, Subsection 9.4.1 (Ref. 1), are verified by this SR. This SR also verifies the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the same division automatically starts and realigns to emergency mode [or toxic gas isolation mode] when the running CRHS train in a division fails to operate in emergency mode [or toxic gas isolation mode], and the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the other division automatically starts and realigns to emergency mode [or toxic gas isolation mode] when a CRHS division fails to operate in emergency mode [or toxic gas isolation mode].

Since the above changes to the Bases are technically accurate, the staff concludes that they are acceptable. Therefore, RAI 526-8651, Question 16-223, Sub-question 5b, is resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 6, the staff requested that the applicant consider additional modification of revised Action F (relabeled as Action G) for clarity and consistency with other proposed changes, as indicated to state:

> ~~F~~G. Two ~~CRHS~~ CREACS divisions inoperable in MODE 1, 2, 3, or 4 for reasons other than ~~Condition B~~ Condition C. OR Two CRSRS divisions inoperable in MODE 1, 2, 3, or 4. | ~~F~~G.1 Enter LCO 3.0.3. | Immediately

In its response (ML16335A460) to Question 16-223, Sub-question 6, the applicant adopted the above suggested changes. Therefore, RAI 526-8651, Question 16-223, Sub-question 6, is resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 7, the applicant was requested to revise SR 3.7.11.3 for clarity and consistency with other proposed changes, as indicated:

> Verify active CREACS and CRSRS components in each CRHS division ~~actuates~~ actuate on an actual or simulated actuation signal. | 18 months

In its response (ML16335A460) Question 16-223, regarding Sub-question 7, the applicant stated:

> KHNP considers that the test for SR 3.7.11.3 in STS is just to verify that each CREACS division starts and operates on an actual or simulated ESFAS which is supposed to start upon receipt of an ESFAS. Because CRSRS divisions are not started and operated by receiving an ESFAS and a CRSRS division which is running during the normal operation operates continuously whether an ESFAS is initiated or not. The SR 3.7.11.3 will be revised to meet the purpose of SR 3.7.11.3 in STS as follows:
>
> > Verify active components in each CREACS division actuate on actual or simulated actual signal. | 18 months

The staff disagrees with the response, which only partially adopts the above suggested changes, because it reduces the scope of SR 3.7.11.3 to only include active components associated with the flow path through the ACU. Therefore, RAI 526-8651, Question 16-223, Sub-question 7, was tracked as an open item. In its revised response (ML17255A101) to Question 16-223, for Sub-question 7, the applicant replaced "CREACS" with "CRHS" in the surveillance statement to ensure the operability of all applicable ESF actuations and interlocks used for the automatic response of active components in each CRHS division." Since an operable CRHS division requires the automatically actuated active components in the associated CRSRS division, as well as the associated CREACS division, to be operable, this change resolves Question 16-223, Sub-question 7.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-questions 8 through 16, the staff requested that the applicant consider various suggested conforming changes to associated Subsection B 3.7.11. In its response (ML16335A460) to Question 16-223, regarding Sub-questions 8 through 16, the applicant proposed the following changes to the associated Bases.

- (Sub-question 8) In the LCO section of Subsection B 3.7.11, the first paragraph is revised as indicated below (The staff noted apparent corrections, indicated by gray highlight.):

> Two independent and redundant divisions of the CRHS are required to be OPERABLE to ensure that ~~at least~~ one division is available during an event requiring the CRHS, if a single failure disables the other division. An OPERABLE CRHS division requires the emergency makeup air cleaning unit (ACU) in the associated CREACS division and one of two air handling units (AHUs) in the associated CRSRS division to be OPERABLE. The outside air intake isolation dampers, the ACU ~~emergency makeup air and return air~~ inlet isolation damper~~s~~, the ACU return air isolation damper, ~~and~~ the emergency makeup ACU fan, and the ACU discharge airflow control damper, which are associated with the required AHU flow path, are also required to be OPERABLE for OPERABILITY of the CRHS division.
>
> Total ~~system~~ CRHS failure, such as from a loss of both CRSRS ~~ventilation~~ divisions, both CREACS divisions, or one CRSRS division and the CREACS in the opposite division, or from an inoperable CRE boundary, could result in

exceeding a dose of 50 mSv (5 rem) to the control room operators in the event of an accident with a large radioactive release ~~and in the equipment operating temperature exceeding limits in the event of an accident~~.

Total CRSRS failure, such as from the loss of all AHUs, could result in exceeding operating temperature limits of equipment in the CRE, not just in the event of an accident when the CRSRS may be needed to operate in the recirculation or emergency mode, but also during normal operation.

Pending correction of the noted errors, Sub-question 8 was tracked as an open item. In its revised response (ML17255A101) to Question 16-223, regarding Sub-question 8, the applicant made the suggested changes, except for the phrases marked with double line out, which are omitted to preserve consistency in terminology. Finding that these changes clarify the subject paragraphs, the staff concludes that Question 16-223, Sub-question 8, is resolved.

- (Sub-question 9) In the LCO section of Subsection B 3.7.11, the second paragraph is revised as indicated below:

  ~~The~~ A CRSRS division is considered OPERABLE when the necessary individual components associated with one ~~AHU~~ of the two AHUs ~~that is~~ are OPERABLE. The necessary components are those needed to maintain ~~MCR~~ CRE temperatures and relative humidity within limits ~~is OPERABLE in both divisions~~ to meet equipment OPERABILITY requirements. These components include the AHU cooling coils and associated essential chilled water system three-way flow control valve, the heating coils, and associated temperature control instrumentation, and the AHU supply fan, AHU inlet isolation dampers, the AHU discharge airflow control damper, and the humidifier in the AHU discharge duct. In addition, the CRSRS division must be OPERABLE to the extent that the minimum necessary air circulation in the CRE can be maintained.

  In DCD Revision 1, the applicant included the suggested changes. However, in its revised response (ML17255A101) to Question 16-223, regarding Sub-question 5, the applicant replaced the above paragraph with a clearer and more comprehensive description of CRSRS operability. See the above discussion of Sub-question 5 of Question 16-223. Therefore, Question 16-223, Sub-question 9, is resolved.

- (Sub-question 16) The Applicability section of Subsection B 3.7.11 is revised as indicated below:

  In MODES 1, 2, 3, 4, ~~5, and 6~~ [5, and 6] and during movement of irradiated fuel assemblies, the CRHS must be OPERABLE to ensure that the CRE will remain habitable during and following a DBA and ensure that the control room temperature will not exceed equipment operational requirements following isolation of the control room.

  [In MODES 5 and 6, the CRHS is also required to cope with a failure of the Gaseous Radwaste System.]

  During movement of irradiated fuel assemblies, the CRHS must be OPERABLE to cope with the radioactivity release from a fuel handling accident.

In its revised response (ML17255A101) to Question 16-223, regarding Sub-question 16, the applicant made the suggested changes, which result in a clearer and more comprehensive description of the specified applicability of the CRHS operability requirement. Therefore, Question 16-223, Sub-question 16, is resolved.

- (Sub-question 10) In the Actions section of Subsection B 3.7.11, the discussions of Required Action A.1, new Required Action B.1 and relabeled Required Actions C.1, C.2 and C.3 are revised as indicated below:

  A.1

  With one ~~CRHS~~ CREACS division inoperable, for reasons other than an inoperable CRE boundary, action must be taken to restore the division to OPERABLE status within 7 days. In this condition, the remaining OPERABLE ~~CRHS~~ CREACS division is adequate to ~~maintain the control room temperature within limits and to~~ perform the CRE ~~occupants~~ occupant protection function. However, the overall reliability is reduced because a single failure in the OPERABLE CREACS division could result in ~~less~~ loss of the ~~CRHS~~ CREACS function. The 7 day Completion Time is based on the low probability of a DBA occurring during this time period, and the ability of the remaining division to provide the required capabilities.

  B.1

  An OPERABLE CRSRS division requires just one AHU. With one CRSRS division inoperable, action must be taken to restore the division to OPERABLE status within 7 days. In this condition, the remaining OPERABLE CRSRS division is adequate to maintain the control room temperature and relative humidity within limits ~~and to perform the CRE occupant protection function~~. However, the overall reliability is reduced because a single failure in the OPERABLE CRSRS division could result in loss of the CRSRS function. The 7 day Completion Time is based on the low probability of a DBA occurring during this time period and the ability of the remaining AHU of the OPERABLE CRSRS division to provide the required capabilities.

  ~~B~~C.1, ~~B~~C.2 and ~~B~~C.3

  In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 10, the applicant included the suggested clarifying changes, with one exception. The accepted changes result in a clearer and more comprehensive description of the rationale for the specified actions for an inoperable CREACS division (Condition A) and an inoperable CRSRS division (Condition B), and are therefore acceptable. The exception is indicated by double line out. This omission is acceptable because the CRSRS does not function to protect CRE occupants from radiation exposure. Therefore, Question 16-223, Sub-question 10, is resolved.

- (Sub-question 11) In the Actions section of Subsection B 3.7.11, the discussions of relabeled Actions D.1 and D.2 are revised as indicated below:

  ~~C~~D.1 and ~~C~~D.2

In MODE 1, 2, 3, or 4, if the inoperable ~~CRHS~~ CREACS or CRSRS division or the CRE boundary cannot be ~~restore~~ restored to OPERABLE status within the required Completion Time, the unit must be placed in a MODE that minimizes the accident risk. To achieve this status, the unit must be placed in at least MODE 3 within 6 hours, and MODE 5 within 36 hours.

In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 11, the applicant included the suggested clarifying changes, which resolves Sub-question 11.

- (Sub-question 15) In the Actions section of Subsection B 3.7.11, the discussions of relabeled Required Actions E.1 and E.2 are revised as indicated below:

~~D~~E.1 and ~~D~~E.2

Required Action ~~D~~E.1 is ~~operated~~ performed manually.

~~MODE 5, 6, or during~~ [In MODE 5 or 6, or during] [During] movement of irradiated fuel assemblies, if Required Action A.1 or B.1 cannot be completed within the required Completion Time, the CREACS and CRSRS of the OPERABLE CRHS division must be immediately placed in the emergency MODE of operation. This action ensures that the remaining division is OPERABLE, that no failures preventing automatic actuation will occur, and that any active failure will be readily detected.

An alternative to Required Action ~~D~~E.1 is Required Action[s] E.2[.1 and E.2.2] to immediately suspend activities that could result in a release of radioactivity that may require isolation of the ~~control room~~ CRE. This places the unit in a condition that minimizes the accident risk.

This does not preclude the movement of fuel assemblies to a safe position.

In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 15, the applicant included the suggested clarifying changes, which resolves Sub-question 15.

- (Sub-question 12) In the Actions section of Subsection B 3.7.11, the discussion of relabeled Actions F.1 and F.2 is revised as indicated below:

~~E~~F.1[and F.2]

~~In MODE 5, 6, or~~ [In MODE 5 or 6, or] during movement of irradiated fuel assemblies with two ~~CRHS~~ CREACS divisions inoperable or two CRSRS divisions inoperable, or with one or two CREACS divisions inoperable due to an inoperable CRE boundary, ~~action~~ Required Action[s] F.1 [and F.2] must be taken immediately to suspend activities that could result in a release of radioactivity that may require isolation of *the* CRE. This places the unit in a condition that minimizes the accident risk. This does not preclude the movement of fuel to a safe position.

~~[*Bases discussion for Required Action F.2*]~~

Pending addition of a Bases discussion for Required Action F.2 ("Suspend operations with a potential for releasing radioactivity from Gaseous Radwaste System. | Immediately"), as suggested in Sub-question 5.c, Sub-question 12 was tracked as an open item.

In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 12, the applicant made the suggested changes, but declined to add a Bases discussion specific to Required Action F.2, as indicated by double line out, because it considers that the above discussion, as revised, also suffices for Required Action F.2. The staff considers this position is correct. Therefore, the above accepted changes resolve Sub-question 12.

- (Sub-question 13) In the Actions section of Subsection B 3.7.11, the discussion of relabeled Action G.1 is revised as indicated below:

    ~~F~~G.1

    If both ~~CRHS~~ CREACS divisions are inoperable in MODE 1, 2, 3, or 4 for ~~reason~~ reasons other than an inoperable CRE boundary (i.e., Condition ~~B~~C) or both CRSRS divisions are inoperable in MODE 1, 2, 3, or 4, the CRHS may not be capable of performing the intended ~~function~~ functions and the unit is in a condition outside the accident analyses. Therefore, LCO 3.0.3 must be entered immediately.

    In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 13, the applicant included the suggested clarifying changes, which resolves Sub-question 13.

- (Sub-question 14) In the SR section of Subsection B 3.7.11, the staff requested that the applicant revise the discussion of SR 3.7.11.3, in part, as indicated below:

    This SR verifies each respective component in the ~~CRHS~~ CREACS division and CRSRS division starts and operates on an actual or simulated actuation signal …

    In its response to Question 16-223 (ML16335A460), regarding Sub-question 14, the applicant stated:

    As responded in the response of sub-questions 4.e and 7, KHNP believes that the test for SR 3.7.11.3 is to verify that each CREACS division starts and operates on an actual or simulated ESFAS. Therefore, the part of Bases for SR 3.7.11.3 will be revised as follows:

    This SR verifies active components in each CREACS division start and operate on an actual or simulated actuation signal…

    The staff disagrees with the response, which only partially adopts the above suggested changes, because it reduces the scope of SR 3.7.11.3 to only include active components associated with the flow path through the ACU. Therefore, RAI 526-8651, Question 16-223, Sub-question 14, was tracked as an open item. This item is related to the open item for Sub-question 7.

    In its revised response to Question 16-223 (ML17255A101), regarding Sub-question 14, the applicant revised the subject sentence in DCD Revision 0 of the Bases for SR 3.7.11.3 as follows:

    This SR verifies active components in each CRHS division ~~starts and operates~~ start and operate on an actual or simulated actuation signal…

Based on the proposed sentence, and the resolution of Sub-question 7, which is discussed above, the staff concludes that the revised statement of SR 3.7.11.3 ("Verify active components in each CRHS division ~~actuates~~ actuate on an actual or simulated actuation signal. | 18 months") and the above revised sentence are acceptable because they are consistent with the intended scope of automatic actuations verified by this surveillance. Therefore, RAI 526-8651, Question 16-223, Sub-question 14, is resolved.

In summary, based on the proposed changes to Subsection B 3.7.11, as described above, RAI 526-8651, Question 16-223, Sub-questions 8, 9, 10, 11, 12, 13, 14, 15, and 16 are resolved.

In RAI 526-8651 (ML16291A395), Question 16-223, Sub-question 17, the staff requested that the applicant clarify the following aspects of the CRHS design. The applicant's response (ML16335A460) and the staff's assessment follow each enumerated request:

a. (Sub-question 17.a, items i, ii, iii, iv.A and iv.B) Explain whether the following active components of an operable CRHS division must be powered by the same Class 1E electrical power division and train (Div. I, Train A or C) or (Div. II, Train B or D):

   i. The CREACS division required ACU, required ACU fan, ACU makeup air inlet isolation damper, ACU recirculation inlet isolation damper, and ACU fan discharge air flow control damper;

      Response: Each of the ACU inlet isolation dampers, the ACU return air isolation dampers, and the ACU discharge air flow control dampers is powered by same Class 1E electric power train of their associated ACU fan.

      Assessment: The staff concludes that each ACU fan train is supported by the same EDG. This resolves item 17.a.i.

   ii. The CRSRS division required AHU, AHU fan, AHU outside air inlet isolation damper pair, and AHU fan discharge air flow control damper; and

      Response: Each of the AHU inlet isolation dampers and the AHU discharge air flow control dampers is powered by same Class 1E electric power train of their associated AHU fan.

      Assessment: The staff concludes that each AHU fan train is supported by the same EDG. This resolves item 17.a.ii.

   iii. The CRSRS kitchen isolation damper pair and the smoke removal fan isolation damper pair.

      Response: The individual isolation dampers in the CRSRS kitchen isolation damper pair or the smoke removal fan isolation damper pair are powered by different power divisions. One isolation damper of a pair is powered by Class 1E electric power Div. I and the other isolation damper of a pair is powered by Class 1E electrical power Div. II.

Assessment: The staff concludes that each kitchen isolation damper (in a pair) is supported by a separate EDG in a separate electrical division; likewise for each smoke removal fan isolation damper. This resolves item 17.a.iii.

iv. The two pairs of CRHS outside air dampers, one pair of which closes on a CREVAS main control room air intake high radiation signal.

Response: The two pairs of CRHS outside air dampers are powered by different power divisions. One pair is powered by Div. I and the other pair is powered by Div. II.

Assessment: The staff needs additional detail regarding whether each of the four CRHS outside air dampers is powered by a separate EDG. Sub-question 17.a.iv was tracked as an open item until this design detailed is verified.

In its revised response to Question 16-223 (ML17255A101), for Sub-question 17.a.iv, the applicant revised the response as indicated:

Revised Resp.: The two pairs of CRHS outside air dampers are powered by different power divisions. One pair is powered by Div. I <u>(Train A and C)</u> and the other pair is powered by Div. II <u>(Train B and D). And each of the four CRHS outside air dampers is powered by a separate Class 1E electric power train, Train A, Train C, Train B, and Train D, respectively.</u>

Assessment: The revised response provides the requested information about electrical power for each CRHS outside air damper. Therefore, Question 16-223, Sub-question 17.a.iv, is resolved.

A. (Sub-question 17.a.iv.A) The applicant is requested to state whether the instrumentation control logic to isolate the damper pair, which corresponds to the higher radiation signal, is required for operability of CREACS. Where is this logic implemented?

Response: The control logic to isolate the outside air intake isolation damper pair upon receipt of the higher radiation signal exists to isolate the outside air intake having higher radioactivity between dual outside air intakes and it is required for operability of CREACS. This control logic is implemented in safety-related component control system, which is called ESF-CCS. The ESF-CCS is discussed in DCD Tier 2, Section 7.3.

Assessment: The staff concludes that the operability of both CREACS fan trains requires the operability of the control logic in the ESF-CCS that isolates the outside air intake having higher radioactivity between dual outside air intakes. This resolves Sub-question 17.a.iv.A.

B. (Sub-question 17.a.iv.B) According to DCD Tier 2, Figure 7.3-11, ESFAS Functional Logic (CREVAS), just one of the four main control room air intake radiation monitors needs to reach its trip setpoint to initiate placing the CRHS division with the operating AHU in the emergency mode of operation, and the other CRHS division in standby. Explain how the CRSRS division with the operating AHU determines which CREACS train initiates ACU filtering of makeup air and MCR recirculated air.

Response: As stated in the "Emergency Mode" of DCD Tier 2, Subsection 9.4.1.2, the CRHS is interlocked to start the ACU in the same division of the operating AHU.

Assessment: Pending receipt of a more detailed response regarding the design of the interlock, and the design of the interlock that starts the standby CRHS division if the initially running CRHS division fails, Sub-question 17.a.iv.B was tracked as an open item.

In its revised response (ML17255A101) to Question 16-223,, for Sub-question 17.a.iv.B, the applicant modified the response as indicated:

Revised Resp.: As stated in the "Emergency Mode" of DCD Tier 2 subsection 9.4.1.2, the CRHS is interlocked to start the <u>designated</u> ACU fan in the same division of the <u>running</u> AHU. <u>It is also interlocked to automatically start the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the same division when the running CRHS train fails to operate, and to automatically start the standby CRHS train (which includes the standby AHU and the standby ACU fan) in the other division when a CRHS division fails to operate.</u>

Assessment: The revised response clarifies that the interlock initiates (1) in normal mode, automatic start of a standby CRSRS train upon failure of the running CRSRS train in the same division; (2) in emergency mode, automatic start of a standby CREACS train and associated CRSRS train upon failure of the running CRSRS train or CREACS train in the same division; (3) in normal mode, automatic start of a standby CRSRS train in the opposite division upon failure of the running CRSRS train, assuming only the running train was operable; and (4) in emergency mode, automatic start of a standby CRHS train in the opposite division upon failure of the running CRSRS train or CREACS train, assuming only the running CRHS train in the division was operable. Therefore, Question 16-223, Sub-question 17.a.iv.B, is resolved.

b. (Sub-question 17.b) The applicant is requested to list the four ACU fans in DCD, Tier 1, Table 2.7.3.1-1, and state the Class 1E electrical power source and distribution that powers each fan.

Response: DCD Tier 1 Table 2.7.3.1-1 is prepared on a HVAC equipment basis such as AHU and ACU and therefore individual fans of ACUs are not listed in the Table 2.7.3.1-1. And DCD Tier 1 has a standard format that does not state the Class 1E electric power source in the Tables. KHNP will revise DCD Tier 1 Table 2.7.3.1-1 to add a Note to the "Emergency Makeup ACU" that indicates each ACU has two fans and each fan is powered by different Class 1E electric power trains.

Assessment: The staff reviewed the markup of DCD Tier 1 Table 2.7.3.1-1, "Control Room HVAC System Components List," which lists the CRHS dampers, the ACU fans, and the AHU fans, and includes new Note (4) which states, "Each ACU has two fans. Two fans in AU01A are powered by Class 1E train A and C, respectively, and two fans in AU01B are powered by Class 1E train B and D, respectively. The revised table contains the requested information. Therefore, Question 16-223, Sub-question 17.b, is resolved.

c. (Sub-question 17.c) The applicant is requested to describe how the ACU fan air flow control damper and the AHU fan air flow control damper maintain air flow within design limits during normal, emergency, and isolation modes of operation of the CRHS.

Response: Flow controllers are located upstream of the ACU fan air flow control damper and the AHU fan air flow control damper. The flow controllers measure the discharge airflow rate and continuously modulate the opening of the air flow control dampers to maintain air flow within design limits.

Assessment: The staff concludes that the provided information answers the staff's request. However, the applicant is also requested to describe how CRHS flow is verified to be within limits for each mode of operation, for each ACU/AHU train flow path, since the surveillances specified by Subsection 3.7.11 do not appear to include such verification. Pending receipt of the requested description, Sub-question 17.c was tracked as an open item.

In its revised response (ML17255A101) to Question 16-223, for Sub-question 17.c, the applicant modified the response as indicated:

Revised Resp.: Flow controllers are located upstream of the ACU fan air flow control damper and the AHU fan air flow control damper. The flow controllers measure the discharge airflow rate and continuously modulate the opening of the air flow control dampers to maintain air flow within design limits. The flow control test for each of the ACU air flow control dampers and the AHU fan air flow control dampers is tested periodically in accordance with ASME N511 to verify that the flow control dampers maintain air flow within design limits. KHNP will revise the statement in DCD Tier 2 subsection 9.4.1.4, "The safety-related isolation dampers are inspected periodically~" to "The safety-related dampers are inspected and tested periodically in accordance with ASME N511~" to explicitly state that the safety-related dampers including the flow control dampers are inspected and tested periodically in accordance with ASME N511.

Assessment: Based on the revised discussion in DCD, Tier 2, Subsection 9.4.1.4, regarding periodic testing of "safety-related dampers" per ASME N511, the staff concludes that the ACU and AHU flow control dampers' capability to maintain HVAC flow through the ACU and AHU to the control room within design limits will be adequately verified. Therefore, Question 16-223, Sub-question 17.c, is resolved.

d. (Sub-question 17.d) The applicant is requested to state whether operability of the four CRHS tornado dampers is required for CRHS operability.

Response: As stated in DCD Tier 2, subsection 9.4.1.2, tornado dampers are provided to protect the CRHS against instantaneous pressure change caused by tornadoes and they are required for CRHS operability.

Assessment: The staff concludes that the provided information answers the staff's request. However, the applicant is also requested to describe how tornado dampers are verified to be operable, since the surveillances specified by Subsection 3.7.11 do not appear to include such verification. Pending receipt of the requested description, Sub-question 17.d was tracked as an open item.

In its revised response (ML17255A101) to Question 16-223, for Sub-question 17.d, the applicant modified the response as indicated:

Revised Resp.: As stated in DCD Tier 2 subsection 9.4.1.2, tornado dampers are provided to protect the CRHS against instantaneous pressure change caused by tornadoes and they are required for CRHS operability. The exercise test for each of tornado dampers is tested periodically in accordance with ASME N511 to verify it is operated as required. KHNP will revise the statement in DCD Tier 2 subsection 9.4.1.4, "The safety-related isolation dampers are inspected periodically~" to "The safety-related dampers are inspected and tested periodically in accordance with ASME N511~" to explicitly state that the safety-related dampers including the tornado dampers are inspected and tested periodically in accordance with ASME N511.

Assessment: Based on the revised discussion in DCD, Tier 2, Subsection 9.4.1.2, regarding periodic testing and inspection of "safety-related dampers" per ASME N511, the staff concludes that the tornado dampers' capability to protect the CRHS and the control room from the effects of a tornado will be adequately verified. Therefore, Question 16-223, Sub-question 17.d, is resolved.

In its response (ML16335A460) to RAI 526-8651, Question 16-223, Sub-question 17, the applicant provided the requested clarifying details and DCD changes. However, the applicant did not provide information, such as surveillance requirements for testing the outside air intake isolation dampers and tornado dampers, which the staff needed to complete its review. As such, RAI 526-8651, Question 16-223, Sub-questions 17.a.iv, 17.a.iv.B, 17.c and 17.d, were tracked as open items. As described above, the revised response (ML17255A101) to RAI 526-8651, Question 16-223, resolved Sub-question 17.

The staff reviewed Subsection 3.7.11 and Subsection B 3.7.11 and verified that the CRHS LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the CRHS, so that in the event an accident occurs in Mode 1, 2, 3, 4, 5, or 6, or during movement of irradiated fuel assemblies, the habitability of the control room is maintained as required by GDC 19, which will ensure that control room occupants do not incur radiological doses greater than the GDC 19 limit, and are protected from smoke and toxic gas hazards. Accordingly, the staff concludes that Subsection 3.7.11 satisfies GDC 19 and paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.11 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.11. The staff also verified that Subsections 3.7.11 and B 3.7.11 are consistent with the guidance in CE STS Subsections 3.7.11, "CREACS," and 3.7.12, "Control Room Emergency Air Temperature Control System," and Subsections B 3.7.11 and B 3.7.12, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.7.11 and Subsection B 3.7.11 are acceptable.

Subsection 3.7.12 Auxiliary Building Controlled Area Emergency Exhaust System (ABCAEES)

Subsection 3.7.12 includes requirements for the ABCAEES, which filters air from the radiologically-controlled area of the Auxiliary Building following a design basis LOCA. The Auxiliary Building radiologically-controlled area boundary covers the safety-related mechanical equipment rooms including emergency core cooling system (ECCS) equipment rooms and the mechanical penetration rooms.

In the APR1400 design, the single ABCAEES will serve the combined radiologically-controlled-area boundary as opposed to the two different systems of “ECCS Pump Room Exhaust Air Cleanup System” and “Penetration Room Exhaust Air Cleanup System” in the CE PWR design.

The following table lists the RAI questions concerning Subsection 3.7.12.

Subsection 3.7.12 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.4	120-7977 ML15209A000 Response: ML16050A530	SR 3.7.12.4	CU	16-144.4
16-108.11	289-8215 ML15307A004 Response: ML16027A196	3.7.12 Actions table – added a new Action B and relabeled existing Action B as Action C; B 3.7.12 Actions section – added discussion of the new Required Action B.1	CC	
16-144.4	481-8546	SR 3.7.12.4 – Made editorial correction	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

The staff noted that Subsection 3.7.12 provisions do not contain requirements for maintaining integrity of the radiologically-controlled-area boundary as specified in STS Subsection 3.7.12, even though there is no difference between the APR1400 design and the CE PWR design for this system. In RAI 289-8215 (ML15307A004), Question 16-108, Sub-question 11, the applicant was requested to address the missing elements. In its response (ML16027A196) to Question 16-108, regarding Sub-question 11, the applicant proposed to add a new Condition B to address an inoperable radiologically-controlled-area boundary as indicated below:

> B. Two ABCAEES divisions inoperable due to inoperable mechanical penetration room or safety-related mechanical equipment room boundary. | B.1 Restore mechanical penetration room and safety-related mechanical equipment room boundary to OPERABLE status. | 24 hours

The applicant also proposed to revise the associated Bases (Subsection B 3.7.12 Actions section) by adding a discussion of Required Action B.1, as indicated below:

> <u>B.1</u>

[---------------------------------------REVIEWER'S NOTE--------------------------------------
Adoption of Condition B is dependent on a commitment from the COL applicant to have guidance available describing compensatory measures to be taken in the event of an intentional and unintentional entry into Condition B.
--]

[---------------------------------------REVIEWER'S NOTE--------------------------------------
The need for toxic gas isolation mode will be determined by the COL applicant.
--]

If the mechanical penetration room or safety-related mechanical equipment room boundary is inoperable, the ABCAEES divisions cannot perform their intended functions. Actions must be taken to restore an OPERABLE mechanical penetration room and safety-related mechanical equipment room boundary within 24 hours. During the period that the mechanical penetration room or safety-related mechanical equipment room boundary is inoperable, appropriate compensatory measures [consistent with the intent, as applicable, of GDC 19, 60, 64 and 10 CFR 50.34] should be utilized to protect plant personnel from potential hazards such as radioactive contamination, [toxic gases], smoke, temperature, and physical security. Preplanned measures should be available to address these concerns for intentional and unintentional entry into the condition. The 24 hour Completion Time is reasonable based on the low probability of a DBA occurring during this time period, and the use of compensatory measures. The 24 hour Completion Time is a typically reasonable time to diagnose, plan and possibly repair, and test most problems with the mechanical penetration room or safety-related mechanical equipment room boundary.

The staff finds this response acceptable because the new Action B and Bases adequately address the staff's concern with regard to an inoperable radiologically-controlled-area boundary. Therefore, RAI 289-8215, Question 16-108, Sub-question 11, is resolved.

The staff reviewed Subsection 3.7.12 and Subsection B 3.7.12 and verified that the ABCAEES LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the ABCAEES, so that in the event an accident occurs in Mode 1, 2, 3, 4, 5, or 6, or during movement of irradiated fuel assemblies, the habitability of the mechanical penetration rooms and safety-related mechanical equipment rooms is maintained as required by GDC 19, which will ensure that room occupants do not incur radiological doses greater than the GDC 19 limit, and are protected from smoke and toxic gas hazards. Accordingly, the staff concludes that Subsection 3.7.12 satisfies GDC 19 and paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.7.12 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing "a summary statement of the bases or reasons" for the requirements specified in Subsection 3.7.12. The staff also verified that Subsections 3.7.12 and B 3.7.12 are consistent with the guidance in CE STS Subsections 3.7.13, "ECCS Pump Room Exhaust Air Cleanup System," and 3.7.15, "Penetration Room Exhaust Air Cleanup System," and STS Subsections B 3.7.13 and B 3.7.15, and the APR1400 ABCAEES design as described in the DCD. Therefore, based on its review, the staff concludes that Subsection 3.7.12 and Subsection B 3.7.12 are acceptable.

Subsection 3.7.13 Fuel Handling Area Emergency Exhaust System (FHAEES)

Subsection 3.7.13 includes requirements for the FHAEES, which filters airborne radioactive particulates from the area of the spent fuel pool following a fuel handling accident.

There were no RAI questions concerning Subsection 3.7.13.

Subsection 3.7.13 provisions match those in STS Subsection 3.7.14, "Fuel Building Air Cleanup System (FBACS)." There is no difference between the APR1400 design and the CE PWR design for this system. Since the requirements in Subsection 3.7.13 and the Bases in Subsection B 3.7.13 are consistent with the APR1400 FHAEES design, and CE STS Subsections 3.3.14 and B 3.7.14, the staff concludes that Subsections 3.7.13 and B 3.7.13 are acceptable.

Subsection 3.7.14 Spent Fuel Pool Water Level (SFPWL)

Subsection 3.7.14 includes requirements for the minimum water level of the spent fuel pool while moving irradiated fuel assemblies in the fuel handling area.

There were no RAI questions concerning Subsection 3.7.14.

Subsection 3.7.14 provisions match those in STS Subsection 3.7.16, "Fuel Storage Pool Water Level." There is no difference between the APR1400 design and the CE PWR design regarding the spent fuel pool water level requirements as assumed in DCD Section 15.7.4, "Fuel Handling Accident (FHA)." Since the requirements in Subsection 3.7.14 and the Bases in Subsection B 3.7.14 are consistent with the APR1400 FHA analysis, and CE STS Subsections 3.7.16 and B 3.7.16, the staff concludes that these Subsections are acceptable.

Subsection 3.7.15 Spent Fuel Pool Boron Concentration

Subsection 3.7.15 includes requirements for the water in the spent fuel pool which is normally borated to greater than or equal to 2,150 ppm.

There was one RAI question concerning Subsection 3.7.15. See Section 6.3 of this SER for discussion of RAI 496-8630, Question 6.3-10, which was tracked as an open item. The resolution of the technical specification aspect of Question 6.3-10 is described in the evaluation of Subsection 3.5.1 in Section 16.4.10 of this SER.

Subsection 3.7.15 provisions match those in STS Subsection 3.7.17, "Fuel Storage Pool Boron Concentration." There is no design difference between the APR1400 design and the CE PWR design with respect to the spent fuel pool boron concentration other than the design-specific concentration value that is applicable to the APR1400 design. Since the requirements in Subsection 3.7.15 and the Bases in Subsection B 3.7.15 are consistent with the APR1400 spent fuel storage facility design, and CE STS Subsections 3.7.17 and B 3.7.17, the staff concludes that Subsections 3.7.15 and B 3.7.15 are acceptable.

Subsection 3.7.16 Spent Fuel Assembly Storage

The following table lists the RAI questions concerning Subsection 3.7.16.

Subsection 3.7.16 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-24.14	120-7977 ML15209A000 Response: ML16050A530 ML17191B261	3.7.16 – Address bracketed provisions in STS B 3.7.16 – Provide basis information from the criticality analyses 4.3.1.1 – revise to reflect the NRC approved SFP storage configuration	CU	16-150.4
16-150.4A	481-8546 ML16133A271 Response: ML16187A207	4.3.1.1.b – revised to capture assumptions of the SFP criticality analyses 4.3.1.1.e – revised to reflect the NRC approved SFP storage configuration 4.3.1.1.f – revised to reflect the NRC approved SFP storage configuration	CC	
16-150.4B 16-150.4C 16-150.4D	481-8546 ML16133A271 Response: ML16187A207	4.3 – added new Figure 4.3-1 showing the physical layout of the spent fuel storage racks B 3.7.16 Background – revised to include discussion of minimum boron concentration assumed in the SFP criticality analyses B 3.7.16 References – added technical report for the SFP criticality analyses to the list of references	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Subsection 3.7.16 provisions, in general, match the STS Subsection 3.7.16 provisions; however, some parts of those provisions in the CE STS are placed within brackets indicating their reliance on a specific plant configuration that was previously approved by the NRC staff. In RAI 120-7977 (ML15209A000), Question 16-24, Sub-question 14, the applicant was requested to provide clarification on the NRC approved configuration. In its response (ML16050A530) to Sub-question 14, the applicant provided incomplete information regarding an NRC approved storage configuration. Follow up RAI 481-8546 (ML16133A271), Question 16-150, Sub-question 4, was issued requesting the applicant to fully address the original staff concern. In its response (ML16187A207) to Question 16-150, regarding Sub-question 4, the applicant proposed (1) to revise Section 4.3 to add the spent fuel storage configuration (i.e., a new

Figure 4.3-1) that is used in the SFP criticality analyses, (2) to revise TS 4.3.1.1 to capture the results of the SFP criticality analyses as indicated below:

4.3.1.1.b k_{eff} < 1.0 if flooded with unborated water and k_{eff} ≤ 0.95 if flooded with water borated to 1231 ppm enriched, which includes an allowance for uncertainties ~~as described in Section 9.1, "Fuel Storage and Handling."~~;

4.3.1.1.e ~~New or partially spent fuel assemblies~~ Fuel assemblies with a discharge burnup in the "acceptable domain" of Figure 3.7.16-1 may be allowed unrestricted storage in Region I or Region II of ~~spent fuel storage rack(s)~~Figure 4.3-1; and

4.3.1.1.f New or partially spent fuel assemblies with a discharge burnup in the "unacceptable domain" of Figure 3.7.16-1 ~~will be stored in compliance with the NRC-approved specific document containing the analytical methods, title, date, or specific configuration or figure~~ shall be stored only in the Region I of Figure 4.3-1.

and (3) to revise Subsection B 3.7.16 to add clarifying details regarding the minimum boron concentration as credited in the SFP criticality analysis as follows:

- In B 3.7.16 Background section, add the following paragraph at the end:

  The spent fuel storage racks are required to maintain a k_{eff} of < 1.0 under normal conditions at a 95/95 level assuming the pool is flooded with unborated water. Compliance with this regulatory requirement has been ensured by developing storage requirements as a function of burnup and initial enrichment (Figure 3.7.16-1). Once the burnup requirements have been determined, the amount of soluble boron necessary to maintain a k_{eff} of ≤ 0.95 under normal and postulated accident conditions is calculated. The details of the analyses are provided in Reference 1. It is shown that a soluble boron concentration of 1,231 ppm enriched boron is required to maintain a k_{eff} of ≤ 0.95 for allowable storage configurations, which is well within the 2,150 ppm enriched boron requirement of LCO 3.7.15.

- In B 3.7.16 References section, add the following reference:

  1. APR1400-Z-A-NR-14011-P, "Criticality Analysis of New and Spent Fuel Storage Racks," Rev. 2, KHNP, January 2018.

The staff's evaluation of the SFP criticality analysis is documented in Section 9.1.1 of this SER. The staff finds the final response regarding the SFP storage acceptable because the revised Subsection 3.7.16 and the related TS 4.3.1.1 conform to the guidance in CE STS Subsections 3.7.18, Spent Fuel Pool Storage," and B 3.7.18, as well as reflecting the APR1400 SFP design described in DCD Tier 2, Section 9.1.1. Therefore, RAI 481-8546, Question 16-150, Sub-question 4 is resolved.

Based on its review and the above evaluation, the staff concludes that Subsection 3.7.16 and Subsection B 3.7.16 are acceptable.

Subsection 3.7.17 Secondary Specific Activity

Subsection 3.7.17 includes requirements for the activity in the secondary side fluid, resulting from a steam generator tube leakage of reactor coolant from the RCS.

There were no RAI questions concerning Subsection 3.7.17.

Subsection 3.7.17 provisions match those in CE STS Subsection 3.7.19, “Secondary Specific Activity.” There is no design difference between the APR1400 design and the CE PWR design with respect to the secondary specific activity as described in DCD Section 15.0.3, “Radiation Dose Consequence Analysis.” Since the requirements in Subsection 3.7.17 and the Bases in Subsection B 3.7.17 are consistent with the APR1400 radiation dose consequence analysis, and the guidance in CE STS Subsections 3.7.19 and B 3.7.19, the staff concludes that these Subsections are acceptable.

Conclusion for Section 3.7 and Section B 3.7

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.7 and Section B 3.7 are acceptable.

16.4.13 TS Chapter 3.0 LCOs and SRs ─ Section 3.8 Electrical Power Systems

GTS Section 3.8 provides requirements for the electrical power systems that provide redundant, diverse and dependable power to support all plant operating conditions. In the event of a total loss of off-site ac power, on-site emergency diesel generators (EDGs), batteries and inverters are provided to supply electrical power to equipment necessary for the safe shutdown of the plant.

In general, GTS Section 3.8 is modeled after STS Section 3.8, with differences to reflect APR1400 unique design features. These unique design features include having (1) four trains of onsite emergency ac power, with each train having one EDG; the four trains are divided into two electrical power divisions with each division supporting a redundant set of 100 percent capacity safety equipment; (2) four divisions of battery backed dc power; and four divisions of vital ac power. In contrast, the electrical power system of a typical CE digital PWR design has just (1) two diesel generators (DGs), each supporting one of two ac divisions; and (2) two batteries, each supporting one of two dc divisions and two of four vital ac divisions.

The GTS Subsections for electrical power systems correspond to CE STS Subsections for electrical power systems in the following manner:

STS	GTS	Title
3.8.1	3.8.1	AC Sources – Operating
3.8.2	3.8.2	AC Sources – Shutdown
3.8.3	3.8.3	Diesel Fuel Oil, Lube Oil, and Starting Air
3.8.4	3.8.4	DC Sources – Operating
3.8.5	3.8.5	DC Sources – Shutdown
3.8.6	3.8.6	Battery Cell Parameters (*Battery Parameters)

3.8.7	3.8.7	Inverters – Operating
3.8.8	3.8.8	Inverters – Shutdown
3.8.9	3.8.9	Distribution Systems – Operating
3.8.10	3.8.10	Distribution Systems – Shutdown

Although GTS Section 3.8 is modeled on STS format and content, the staff noted differences from the STS that warranted technical justification and clarification beyond what was given in Section 3.8 and the deviation report. The following evaluation summarizes key concerns raised during the staff's review of each Subsection in Section 3.8.

Subsection 3.8.1 AC Sources – Operating

Subsection 3.8.1 includes requirements in Modes 1, 2, 3, and 4 for the Class-1E Electrical Power Distribution System ac power sources, which consist of the offsite power sources (preferred power sources, normal and alternate), and the onsite standby power sources—two divisions of emergency diesel generators (EDGs), each division consisting of two EDGs (EDG A and EDG C for division I, and EDG B and EDG D for division II).

The following table lists the RAI questions concerning Subsection 3.8.1.

Subsection 3.8.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
8.3.1-2	57-7965 ML15189A490 Response: ML15231A804	B 3.8.1 Background section last paragraph – Revised the stated continuous service rating for each EDG to <u>9100 kW</u> for EDGs A and B, and to <u>7500 kW</u> for EDGs C and D with 10% overload permissible for up to 2 hours in any 24 hour period, consistent with DCD Tier 2, Section 8.3.1.1.2.4.	CC	16-3
9.5.4-12.2	355-8438 ML15362A446 Response: ML16064A044 ML16201A211	SR 3.8.1.5 – revised to state "Check for and remove accumulated water <u>and sediment</u> from each day tank and engine mounted tank."	CC	
16-2	96-8073 ML15234A002 Response: ML15266A517	3.8.1 – Condition F, "One automatic load sequencer inoperable," was noted as deleted in the deviation report, yet was retained in Subsection 3.8.1; since a loss of an ESF bus load sequencer affects every major ESF system supported	CC	*16-43

Subsection 3.8.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		by the affected electrical train, the 3.8.1 Actions table retains Condition F, consistent with the STS, and the deviation report is corrected*		
16-3	96-8073 ML15234A002 Response: ML15266A517	SR 3.8.1.3 acceptance criteria - Justified using the EDG “percent of rating,” vs the actual “kW rating,” which is stated in Subsection B 3.8.1 *Background section.	CC	*8.3.1-2
16-4	96-8073 ML15234A002 Response: ML15266A517	SR 3.8.1.7 – Removed inapplicable surveillance column Notes 1, 2, 3, and 4, which are not included in the STS; SR 3.8.1.2 and SR 3.8.1.7 - added a surveillance column Note (“All EDG starts may be preceded by an engine prelube period.”), which is included in the STS.	CC	
16-7	96-8073 ML15234A002 Response: ML15266A517 ML16113A307	Explained difference between “EDG train” in B 3.8.1, and “EDG subsystem” in B 3.8.3	CU	16-141.1
16-50	162-8055 ML15235A003 Response: ML15301A207	• SR 3.8.1.2, SR 3.8.1.9, SR 3.8.1.10, SR 3.8.1.11 – changed surveillance column Note title to “NOTES” because there are two Notes • SR 3.8.1.3 – changed surveillance column Note title to “NOTES” because there are four Notes	CC	
16-51	162-8055 ML15235A003 Response: ML15301A207	3.8.1 Required Actions B.3.1 and B.3.2 – corrected indentation of logical connector “<u>OR</u>”	CC	
16-106.a	243-8289 ML15296A012	B 3.8.1 SR section, Bases for SR 3.8.1.6 (“Verify fuel oil	CC	

Subsection 3.8.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16007A391	transfer system operates to automatically transfer fuel oil from storage tank to the day tank.”) – Revised B 3.8.1 SR section to justify SR 3.8.1.6 Frequency of 92 days instead of 31 days.		
16-106.b	243-8289 ML15296A012 Response: ML16007A391	SR 3.8.1.14 acceptance criteria – Justified using the EDG “percent of rating,” vs the actual “kW rating,” which is stated in Subsection B 3.8.1 Background section.	CR	16-3
16-107.a	243-8289 ML15296A012 Response: ML15351A182	SR 3.8.1.4 – Added square brackets around value for minimum volume of fuel oil in each EDG day tank – COL action item	CC	16-44
16-107.b	243-8289 ML15296A012 Response: ML15351A182	SR 3.8.3.4 – Added square brackets around values for minimum pressure in each EDG starting air receiver – COL action item	CC	16-44
16-130.2B5	439-8524 ML16074A284 Response: ML16187A196	Removed paragraph taken from STS Rev. 4, Subsection B 3.8.1 start of Actions section, which was first introduced by TSTF-359 regarding the Actions table Note excepting LCO 3.0.4b – because GTS do not include TSTF-359	CC	
16-141.1	478-8568 ML16131A614 Response: ML16223A964 ML17240A394	Deviation Report III.4.1-consistent use of divisions, channels, load groups, subsystems, and trains; examples: III.4.1.2, III.4.1.3	CC	
16-141.2	478-8568 ML16131A614 Response: ML16223A964 ML17240A394	Explained how to apply 3.8.1 Required Actions A.2 and B.2 – that is, interpret the phrase “its redundant required feature(s)”	CR	

Status Codes:

Although GTS Subsection 3.8.1 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Section 3.8.1 and the deviation report (DR).

In RAI 355-8438 (ML15362A446), Question 9.5.4-12, staff noted that fuel in the storage tanks and day tanks will be sampled periodically according to the Fuel Oil Testing Program in Subsection 5.5.13, and that accumulated water shall be removed in accordance with SR 3.8.1.5 and SR 3.8.3.5. In its response (ML16201A211) to Question 9.5.4-12, regarding Sub-question 2, the applicant revised these SRs to require removal of sediment and moisture since an accumulation of sediment in fuel oil can (a) obstruct the flow of oil from the tank to the combustor and (b) it is difficult to remove only accumulated water excluding sediment in the tank; ASTM D975 provides the limits for fuel oil properties including limits on sediment. See Section 9.5.4 of this report for a discussion of the concerns and resolution of RAI 355-8438, Question 9.5.4-12, regarding clarification of SR 3.8.1.5 and SR 3.8.3.5 to be consistent with STS and DCD Tier 2, Section 9.5.4.5. Based on the applicant's response, RAI 355-8438, Question 9.5.4-12, Sub-question 2 is resolved.

The DR indicated that Subsection 3.8.1 Action F is being deleted because it is unnecessary; however the Actions table and associated Bases still included Action F. In RAI 96-8073 (ML15234A002), Question 16-2, the staff requested that the applicant resolve this discrepancy. In its response (ML15266A517) to Question 16-2, the applicant pointed out that the Subsection B 3.8.1 Actions section discussion of Required Action F.1 explains that a loss of an EDG's ESF bus load sequencer affects every major ESF system powered by the affected electrical train. The applicant stated that Action F will be retained, since the APR1400 design includes an ESF bus load sequencer for each EDG, and that the above-mentioned deviation will be removed from the DR. Therefore, RAI 96-8073, Question 16-2, is resolved.

In RAI 96-8073 (ML15234A002), Question 16-3, the staff requested that the applicant justify expressing the SR 3.8.1.3 acceptance criteria as a "percent of rating," vs the actual kW rating as presented in the STS. In its response (ML15266A517) the applicant stated that since the continuous rated load is not uniform for all EDGs, the specified EDG load range for the surveillance is indicated as a percentage of the rating rather than the specific value in kW to avoid multiple values and potential misapplication when performing the SR. Consistent with DCD Tier 2, Section 8.3.1.1.2.4, the last paragraph of the Background section of the Bases for Subsection 3.8.1 states that the continuous service rating for each EDG is <u>9100 kW</u> for EDGs A and B, and <u>7500 kW</u> for EDGs C and D with 10% overload permissible for up to 2 hours in any 24 hour period. Therefore, RAI 96-8073, Question 16-3, is resolved.

In RAI 96-8073 (ML15234A002), Question 16-7, the staff noted that the Actions section of the Bases for Subsection 3.8.3 refers to an inoperable EDG subsystem, while the Bases for Subsection 3.8.1 refer to EDG trains. The applicant was requested to address the difference between an EDG subsystem and an EDG train in the Section 3.8 Bases. In its response (ML15266A517) to Question 16-7, the applicant stated,

> The EDG system is a safety related system consisting of four EDG trains, each of which serves Train A, Train B, Train C, or Train D onsite power distribution systems, respectively. Each EDG train is comprised of a diesel generator and its supporting subsystems, such as fuel oil, lube oil, engine cooling water, starting air, and combustion air intake and exhaust systems.

This information is included in the Bases for Subsection 3.8.3. In particular, the Applicability section states

> Since stored diesel fuel oil, lube oil, and starting air subsystems support LCO 3.8.1 and LCO 3.8.2, stored diesel fuel oil, lube oil and starting air are required to be within limits when the associated EDG is required to be OPERABLE.

Based on the above response, staff concludes that RAI 96-8073, Question 16-7 is unresolved, mostly because the Bases do not explicitly discuss the EDG subsystems that support an onsite ac source train. Although in Subsection 3.8.3, the term "subsystem" seems to denote association with just one onsite AC source train, staff requested the applicant to address this terminology consistency issue in a more comprehensive manner, in follow up RAI 478-8568 (ML16131A614), Question 16-141.

In RAI 478-8568, Question 16-141, Sub-question 1, the staff requested that the applicant revise the DCD where appropriate to consistently use the terms divisions, channels, subsystems, load groups, and trains to prevent incorrect interpretations of GTS and Bases that could occur if these terms are used inconsistently. The request stemmed from two statements in the deviation report (Revision 1) that seemed to incorrectly use several of these terms as synonyms:

- (DR Section III.4.1.2) "Class 1E 125 Vdc system consists of four independent subsystems, trains A, B, C, and D, each corresponding to one of the four reactor protection instrumentation channels A, B, C, and D ..."
- (DR Section III.4.1.3) "The Class 1E 120 Vac I&C power system is separated into four subsystems, trains A, B, C, and D that supply power to the Plant Protection System channels A, B, C, and D."

In its response (ML16223A964) to Question 16-141, Sub-question 1, the applicant described the meaning of each of the terms as follows:

Division	A division is a set of trains, performing various safety functions, separated both mechanically and electrically from another division. The separation between the divisions is provided geographically or by physical barrier. [DCD Subsections 8.3.1.1.2.1 and 8.3.2.1.2.3 state that] the Class 1E onsite power system consists of two redundant divisions (Division I and Division II) and each division is further broken down into Trains A and C for Division I and Trains B and D for Division II.
Train	A train is defined as a subset of a system. It is a set of components providing totally or partially one or several function(s)

of a system. A train is redundant to, one or more similar train(s), each with the same capability to provide the specified function(s).

Channel	According to IEEE Std. 603, a channel is an arrangement of components and modules as required to generate a single protective action signal when required by a generating station condition. In the STS [and the GTS], the term 'channel' is used in plant control and protection systems such as the Reactor Protection System (RPS) and Engineered Safety Features Actuation System (ESFAS).
Load group	According to IEEE Std. 308, a load group is an arrangement of buses, transformers, switching equipment, and loads fed from a common power supply within a division. In APR1400, the Class 1E onsite power system consists of redundant load groups (Division I and Division II) as stated in DCD Tier 2, Subsections 8.1.2 and 8.3.1.1.2.1. In some instances, a load group refers to a small load group (a train) as necessary in the DCD texts.
Subsystem	According to IEEE Std. 804, a subsystem is a portion of a system containing two or more interrelated components which may be isolated for design, test, or maintenance. In the APR1400 DCD, the term 'subsystem' is used to represent a smaller set within a complete system. In comparison to STS, the terms 'subsystem(s)' in the generic Technical Specifications of APR1400 have been replaced as necessary by the term 'division(s)' or 'train(s)' to avoid ambiguity in the meaning.

Although the response did not explicitly discuss the above two examples from the deviation report, the staff finds that the response provides sufficient clarification of the use of these terms in the DCD and in particular, Chapter 16. However, the Bases for Subsection 3.8.4 was not revised to replace "subsystem" with "train" and appears to use "subsystem" as a synonym for "division" in the Actions section. Pending correction of this example and any other such inconsistencies in the Specifications and Bases, RAI 478-8568, Question 16-141, Sub-question 1 was tracked as an open item.

In its revised response (ML17240A394) to Question 16-141, Sub-question 1, the applicant stated it had reviewed the Specifications and Bases and made appropriate clarifications in Subsections 3.8.4, 3.8.5, 3.8.9, B 3.3.7, B 3.8.1, B 3.8.2, B 3.8.4, B 3.8.5, B 3.8.7, B 3.8.8, and B 3.8.9, and Table B 3.8.9-1. In particular,

- The LCO statement of Subsection 3.8.4 is revised to state, "Division I and Division II of the DC Electrical Power System shall be OPERABLE."
- Required Action C.1 of Subsection 3.8.4 is revised to state, "Restore DC Electrical Power System division to OPERABLE status. | 2 hours".
- Replaced "Battery charger(s)" with "battery chargers" in Subsection 3.8.4, Condition A and Required Action A.3; and Subsection 3.8.5, Required Action A.3 for consistency with STS Subsections 3.8.4 and 3.8.5.

- Replaced "One or more required DC Electrical Power System division(s) inoperable" with "One or more required DC Electrical Power System divisions inoperable" in Condition B of Subsection 3.8.5.

- Required Action B.2.3 of Subsection 3.8.5 is revised to state, "Initiate action to restore required DC ~~electrical power subsystems~~ Electrical Power System divisions to OPERABLE status. | Immediately".

- Required Action A.1 Note of Subsection 3.8.9 is revised to state, "Enter applicable Conditions and Required Actions of LCO 3.8.4, 'DC Sources – Operating,' for DC ~~trains~~ divisions made inoperable by inoperable power distribution subsystems."

- Required Action A.1 of Subsection 3.8.9 is revised to state, "Restore AC electrical power distribution ~~subsystems~~ subsystem(s) to OPERABLE status. | 8 hours" for consistency with STS Subsection 3.8.9.

- Table B 3.8.9-1 is revised to list the following AC and DC electrical power distribution systems:

AC safety buses

(4,160 V)	ESF Bus 1A	Division I	Train A
(4,160 V)	ESF Bus 1C	Division I	Train C
(4,160 V)	ESF Bus 1B	Division II	Train B
(4,160 V)	ESF Bus 1D	Division II	Train D
(480 V)	Load Center 1A	Division I	Train A
(480 V)	Load Center 1C	Division I	Train C
(480 V)	Load Center 1B	Division II	Train B
(480 V)	Load Center 1D	Division II	Train D
(480 V)	Motor Control Centers 1A, 2A, 3A, 4A	Division I	Train A
(480 V)	Motor Control Centers 1C, 2C, 3C, 4C	Division I	Train C
(480 V)	Motor Control Centers 1B, 2B, 3B, 4B	Division II	Train B
(480 V)	Motor Control Centers 1D, 2D, 3D, 4D	Division II	Train D

DC safety buses

(125 V)	Bus 1A	Division I	Train A
(125 V)	Bus 1C	Division I	Train C
(125 V)	Bus 1B	Division II	Train B
(125 V)	Bus 1D	Division II	Train D

AC vital buses

(120 V)	Bus 1A	Division I	Train A
(120 V)	Bus 1C	Division I	Train C
(120 V)	Bus 1B	Division II	Train B
(120 V)	Bus 1D	Division II	Train D

Note (1) Each ~~division~~ train of the AC and DC Electrical Power Distribution Systems is a subsystem.

The staff found the proposed changes provided the requested clarification. Therefore, RAI 478-8568, Question 16-141, Sub-question 1, is resolved.

In RAI 478-8568 (ML16131A614), Question 16-141, Sub-question 2, the staff requested that the applicant state for each of the [safety systems of Safety Injection System (SIS), Containment Spray System (CSS), Essential Service Water System (ESWS), Component Cooling Water System (CCWS), and Auxiliary Feedwater System (AFWS)] the minimum number of trains needed to perform the safety function, assuming the limiting design basis event and the associated worst case single failure, and for each system, what constitutes redundancy. The staff requested this information to understand how GTS Subsection 3.8.1 Required Actions A.2 and B.2 are intended to be implemented for the APR1400 design. These actions state (emphasis added):

> For Condition A: "One offsite circuit inoperable."
>
> A.2 Declare required feature(s) with no offsite power available inoperable when *its redundant required feature(s)* is inoperable. | 24 hours from discovery of no offsite power to one division concurrent with inoperability of *redundant required feature(s)*
>
> For Condition B: "One or two EDGs in one division inoperable."
>
> B.2 Declare required feature(s) supported by the inoperable EDG(s) inoperable when *its redundant required feature(s)* is inoperable. | 4 hours from discovery of Condition B concurrent with inoperability of *redundant required feature(s)*

In addition, this concern also relates to the proper understanding of Action C:

> For Condition C: "Two offsite circuits inoperable."
>
> C.1 Declare required feature(s) inoperable when *its redundant required feature(s)* is inoperable. | 12 hours from discovery of Condition C concurrent with inoperability of *redundant required feature(s)*

In the response, the applicant provided a table describing the minimum required train(s) and redundancy of the safety systems; based on this information, the staff concludes:

- In Condition A (one division with the one offsite circuit inoperable), to complete Required Action A.2, or in Condition B (one division with one or two of the two EDGs inoperable), to complete Required Action B.2:
    - SIS: the operability of the two trains in the opposite division must be verified.
    - ESWS: the operability of one of the two trains in the opposite division must be verified.
    - CSS: the operability of the one train in the opposite division must be verified.
    - AFWS for Steam Generator 1 (SG1): the operability of the motor driven pump train for SG2, which is supported by electrical Division II, must be verified; the operability status of the turbine driven pump train for SG1 and the turbine driven pump train for SG2 is not relevant since these trains do not directly depend on offsite or onsite Class 1E ac electrical power.

- AFWS for Steam Generator 2 (SG2): the operability of the motor driven pump train for SG1, which is supported by electrical Division I, must be verified; the operability status of the turbine driven pump train for SG2 and the turbine driven pump train for SG1 is not relevant since these trains do not directly depend on offsite or onsite Class 1E ac electrical power.

- CCWS (Division I, Train A; Division II, Train B) (Trains A and B support placing the unit in Mode 5, considered to be a safe shutdown condition): the operability of the "safe shutdown" train in the opposite division must be verified.

- CCWS (Division I, Train C; Division II, Train D) (Trains C and D support accident mitigation functions): the operability of the "accident mitigation" train in the opposite division must be verified.

For each of the above operability verifications that cannot be completed within the specified Completion Time, each train without ac power from an operable offsite circuit, or with its associated EDG inoperable, must be declared inoperable and applicable Conditions of associated Specifications must be entered.

- In Condition C (two divisions with the one offsite circuit inoperable), to complete Required Action C.1, the operability of redundant trains in both ac electrical divisions must be verified, since no operable offsite circuits are available to power the Class 1E 4160 Vac buses that supply the SIS, CSS, ESWS, CCWS, and AFWS trains.

  For each of the above operability verifications that cannot be completed within the specified Completion Time, each train without ac power from an operable offsite circuit must be declared inoperable and applicable Conditions of associated Specifications must be entered.

Pending confirmation that the above interpretation of the applicant's response is correct, and that it can be applied to correctly interpret how to complete Required Actions A.2, B.2, and C.1 for all other specified safety systems (e.g., control room habitability system, chilled water system, containment penetration flow path isolation valves) RAI 478-8568, Question 16-141, Sub-question 2 was tracked as an open item.

In its revised response (ML17240A394) to Question 16-141, for Sub-question 2, the applicant confirmed the above description of how to correctly implement Subsection 3.8.1 Required Actions A.2, B.2, and C.1 for the supported systems listed. However, the applicant did not address the CRHS, the Essential Chilled Water System, and the CIVs. Since the staff understands the redundancy of the divisions and trains of these systems and components, it may be concluded that these action requirements can be correctly implemented for these systems and components. Therefore, the staff concludes that RAI 478-8568, Question 16-141, Sub-question 2, is resolved.

In RAI 243-8289 (ML15296A012), Question 16-106, Sub-question a), the staff requested that the applicant provide additional justification for selecting a 92 day Frequency instead of a 31 day Frequency for SR 3.8.1.6 ("Verify fuel oil transfer system operates to automatically transfer fuel oil from storage tank to day tank."). In its response (ML16007A391) to Question 16-106, the applicant clarified the rationale for the 92 Frequency in the Bases for SR 3.8.1.6, as indicated by markup:

> ~~The Frequency for this SR is variable, depending on individual system design, with up to a 92-day interval.~~ The 92 day Frequency corresponds to the testing requirements for pumps as contained in the ASME Code (Reference 11)~~. However,~~ <u>; however,</u> the design of fuel transfer systems is such that pumps will operate automatically ~~or must be started manually~~ in order to maintain an adequate volume of fuel oil in the day tanks during or following EDG testing. In such a case, ~~a 31-day Frequency is appropriate~~ <u>the pumps and fuel oil level can be checked by an operator</u>. Since proper operation of fuel transfer systems is an inherent part of EDG OPERABILITY, the Frequency of this SR ~~should be modified to reflect individual designs~~ <u>reflects the standard design</u>.

Pending completion of its evaluation of the response, the staff tracked Question 16-106, Sub-question a), as an open item. In the response, the applicant stated:

> For the APR1400 design, the 92-day frequency corresponds to the testing requirements for the transfer pumps as contained in the ASME OM Code. The APR 1400 fuel oil transfer system is such that the pumps do not need to be started manually in order to maintain an adequate volume of fuel oil in the associated EDG day tank during or following DG testing. The pumps will operate automatically upon EDG day tank level during or following DG testing, the pumps and fuel oil level can be checked by an operator. Therefore, a 31 day frequency is not necessary.

Because the 92 day Frequency is based on the guidance in the ASME OM Code for DG fuel oil transfer systems that automatically actuate to maintain day tank inventory, the staff accepts the 92 Frequency as being appropriate. Therefore, RAI 243-8289, Question 16-106, Sub-question a), is resolved.

In RAI 243-8289 (ML15296A012), Question 16-107, Sub-question a), staff noted that SR 3.8.1.4 requires verification that each day tank contains ≥ 2,404 L (635 Gal) of fuel oil. However, DCD Tier 2, Table 9.5.4-1 states that a fuel oil day tank has a capacity (usable volume) of 2,078 L (549 Gal). The applicant was asked to resolve this apparent discrepancy. In its response (ML15351A182) to Question 16-107, the applicant stated:

> The day tank level expressed in the TS SR 3.8.1.4 is the equivalent volume in liters (gallons) to ensure adequate fuel oil for a minimum of 1 hour of EDG operation at full load plus ten percent. The value listed of ≥ 2,404 L (635 Gal) of fuel oil is an approximate amount based on existing plant EDGs and is not the specific value to be used in the generic TS. The specific value will depend upon vendor specific engine data supplied by the COL applicant. Therefore, this value will be bracketed to denote that it is not an established quantity. The fuel oil day tank capacity listed in Table 9.5.4-1 provides a description of the day tank [which] is not associated with the value in the TS. Also, in accordance with the response to RAI 152-8006, Question No. 09.05.04-05, (reference MKD/NW-15-0142L dated 9/14/2015; ML15257A429) the capacity of the fuel oil day tank is to be deleted from DCD Tier 2, Table 9.5.4-1.

The staff finds that designating the required volume of fuel oil in each EDG day tank in SR 3.8.1.4 as a COL action item is acceptable and that it resolves the noted discrepancy. Therefore, RAI 243-8289, Question 16-107, Sub-question a), is resolved.

In RAI 243-8289, Question 16-107, Sub-question b), staff noted that Subsection 3.8.3 Condition E, Required Action E.1, and SR 3.8.3.4 indicate EDG starting air receiver pressure as < 40.77 kg/cm^{2}G (580 psig) and ≥ 8.78 kg/cm^{2}G (125 psig). The applicant was requested to justify these values. In its response (ML15351A182) to Question 16-107, the applicant stated:

> The pressure specified in this SR is intended to reflect the lowest value for which a minimum of five engine start cycles can be supplied without recharging. The air pressure of the starting air receiver will vary depending on engine manufacturer specific design requirements. The starting air receiver [pressure range] listed, < 40.77 kg/cm^{2}G (580 psig) and ≥ 8.78 kg/cm^{2}G (125 psig), is an approximate amount based on existing plant EDGs in Korea and is not the specific value to be used in the APR1400 generic TS. Therefore, this value will be bracketed to denote that it is not an established quantity.

The staff observes that SR 3.8.3.4 actually verifies that starting air receiver pressure is ≥ 580 psig, whereas Action E describes a range of values between 125 psig and 580 psig. The staff finds that designating the required starting air receiver pressure as a COL action item is acceptable. Therefore, RAI 243-8289, Question 16-107, Sub-question b), is resolved.

Based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.8.1 and Subsection B 3.8.1 are acceptable.

Subsection 3.8.2 AC Sources – Shutdown

Subsection 3.8.2 includes the Mode 5 and Mode 6 requirements for the Class 1E Electrical Power Distribution System ac power sources. LCO 3.8.2 requires one of the two offsite ac power sources (preferred power sources, normal or alternate), which consists of a qualified circuit between the offsite transmission network and the onsite Class 1E Electrical Power Distribution System required by LCO 3.8.10; and one division of onsite standby ac power sources—one division of EDGs, EDG A and EDG C for division I, or EDG B and EDG D for division II—capable of supplying one division of the onsite Class 1E Electrical Power Distribution System required by LCO 3.8.10. Since irradiated fuel assembly movement can occur when the unit is not in any defined Mode, such as when the reactor vessel contains no fuel, the Applicability of LCO 3.8.2 also includes “during movement of irradiated fuel assemblies.”

The following table lists the RAI questions concerning Subsection 3.8.2.

Subsection 3.8.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-5	96-8073 ML15234A002 Response: ML15266A517	3.8.2 – added missing STS 3.8.2 Actions table Note that LCO 3.0.3 is not applicable	CC	
16-6	96-8073 ML15234A002 Responses: ML15266A517 ML16098A291	B 3.8.2 LCO section – added missing paragraph from STS B 3.8.2;	CC	

Subsection 3.8.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		B 3.8.2 References section – added reference to FSAR Section 8.2		
16-50	162-8055 ML15235A003 Response: ML15301A207	SR 3.8.4.3 – changed surveillance column Note title to "NOTES" because there are two Notes	CC	
16-142	478-8568 ML16131A614 Response: ML16187A200	Explained how LCO 3.8.2 supports LCO 3.9.5, and how Subsection 3.8.10 Required Action A.2.4 is not a duplication of Subsection 3.8.10 Required Action A.1.	CR	

Status Codes:
RC Resolved Confirmatory CR Closed Resolved CC Closed Confirmed

Although Subsection 3.8.2 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.8.2 and the deviation report.

In RAI 96-8073 (ML15234A002), Question 16-5, the staff noted that the STS Subsection 3.8.2 Actions table Note stating that "LCO 3.0.3 is not applicable" is missing from the GTS Subsection 3.8.2 Actions table. Since GTS LCO 3.0.3 is only applicable in Modes 1, 2, 3, and 4, and GTS Subsection 3.8.2 is also applicable during movement of irradiated fuel assemblies, as well as in Modes 5 and 6, including the Note makes it clear that if irradiated fuel assembly movement occurs during Modes 1, 2, 3, 4, 5, or 6, or with no fuel assemblies in the reactor vessel, then LCO 3.0.3 would not apply to the Actions of Subsection 3.8.2. In its response (ML15266A517) to Question 16-5, the applicant agreed to add this Note to Subsection 3.8.2. Therefore, RAI 96-8073, Question 16-5 is resolved.

In RAI 96-8073 (ML15234A002), Question 16-6, the staff noted that the LCO section of the Bases for Subsection 3.8.2 is missing the second paragraph of the LCO section of the Bases for STS Subsection 3.8.2. In its responses (ML15266A517 and ML16098A291) to Question 16-6, since this paragraph is applicable to the APR1400 design, the applicant agreed to add this paragraph to the Subsection B 3.8.2 LCO section; the paragraph states:

> The qualified offsite circuit must be capable of maintaining rated frequency and voltage, and accepting required loads during an accident, while connected to the Engineered Safety Feature (ESF) bus(es). Qualified offsite circuits are those that are described in the FSAR and are part of the licensing basis for the unit.

Therefore, RAI 96-8073, Question 16-6, is resolved.

Based on its review, and consistency with CE STS Subsections 3.8.2 and B 3.8.2, the staff concludes that Subsection 3.8.2 and Subsection B 3.8.2 are acceptable.

Subsection 3.8.3 Diesel Fuel Oil, Lube Oil, and Starting Air

Subsection 3.8.3 include requirements for the EDG fuel oil, lube oil and starting air subsystems that are necessary for the operability of EDGs A, B, C, and D.

The following table lists the RAI questions concerning Subsection 3.8.3.

Subsection 3.8.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
9.5.4-11	355-8438 ML15362A446 Response: ML16064A044	B 3.8.3 Surveillance Requirements section – changed last paragraph of Bases for SR 3.8.3.3, as indicated: "Particulate concentrations should be determined in accordance with ASTM D6217-11 ~~D5452-12~~ (Ref.~~erence~~ 6). This method involves ~~a gravimetric determination of total~~ the determination of the particulate concentration in the fuel oil and has a limit of 10 mg/l...."	CC	
9.5.4-11	355-8438 ML15362A446 Response: ML16064A044	B 3.8.3 References section – in Reference 6, corrected last entry in the list of ASTM Standards from D5452-12 to D6217-11, in accordance with Positions C.13.1 and C13.8 of Regulatory Guide (RG) 1.137, Rev. 2, "Fuel Oil Systems for Emergency Power Supplies"	CC	
9.5.4-12.3	355-8438 ML15362A446 Response: ML16064A044 ML16201A211	SR 3.8.3.5 – revised to state "Check for and remove accumulated water and sediment from each fuel oil storage tank."	CC	
16-7	96-8073 ML15234A002 Response: ML15266A517	Explained difference between "EDG train" in B 3.8.1, and "EDG subsystem" in B 3.8.3	CU	16-141.1

Status Codes:
CU Closed unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Although Subsection 3.8.3 closely follows the STS in format and content, the staff noted the following differences that were not revised to be consistent with the STS and warranted clarification beyond what was given in Subsection 3.8.3 and the deviation report.

See Section 9.5.4 of this SER for a discussion of the concerns and resolution of RAI 355-8438, Question 9.5.4-12, regarding clarification of SR 3.8.3.5 to be consistent with CE STS Subsections 3.8.3 and DCD Tier 2, Section 9.5.4.5.

See evaluation of Subsection 3.8.1 for discussion of RAI 96-8073, Question 16-7; and the resolution of the open item for RAI 478-8568, Question 16-141, Sub-question 1, which had no impact on Subsection 3.8.3 or Subsection B 3.8.3.

Based on its review, and consistency with CE STS Subsections 3.8.3 and B 3.8.3, the staff concludes that Subsection 3.8.3 and Subsection B 3.8.3 are acceptable.

Subsection 3.8.4 DC Sources – Operating

Subsection 3.8.4 includes the Mode 1, 2, 3, and 4 requirements for division I and division II of the Class 1E Direct Current (dc) Electrical Power System, including its 125 Vdc electrical power sources. The 125 Vdc electrical power system provides the onsite Alternating Current (ac) Emergency Electrical Power System with dc control power. The 125 Vdc electrical power system also provides both motive and control power to selected safety related equipment and preferred 120 Vac vital bus power by way of 125 Vdc to 120 Vac inverters. Each dc electrical power division consists of two independent trains, A and C for division I, and B and D for division II. Each 125 Vdc electrical power train includes one 125 Vdc vented lead acid battery, with a dedicated battery charger and a backup battery charger.

The following table lists the RAI questions concerning Subsection 3.8.4.

Subsection 3.8.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-8	96-8073 ML15234A002 Response: ML15266A517	3.8.4 Required Actions D.1 and D.2 – changed Logical Connector to “<u>AND</u>”	CC	
16-9	96-8073 ML15234A002 Response: ML15266A517	SR 3.8.4.3 – corrected typographical error that omitted “SR 3.8.4.3”	CC	
16-106.c	243-8289 ML15296A012 Response: ML16007A391	SR 3.8.4.3 – corrected typographical error that omitted “SR 3.8.4.3”	CC	
16-141.1	478-8568 ML16131A614 Responses: ML16223A964 ML17240A394	Deviation Report III.4.1- consistent use of divisions, channels, load groups, subsystems, and trains; examples: III.4.1.2, III.4.1.3	CC	See Subsection 3.8.1 evaluation

Subsection 3.8.4 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsections 3.8.4 and B 3.8.4 closely follow CE STS Subsection 3.8.4 and B 3.8.4 in format and content, consistent with the APR1400 125 Vdc electrical power system design differences with the typical CE PWR 125 Vdc electrical power system design.

Based on its review, and the clarifications made as part of the resolution of the open item for RAI 478-8568, Question 16-141, Sub-question 1, which is described above in the evaluation of Subsection 3.8.1, the staff concludes that Subsection 3.8.4 and Subsection B 3.8.4 are acceptable.

Subsection 3.8.5 DC Sources – Shutdown

Subsection 3.8.5 includes the Mode 5 and 6 requirements for division I and division II of the Class 1E Direct Current (dc) Electrical Power System, including its 125 Vdc electrical power sources. These requirements also apply during movement of irradiated fuel assemblies without regard for the operational mode of the unit. LCO 3.8.5 requires operability of one or both of the dc electrical power system division(s) as needed to support the dc electrical power distribution system division(s) required to be operable by LCO 3.8.10.

The following table lists the RAI questions concerning Subsection 3.8.5.

Subsection 3.8.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-10	96-8073 ML15234A002 Response: ML15266A517	3.8.5 – corrected format of Condition A	CC	
16-11	96-8073 ML15234A002 Response: ML15266A517	3.8.5 – removed unnecessary brackets from statement of Condition B	CC	
16-12	96-8073 ML15234A002 Response: ML15266A517	3.8.5 Action B – corrected indentation of Required Action Logical Connectors	CC	
16-141.1	478-8568 ML16131A614 Responses: ML16223A964 ML17240A394	Deviation Report III.4.1-consistent use of divisions, channels, load groups, subsystems, and trains; examples: III.4.1.2, III.4.1.3	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsections 3.8.5 and B 3.8.5 closely follow CE STS Subsection 3.8.5 and B 3.8.5 in format and content, consistent with the APR1400 125 Vdc electrical power system design differences with the typical CE PWR 125 Vdc electrical power system design.

Based on its review, and the clarifications made as part of the resolution of the open item for RAI 478-8568, Question 16-141, Sub-question 1, which is described above in the evaluation of Subsection 3.8.1, the staff concludes that Subsection 3.8.5 and Subsection B 3.8.5 are acceptable.

Subsection 3.8.6 Battery Cell Parameters

Subsection 3.8.6 specifies limits on battery cell parameters for the battery in each train of each division of the dc electrical power system. Included battery cell parameters are the (1) overall battery float current, (2) float voltage and electrolyte temperature of each pilot cell, and (3) electrolyte level and float voltage of each connected cell. This subsection also specifies limits on battery capacity. This subsection applies to each battery dc source when the associated dc electrical power system division is required to be operable by LCO 3.8.4 or LCO 3.8.5.

Subsections 3.8.6 and B 3.8.6 closely follow CE STS Subsections 3.8.6 and B 3.8.6 in format and content, there being no significant differences between the APR1400 Class 1E 125 Vdc battery electrical power source and the Class 1E 125 Vdc battery assumed in the STS for a digital CE PWR.

The following table lists the RAI questions concerning Subsection 3.8.6.

Subsection 3.8.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-13	96-8073 ML15234A002 Response: ML15266A517	3.8.6 Condition C Note and Required Action C Note – corrected deviation from STS 3.8.6 Action C Notes; 3.8.6 Required Action C.1 – changed logical connector from ‘OR” to “AND”	CC	
16-14	96-8073 ML15234A002 Response: ML15266A517	B 3.8.6 SR Section – corrected Bases for the surveillance column Note of SR 3.8.6.6 regarding limitations on when the performance discharge test to verify battery capacity must not be performed, to include Modes 3 and 4, as well as Modes 1 and 2, to match the actual Note	CC	
16-106.d	243-8289 ML15296A012 Response:	SR 3.8.6.5 Frequency – justified a 92 day Frequency for connected cell float	CR	

Subsection 3.8.6 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16007A391	voltage verification as being based on IEEE Std. 450 and consistency with STS SR 3.8.6.5		
16-141.1	478-8568 ML16131A614 Responses: ML16223A964 ML17240A394	Deviation Report III.4.1-consistent use of divisions, channels, load groups, subsystems, and trains; examples: III.4.1.2, III.4.1.3	CR	See Subsection 3.8.1 evaluation

Status Codes:
CR Closed Resolved with no DCD changes needed CC Closed Confirmed
RC Resolved Confirmatory

Based on its review, and the resolution of the open item for RAI 478-8568, Question 16-141, Sub-question 1, which had no impact on Subsections 3.8.6 and B 3.8.6, the staff concludes that Subsection 3.8.6 and Subsection B 3.8.6 are acceptable.

Subsection 3.8.7 Inverters – Operating; and Subsection 3.8.8 Inverters - Shutdown

Subsections 3.8.7 and 3.8.8 include requirements for the inverter between each Class 1E 125 Vdc bus train and the supported train of ac vital buses of the electrical power distribution system. The inverters are the preferred source of power to the ac vital buses. Each inverter can be powered from the train's rectifier or from the train's 125 Vdc battery. The battery with its associated inverter provides an uninterruptible power source for the Reactor Protection System and the Engineered Safety Feature Actuation System instrumentation.

The following table lists the RAI question concerning Subsection 3.8.7. There were no RAI questions concerning Subsection 3.8.8.

Subsection 3.8.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-15	96-8073 ML15234A002 Response: ML15266A517	3.8.7 – Added LCO Note from STS LCO 3.8.7 to GTS LCO 3.8.7 regarding ac vital bus preconditions for disconnecting an inverter from its associated 125 Vdc bus to perform an equalizing charge on its associated battery with a time limit of 24 hours; B 3.8.7 LCO section – added Bases for the LCO Note	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsections 3.8.7, B 3.8.7, 3.8.8, and B 3.8.8 closely follow CE STS Subsections 3.8.7, B 3.8.7, 3.8.8, and B 3.8.8 in format and content, and are consistent with the inverter design as described in DCD Tier 2, Section 8.3.

The staff noted that the first sentence of the Applicability section of the Bases for Subsection 3.8.8 needed clarification as indicated in the following markup:

> The inverters <u>are </u>required to be OPERABLE in MODES 5 and 6<u>, and </u>during movement of irradiated fuel assemblies <u>to </u>provide assurance that: ...

Incorporation of this clarification in the Applicability section of the Bases for Subsection 3.8.8 in DCD Revision 2 was tracked as a confirmatory item. The staff verified that this clarification was adequately incorporated in DCD Revision 3.

Based on its review and the above evaluation, the staff concludes that Subsections 3.8.7 and 3.8.8 are acceptable. The staff also concludes that Subsections B 3.8.7 and B 3.8.8 are acceptable.

Subsection 3.8.9 Distribution Systems – Operating; and Subsection 3.8.10 Distribution Systems – Shutdown

Subsections 3.8.9 and 3.8.10 include requirements for division I and division II of the Class 1E electrical power distribution system. Each division includes two trains of the Class 1E

- onsite AC electrical power distribution system—each train consists of one 4,160 V ESF AC safety bus, one 480 V AC safety-related load center, and four 480 V AC safety-related motor control centers;
- DC electrical power distribution system—each train consists of one 125 V DC safety bus; and
- AC vital bus electrical power distribution system—each train consists of one 120 V AC vital bus.

The following table lists the RAI question concerning Subsection 3.8.9. There were no RAI questions concerning Subsection 3.8.10.

Subsection 3.8.9 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-141.1	478-8568 ML16131A614 Responses: ML16223A964 ML17240A394	Deviation Report III.4.1- consistent use of divisions, channels, load groups, subsystems, and trains; examples: III.4.1.2, III.4.1.3	CC	See Subsection 3.8.1 evaluation

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Subsections 3.8.9, B 3.8.9, 3.8.10, and B 3.8.10 closely follow CE STS Subsections 3.8.9, B 3.8.9, 3.8.10, and B 3.8.10 in format and content, and are consistent with the onsite electrical power distribution system design as described in DCD Tier 2, Section 8.3.

The staff noted that Footnote (1) in Table B 3.8.9-1 is another example of the inconsistent use of the term “subsystem” as a synonym for “division.” Footnote (1) needs clarification, as suggested by the following markup:

> Each ~~division~~ train of the AC and DC Electrical Power Distribution Systems is a subsystem.

Pending incorporation of the noted clarification, RAI 478-8568, Question 16-141, Sub-question 1, was tracked as an open item. In its revised response (ML17240A394) to Question 16-141, regarding Sub-question 1, the applicant incorporated the suggested clarification to Footnote (1) in Table B 3.8.9-1, which resolves Sub-question 1 for Subsection 3.8.9.

Based on its review and resolution of the identified open item, the staff concludes that Subsections 3.8.9, B 3.8.9, 3.8.10, and B 3.8.10 are acceptable.

Conclusion for Section 3.8 and Section B 3.8

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.8 and Section B 3.8 are acceptable.

16.4.14 TS Chapter 3.0 LCOs and SRs ─ Section 3.9 Refueling Operations

The GTS Subsections for refueling operations correspond to CE STS Subsections for refueling operations in the following manner:

STS	GTS	Title (*STS Title – if different)
3.9.1	3.9.1	Boron Concentration
3.9.2	3.9.2	Nuclear Instrumentation
3.9.3	3.9.3	Containment Penetrations
3.9.4	3.9.4	Shutdown Cooling System (SCS) and Coolant Circulation – High Water Level (*Shutdown Cooling (SDC) and Coolant Circulation – High Water Level)
3.9.5	3.9.5	Shutdown Cooling System (SCS) and Coolant Circulation – Low Water Level (*Shutdown Cooling (SDC) and Coolant Circulation – Low Water Level)
3.9.6	3.9.6	Refueling Water Level
─	3.9.7	Unborated Water Source Isolation Valve – MODE 6
─	3.9.8	Decay Time

Subsection 3.9.1 Boron Concentration

Subsection 3.9.1 includes limits on the boron concentration of the water in the RCS, refueling pool and refueling canal during refueling to ensure that the reactor remains subcritical in Mode 6.

The following table lists the RAI questions concerning Subsection 3.9.1.

Subsection 3.9.1 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-59	189-8057 ML15245A387 Responses: ML15315A035 ML16162A792	B 3.9.1 • ASA section- revised reference to limiting boron dilution accident to DCD Tier 2, Section 15.4.6; • ASA and Applicability sections – revised to reflect merging of Subsections 3.1.1 and 3.1.2 of DCD Rev. 0, and renumbering of Subsections 3.1.3 to 3.1.12 as Subsections 3.1.2 to 3.1.11	CC	
16-147	481-8546 ML16133A271 Response: ML16187A207	Justified omission of action to suspend Core Alterations in Action A of Subsections 3.9.1 and 3.9.2 based on new LCO 3.9.7	CR	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed
CR Closed Resolved with no DCD changes needed

The staff reviewed Subsections 3.9.1 and B 3.9.1 and determined that they closely follow CE STS Subsections 3.9.1 and B 3.9.1 in format and content, and are consistent with the APR1400 design. Therefore, the staff concludes that Subsection 3.9.1 and Subsection B 3.9.1 are acceptable.

Subsection 3.9.2 Nuclear Instrumentation

Subsection 3.9.2 includes requirements on the installed startup channels of the Ex-core Neutron Flux Monitoring System (ENFMS), which are used during refueling operations in Mode 6 to monitor the core reactivity condition.

The following table lists the RAI questions concerning Subsection 3.9.2.

Subsection 3.9.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-31.1	133-7978 ML15227A011 Response: ML16036A378	3.9.2 Required Action A.2 – Since the action statement matches the STS, no change is needed; rather corresponding language in the Actions of Subsections 3.9.4 and 3.9.5 is being changed.	CR	
16-113.1	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.13, 3.3.14, 3.9.2, B 3.3.13, B 3.3.14, B 3.9.2, changed to a consistent nomenclature for startup range ex-core neutron flux monitoring system (ENFMS) channels, and boron dilution alarm system (BDAS) channels	CC	
16-113.3	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.9.2 LCO and Actions, Bases for SR 3.9.2.1 – • Revised LCO statement: "Two startup channels ~~range monitors (SRMs)~~ of the Ex-core Neutron Flux Monitoring System (ENFMS) shall be OPERABLE."; • Revised Condition A and Required Action B.1 by replacing "SRM" with "startup channel of the ENFMS"; • Revised Condition B by replacing "SRMs" with "startup channels of the ENFMS"	CC	
16-113.3	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	B 3.9.2 Background, Applicable Safety Analyses (ASA), LCO, Applicability, Actions, and SR sections — defined ENFMS and BDAS, and replaced "SRM(s)" with "startup channel(s) of the ENFMS"	CC	
16-113.3	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	B 3.9.2 Background section – Revised to include the statement: "Each startup channel of the ENFMS provides visual indication in	CC	

Subsection 3.9.2 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
		the main control room (MCR) and startup range neutron flux information to the BDAS for an audible alarm to alert operators to a possible dilution accident."		
16-113.3	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	B 3.9.2 LCO section – added "The BDAS is not required to be OPERABLE in MODE 6 because such an event is precluded by LCO 3.9.7, 'Unborated Water Source Isolation Valve – MODE 6,' which requires the flow paths for unborated makeup water sources to be isolated in MODE 6."	CC	
16-147	481-8546 ML16133A271 Response: ML16187A207	Justified omission of action to suspend Core Alterations in Action A of Subsections 3.9.1 and 3.9.2 based on new LCO 3.9.7	CR	

Status Codes:
CR Closed Resolved with no DCD changes needed CC Closed Confirmed
RC Resolved Confirmatory

The staff reviewed Subsections 3.9.2 and B 3.9.2 and determined that they closely follow CE STS Subsections 3.9.2 and B 3.9.2 in format and content, and are consistent with the APR1400 design. Therefore, the staff concludes that Subsection 3.9.2 and Subsection B 3.9.2 are acceptable.

Subsection 3.9.3 Containment Penetrations

Subsection 3.9.3 includes requirements on the status of containment penetrations during Core Alterations or movement of irradiated fuel assemblies within containment. When the containment closure requirements of LCO 3.9.3 are met, the containment will ensure leakage to the environment following a release of fission product radioactivity within the containment, such as from a fuel handling accident, will be within acceptable limits such that offsite radiation exposures are maintained well within the requirements of 10 CFR 50.34.

The following table lists the RAI questions concerning Subsection 3.9.3.

Subsection 3.9.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
12.2-14	146-8152 ML15222B315 Response: ML15344A155	• SR 3.9.3.1 – changed 72 hours to 100 hours so that the first Frequency states: "Within 100 hours prior to the start of movement of irradiated fuel ~~in the~~ within containment ~~building~~"; • B 3.9.3 ASA section – changed minimum decay time before Core Alterations begins to 100 hours • B 3.9.6 ASA section - changed minimum decay time before fuel handling to 100 hours (These changes are made to be consistent with change in DCD Section 15.7.4.2, "that the irradiated fuel is not removed from the reactor until the unit has been shut down for at least ~~72~~ 100 hours" even though the fuel handling analysis source term is determined based on a 72 hour decay time.)	CC	
16-25.4	125-7975 ML15216A651 Responses: ML16032A596 ML17235B291	LCO 3.6.7.c.1 and B 3.6.7 comparison to LCO 3.9.3.c.1 and B 3.9.3; excluded the use of an "equivalent" penetration closure method for reduced RCS inventory conditions in Mode 5 and Mode 6 for LCO 3.6.7.c.1.	CU	16-149.1
16-31.2	133-7978 ML15227A011 Response: ML16036A378	LCO 3.9.3.a – COL action item on containment equipment hatch - minimum required number of bolts to support dead weight; Page B 3.9.3-1 – added COL action item related Reviewer's Note	CC	

Subsection 3.9.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-31.3	133-7978 ML15227A011 Response: ML16036A378	3.9.3 Applicability to retain “During Core Alterations”; TSTF-471-A is not adopted.	CR	
16-31.4	133-7978 ML15227A011 Response: ML16036A378	LCO 3.9.3.c.2 – editorial correction made	CC	
16-32	133-7978 ML15227A011 Response: ML16036A378	SR 3.9.3.1 Frequency – revised for consistency with STS to use the phrase “within containment” instead of “in the containment building" so the Frequency states: “Within 100 hours prior to the start of movement of irradiated fuel within containment <u>AND</u> Once per 7 days during CORE ALTERATIONS or movement of irradiated fuel within containment”	CC	
16-149.1	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634 ML17362A080	LCO 3.6.7.c.1 and B 3.6.7 comparison to LCO 3.9.3.c.1 and B 3.9.3; discuss Generic Letter 88-17	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
CR Closed Resolved with no DCD changes needed RC Resolved Confirmatory

See evaluation of Subsection 3.6.7 in Section 16.4.11 of this SER for discussion of the resolution of the applicant’s response to RAI 481-8546, Question 16-149, Sub-question 1.

The staff reviewed Subsections 3.9.3 and B 3.9.3 and determined that they closely follow CE STS Subsections 3.9.3 and B 3.9.3 in format and content, and are consistent with the APR1400 design. Therefore, the staff concludes that Subsection 3.9.3 and Subsection B 3.9.3 are acceptable.

Subsection 3.9.4 Shutdown Cooling System (SCS) and Coolant Circulation – High Water Level

Subsection 3.9.4 includes the Mode 6 requirements for the Shutdown Cooling (SC) System with refueling pool water level at least 23 feet above the top of the reactor vessel flange. One operable SC train is required to be in operation to remove core decay heat and sensible heat from the RCS.

The following table lists the RAI questions concerning Subsection 3.9.4.

Subsection 3.9.4 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-31.5	133-7978 ML15227A011 Response: ML16036A378	3.9.4 LCO Note, Required Action A.2, B 3.9.4 LCO and Actions section – revised boron dilution discussion to be more consistent with STS phrasing	CC	
16-31.6	133-7978 ML15227A011 Response: ML16036A378	3.9.4 (relabeled) Required Action A.3 - editorial change to replace “satisfy” with “restore” was obviated by deletion of affected action requirement	CC	
16-31.7	133-7978 ML15227A011 Response: ML16036A378	3.9.4 Action A - logical connector format correction was obviated by other changes	CC	
16-31.11	133-7978 ML15227A011 Response: ML16036A378	3.9.4 Action A - logical connector format correction obviated by deletion of affected action requirement	CC	
16-51	162-8055 ML15235A003 Response: ML15301A207	3.9.4 Required Actions A.6.1 and A.6.2 – logical connector format correction obviated by deletion of affected action requirement	CC	
16-52	162-8055 ML15235A003 Response: ML15301A207	3.9.4 Applicability statement – corrected indentation of carryover line	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

The staff reviewed Subsections 3.9.4 and B 3.9.4 and determined that they closely follow CE STS Subsections 3.9.4 and B 3.9.4 in format and content, and are consistent with the APR1400 design. Therefore, the staff concludes that Subsection 3.9.4 and Subsection B 3.9.4 are acceptable.

Subsection 3.9.5 Shutdown Cooling System (SCS) and Coolant Circulation – Low Water Level

Subsection 3.9.5 includes the Mode 6 requirements for the SCS with refueling pool water level less than 23 feet above the top of the reactor vessel flange. Two SC trains are required to be operable and one train is required to be in operation to remove core decay heat and sensible heat from the RCS.

Subsection 3.9.5 is modeled on STS Subsection 3.9.5, but contains additional requirements to address operating experiences during RCS low reactor coolant inventory conditions, such as when reactor vessel level elevation is more than 3 ft below the reactor vessel flange, or during mid-loop operation when level is within the top half of the hot leg. These experiences are documented in Generic Letter (GL) 88-17, "Loss of Decay Heat Removal," dated October 17, 1988 (ML8810180350).

The following table lists the RAI questions concerning Subsection 3.9.5.

Subsection 3.9.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-25.5	125-7975 ML15216A651 Responses: ML16032A596 ML17235B291	1.1, 3.4.8, 3.5.3, 3.5.4, 3.6.7, 3.9.3, 3.9.5 - Definition of Reduced RCS Inventory; use "< 127 ft 1/4 in" instead	CU	16-149.2B
16-31.8	133-7978 ML15227A011 Response: ML16036A378	3.9.5 Required Actions A.1 and A.2 – changed "<u>AND</u>" to "<u>OR</u>"	CC	
16-31.9	133-7978 ML15227A011 Response: ML16036A378	3.9.5 Required Action B.1; B 3.9.5 Actions – Revised boron dilution action requirements and associated Bases discussion to be consistent with STS phrasing	CC	
16-31.10	133-7978 ML15227A011 Response: ML16036A378	3.9.5 – • Removed Condition E; • Replaced Required Actions E.1 to E.4 with equivalent Required Action B.4 with reference to LCO 3.6.7 containment penetration closure requirements.	CC	
16-31.12	133-7978 ML15227A011	SR 3.9.5.1, minimum reactor coolant circulating flow	CU	16-151

Subsection 3.9.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	Response: ML16036A378	acceptance criterion not explicitly stated		
16-51	162-8055 ML15235A003 Response: ML15301A207	3.9.5 Required Actions E.3.1 and E.3.2 – Logical connector indentation correction obviated by resolution of 16-31.10 to delete Action E	CC	
16-140.3	478-8568 ML16131A614 Responses: ML16182A594 ML17241A147	B 3.9.5 SR section – Clarified Bases for SR 3.9.5.3	CC	
16-140.4	478-8568 ML16131A614 Responses: ML16182A594 ML17241A147	3.9.5 – Clarified statement of LCO 3.9.5.b	CC	
16-140.5	478-8568 ML16131A614 Responses: ML16182A594 ML17241A147	3.9.5 – Applicant declined to add new SR 3.9.5.5 to test containment spray pump in Mode 6.	CR	
16-149.2	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Expand Applicability of proposed shutdown risk mitigation features. • Replaced “RCS level < 127 ft 1/4 in (Reduced RCS Inventory)” as indicated: Subsection 3.6.7: “Mode 5 with RCS loops not filled”; Mode 6 with the water level < 23 ft above the top of the reactor vessel flange” Subsection 3.9.5.b: “RCS level is < 127 ft 1/4 in” • Applicant declined to replace “RCS level < 130 ft 0 in (1/4 in below top of reactor vessel flange elevation)” with “RCS loops not filled” in Subsections 3.5.3 and 3.5.4	CC	

Subsection 3.9.5 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-149.2B	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	Replace “REDUCED RCS INVENTORY” with “< 127 ft 1/4 in” in • 3.4.8, B 3.4.8; • 3.5.3, B 3.5.3; • 3.5.4, B 3.5.4; • 3.6.7, B 3.6.7; • B 3.9.3; • 3.9.5 (LCO 3.9.5.b, Required Action B.3 and D.1, SR 3.9.5.3 Frequency), B 3.9.5 LCO and Actions sections	CC	
16-149.2M	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353 ML17291A634	3.9.5 Required Actions B.3 and D.1 – Applicant declined to state “Initiate action to establish ≥ 7.0 m (23 ft) of water above the top of the reactor vessel flange” in place of “...raise level to ≥ 127 ft 1/4 in”	CR	
16-151	481-8546 ML16133A271 Responses: ML16312A528 ML17262A353	3.9.5 – Added to SR 3.9.5.1 the minimum SC system flow acceptance criterion of 4,150 gpm with reactor vessel level ≥ 127 ft 1/4 in, and 3,800 gpm with reactor vessel level < 127 ft 1/4 in; B 3.9.5 SR section – added discussion of SC minimum flow rate criteria in SR 3.9.5.1 Bases; Also corrected Paragraph A.4.5 of the Shutdown Evaluation Report to specify minimum SC flow of 3,800 gpm.	CC	

Status Codes:
CR Closed Resolved with no DCD changes needed RC Resolved Confirmatory
CU Closed Unresolved (has follow up question) CC Closed Confirmed

The staff found the proposed GTS Subsection 3.9.5 requirements confusing and insufficient to address the concerns of GL 88-17. In RAI 133-7978 (ML15227A011), Question 16-31, Sub-question 10, the staff requested that the applicant improve Subsection 3.9.5 to promote a more efficient implementation of these GTS Subsection 3.9.5 requirements during low reactor vessel water level conditions by the plant operators.

In its response (ML16036A378) to Question 16-31, Sub-question 10, the applicant proposed to delete Subsection 3.9.5 Condition E ("Required Action~~s~~ and associated Completion Time~~s~~ of Condition~~s~~ A, B, ~~and~~ or C not met.") and Required Actions E.1 through E.4 regarding containment closure, and to add Required Action B.4 to specify meeting containment closure requirements of LCO 3.6.7. To further improve integration of all action requirements related to mid-loop conditions or operations with reduced RCS inventory, which are specified in Subsections 3.4.8, 3.5.3, 3.5.4, 3.6.7 and 3.9.5, the staff issued follow up RAI 481-8546 (ML16133A271), Question 16-149, to request the applicant to take a comprehensive look at all issues documented in GL 88-17. See evaluation of Subsection 3.4.8 in Section 16.4.9 of this SER for discussion of the disposition of the applicant's response to RAI 481-8546, Question 16-149, portions of which were tracked as open items.

When one of the two required SC trains is inoperable with refueling pool water level < 23 ft above the top of the reactor vessel flange (and the remaining operable SC train is in operation), Condition A of Subsection 3.9.5 is entered. The operator must immediately either initiate action to restore the train to operable status (Required Action A.1), or (See response to RAI 133-7978, Question 16-31, Sub-question 8.) initiate action to establish ≥ 23 ft of water above the top of reactor vessel flange (Required Action A.2). However, if both SC trains are operable but no SC train is in operation, Condition B is entered; Condition A would not apply in this case. The operator must immediately initiate action to both restore one SC train to operation (Required Action B.2) and raise RCS level to ≥ 127 ft 1/4 in (Required Action B.3). The staff questioned why Required Action B.3 does not direct initiating action [to raise level] to establish ≥ 23 ft of water above the top of reactor vessel flange (an elevation of 153 ft 1/4 in), should both operable SC trains remain idle indefinitely.

In RAI 481-8546 (ML16133A271), Question 16-149, Sub-question 2M, the staff requested that the applicant revise the Subsection 3.9.5, Required Action B.3 to state, "Initiate action to establish ≥ 7.0 m (23 ft) of water above the top of reactor vessel flange. | Immediately," which would exit the Applicability of LCO 3.9.5 and enter the Applicability of LCO 3.9.4, in which only one SC train is required to be operable and in operation. In its response (ML16312A528) to Question 16-149, Sub-question 2M, the applicant stated, in part:

> ... RCS level is required to be established above 38.72 m (127 ft 1/4 in) to ensure air is not ingested into the SCS with the possibility of affecting SCS performance after the SC pump is restored to OPERABLE status and placed in operation. ... Therefore, it is not necessary to have an RCS level of "≥ 7.0 m (23 ft) of water above the top of reactor vessel flange to place the system in operation."

Since the response did not address the condition in which both operable SC trains remain idle indefinitely, RAI 481-8546, Question 16-149, Sub-question 2M, was tracked as an open item.

In its second revised response (ML17262A353) to Question 16 149, Sub-question 2M, the applicant stated:

> With no SCS train OPERABLE or in operation, if the plant is below 38.72 m (127 ft 1/4 in) action B.3 is applied. RCS level is required to be established above 38.72 m (127 ft 1/4 in) to increase the time to core uncovery.

Operable safety injection pumps by LCO 3.5.3 can be used to raise RCS water level. Action B.3 is just an addition to NUREG-1432 of standard TS to enhance plant safety during shutdown mode. Because the Action B.3 is added with “AND” logic, overall Action B is more severe than Action A. In other words, while plant is placed above 38.72 m (127 ft 1/4 in) and the action is continued to restore one SCS train to operable [status] and operation, operator shall prepare to shut the containment even with Action B.3 is completed. Addition of B.3 does not compromise NUREG-1432 requirements.

Also, please note that Action B.3 is only applicable when RCS level is lower than 38.72 m (127 ft 1/4 in). [The] Operator may not need to stop the SIP at 38.72 m (127 ft 1/4 in) water level. However, it is just a minimum level requirement for the TS. The plant condition may not be prepared to fill the Refueling Pool over the reactor during RCS Reduced Inventory Operation.

Reduced inventory level is concern of GL 88-17. RCS level is required to be established above 38.72 m (127 ft 1/4 in) to ensure air is not ingested into the SCS with the possibility of affecting SCS performance after the SC pump is restored to OPERABLE status and placed in operation.

If at least one SCS train is operable, Condition A is entered. Required Action A.2 to “Initiate actions to establish greater than or equal to 7.0 m (23 ft) above the reactor vessel flange” is applicable.

The staff recognizes that Required Action B.3 would apply when (1) no SC train is operable, or no operable SC train is in operation, (2) reactor vessel (RV) level is more than 3 feet below the RV flange, and (3) a containment spray (CS) pump is required by LCO 3.9.5.b to be operable for assuming the role of its associated SC pump. Pending restoration of forced flow through, and removal of decay heat from the reactor core, using an operable SC train, the makeup capability afforded by the two SIPs, which are required to be operable (for manual initiation) by LCO 3.5.3, provides assurance that adequate RCS inventory can be restored and maintained. The requirement for an operable CS pump during reduced RCS inventory conditions, increases the likelihood that SC can be restored in a short time period, thereby limiting the reactor coolant temperature increase and avoiding release of steam into containment. Should steaming occur, the requirement of Required Action B.4 to place containment penetrations in the status required by LCO 3.6.7 will mitigate a loss of SC event which leads to boiling in the reactor vessel. In such circumstances, with no SC train in operation but with one SC train restored to operable status, and before onset of boiling, Required Action A.1 would result in raising level to 23 feet above the RV flange, which was the staff’s suggestion for Required Action B.3. The staff notes that the additional operability requirements in Mode 6 in LCOs 3.5.3, 3.6.7, and 3.9.5 are an improvement over STS operability requirements for systems to mitigate a loss of core decay heat removal capability during reduced RCS inventory conditions in Mode 6. The staff concludes, therefore, that Required Action B.3 is acceptable as proposed, which resolves RAI 481-8546, Question 16-149, Sub-question 2M.

The staff reviewed Subsection 3.9.5 and Subsection B 3.9.5 and verified that the LCO and associated applicability, action, and surveillance requirements are sufficient to ensure the operability of the SC System, so that in the event decay heat removal capability using the SC System is lost in Mode 6 with RCS water level less than 23 ft above the top of the reactor vessel flange, including in the reduced RCS inventory condition, remedial actions can be taken by the control room operators to raise reactor vessel water level and to close containment penetrations before the onset of steaming into the containment, while minimizing the time the unit is without decay heat removal using an SC train. Accordingly, the staff concludes that Subsection 3.9.5 satisfies paragraphs (2) and (3) of 10 CFR 50.36(c). In addition, the staff determined that Subsection B 3.9.5 satisfies paragraphs (1) and (2) of 10 CFR 50.36(a) by providing “a summary statement of the bases or reasons” for the requirements specified in Subsection 3.9.5. The staff also verified that Subsections 3.9.5 and B 3.9.5 are consistent with the guidance in CE STS Subsection 3.9.5 and Subsection B 3.9.5, and the APR1400 design as described in the DCD. Therefore, based on its review, the above evaluation, and resolution of the identified open items, the staff concludes that Subsection 3.9.5 and Subsection B 3.9.5 are acceptable.

Subsection 3.9.6 Refueling Water Level

Subsection 3.9.6 includes requirements for the minimum water level of the refueling pool (refueling water level) while moving irradiated fuel assemblies within containment, or performing Core Alterations, except during the latching and unlatching of control rod drive shafts. The specified level is ≥ 23 ft above the top of the reactor vessel flange, which corresponds to an elevation of 153 ft 1/4 in.

The following table lists the RAI questions concerning Subsection 3.9.6.

Subsection 3.9.6 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
12.2-14	146-8152 ML15222B315 Response: ML15344A155	B 3.9.6 ASA section - changed minimum decay time before fuel handling to 100 hours (See evaluation of Subsection 3.9.3)	CC	
16-31.13	133-7978 ML15227A011 Response: ML16036A378	3.9.6 - retained revised provisions for Core Alterations, which were removed from STS by TSTF-471-A	CC	
16-31.14	133-7978 ML15227A011 Response: ML16036A378	B 3.9.6 ASA section – moved LCO selection criterion applicability statement to customary location at end of ASA section	CC	
16-52	162-8055 ML15235A003 Response: ML15301A207	3.9.6 Applicability statement – corrected indentation of carryover line	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

See Section 12.2 of this SER for the staff’s evaluation of the applicant’s response (ML15344A155) to RAI 146-8152 (ML15222B315), Question 12.2-14, regarding increasing the post shutdown decay time (since the reactor core was last critical) before which the unit operator is not allowed to move irradiated fuel assemblies in the reactor vessel. The decay time was increased from 72 hours to 100 hours, consistent with the revised fuel handling accident analysis discussion in DCD Tier 2, Section 15.7.4.2, and Subsection 3.9.8, “Decay Time.”

The Subsection 3.9.6 Applicability statement and Required Action A.1 include requirements related to Core Alterations, which are not included in the STS, which have incorporated TSTF-471-A, Revision 1 (ML062860320). In RAI 133-7978 (ML15227A011), Question 16-31, Sub-question 13, the staff requested that the applicant address this difference from the STS. In its response (ML16036A378) to Question 16-31, Sub-question 13, the applicant stated that based on past refueling experiences with the Korean nuclear plants it had revised the previously specified definition of Core Alterations to be more precise than the definition used in the STS before incorporation of TSTF-471-A. The response stated “Core alteration activities could involve the dropping of handling tools or heavy objects onto irradiated fuel assemblies during the refueling process and effective controls for these activities are considered as safety measures whenever refueling operations are planned in Korea.” Therefore, the applicant concluded that maintaining controls of core alteration activities under TS is appropriate for the APR1400 rather than incorporating TSTF-471-A, Revision 1. The staff agrees with the applicant’s stated position because it is more restrictive. See Section 16.4.2 of this SER for discussion of changes to the definition of the defined term CORE ALTERATION.

The staff reviewed Subsections 3.9.6 and B 3.9.6 and determined that they closely follow CE STS Subsections 3.9.6 and B 3.9.6 in format and content, and are consistent with the APR1400 design. Therefore, the staff concludes that Subsection 3.9.6 and Subsection B 3.9.6 are acceptable.

Subsection 3.9.7 Unborated Water Source Isolation Valve – MODE 6

The applicant proposed Subsection 3.9.7 and associated Bases to prohibit dilution of the RCS in Mode 6, in response to RAI questions, as discussed below.

The STS Section 3.9 does not include a Specification to require isolation of all unborated water sources when the unit is in Mode 6 because the two Ex-core Neutron Flux Monitoring System (ENFMS) source range monitors (startup channels of the ENFMS for APR1400) required to be operable by STS 3.9.2 are considered to be adequate to alert control room operators of an increase in core reactivity, such as from an inadvertent boron dilution of the RCS. The Applicable Safety Analyses section of the Bases for STS 3.9.2 states, “analysis of the uncontrolled boron dilution accident shows that normally available SHUTDOWN MARGIN would be reduced, but there is sufficient time for the operator to take corrective actions.” Since the applicant did not analyze this anticipated operational occurrence assuming the unit is in Mode 6, an appropriate alternative is including Specification 3.9.7 for isolation of all unborated water sources.

The following table lists the RAI questions concerning Subsection 3.9.7.

Subsection 3.9.7 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-113.3	295-8263 ML15314A020 Responses: ML16006A511	3.3.14 Applicability – explained why BDAS not needed in Mode 6	CR	See evaluation of 3.9.2

Subsection 3.9.7 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
	ML16200A320			
16-113.4	295-8263 ML15314A020 Responses: ML16006A511 ML16200A320	3.3.14 Applicability – explained that LCO 3.9.7 obviates need for BDAS in Mode 6 by requiring isolation of unborated water sources	CR	See evaluation of 3.9.2
15.4.6-1	17-7917 ML15146A260 Responses: ML15238B709 ML17244A657	Section 3.1, Subsections 3.3.13, 3.3.14, and 3.9.7 – Evaluation of boron dilution event in Modes 4 and 5	CC	
15.4.6-7	216-8221 ML15259A829 Response: ML15345A378	New Subsection 3.9.7, “Unborated Water Source Isolation Valve – MODE 6,” to prohibit boron dilution in Mode 6	CC	

Status Codes:
CR Closed Resolved with no DCD changes needed CC Closed Confirmed RC Resolved Confirmatory

Prevention of an inadvertent dilution of reactor coolant boron concentration during refueling

In RAI 295-8263 (ML15314A020), Question 16-113, Sub-question 3, the NRC staff noted that the “Background” and “Applicability” sections of the Bases for GTS 3.3.14 and the “Background” and “Applicability” sections of the Bases for GTS 3.9.2 indicate that LCO 3.9.2 requires two boron dilution alarm system (BDAS) channels to be operable in Mode 6, as well as the two associated “startup range monitor (SRM)” channels. The “Background” section of the Bases for GTS 3.9.2 begins with the following sentence:

> The installed startup range monitors (SRMs) and boron dilution alarm system are used during refueling operations to monitor [the] core reactivity condition.

However, LCO 3.9.2 just states “Two startup range monitors (SRMs) shall be OPERABLE.” If the intent of the GTS is to also require two channels of the BDAS to be operable in Mode 6, then LCO 3.9.2 should explicitly require it. Otherwise, the Applicability of GTS 3.3.14 should include Mode 6. The staff requested that the applicant revise GTS 3.9.2 to require two BDAS channels to be operable in Mode 6. In its response letter (ML16006A511) to Question 16-113, regarding Sub-question 3, the applicant stated:

> ...the boron dilution alarm system is not required in Mode 6 and is not credited in any refueling event analyses. Operators can be alerted by visual indication and an audible alarm coming from two operable SRMs of any unexpected changes in the core reactivity such as a boron dilution event or an improperly loaded fuel assembly. Therefore, neither TS 3.3.14 nor TS 3.9.2 need to be revised to include the operability of BDAS or any other instruments for Mode 6.

In RAI 295-8263, Question 16-113, Sub-question 4, the NRC staff requested that the applicant explain why in Mode 6, the GTS do not include an LCO that requires the isolation (e.g., locked closed CVCS makeup valve) of the RCS from unborated water sources, which is described as an "administrative control" in DCD Tier 2, Section 15.4.6.2, "Sequence of Events and Systems Operation," paragraph e, to preclude an RCS boron dilution event in Mode 6. The staff noted that such an LCO is included in TS for other PWR designs. In its response (ML16006A511) to Question 16-113, regarding Sub-question 4, the applicant stated:

> KHNP is developing a proposed new LCO 3.9.7 and associated Bases to prohibit dilution during Mode 6 in response to RAI 216-8221 Question 15.04.06-7.

In RAI 216-8221 (ML15259A829), Question 15.4.6-7, the NRC staff questioned the basis for the statement in DCD Tier 2, Section 15.4.6.2(e) that administrative controls are used to prevent boron dilution during Mode 6, and therefore no evaluation of the time to reach criticality was performed. The staff needs a basis for using administrative controls instead of an explicit note in an existing technical specification or a new technical specification limiting condition for operation prohibiting dilution, as administrative controls are controlled by the licensees. The applicant was requested to provide the basis and update the DCD as appropriate. In its response (ML15345A378) to Question 15.4.6-7 the applicant stated:

> KNHP has planned to reflect the administrative controls into the operating procedure of APR1400 enabling a relative valve to be closed during Mode 6 to block the flow paths that could allow unborated makeup to reach the RCS. But KHNP will add TS 3.9.7 and its associated Bases to TS 3.9.7 to prohibit dilution during Mode 6.

Since the applicant has proposed to add new Subsection 3.9.7 to prohibit boron dilution of the RCS in Mode 6 by specifying that unborated water sources be isolated from the RCS, the staff concludes that BDAS channel operability is not needed in MODE 6. Therefore, Question 16-113, Sub-question 3, and the related issue in Sub-question 4, as they relate to Subsection 3.9.7, are resolved with no DCD changes needed. The disposition of Question 15.4.6-7, which was tracked as an open item, is addressed in Section 15.4.6, and also in Section 16.4.6, of this SER.

The staff reviewed the proposed Specification and Bases and found that they conform to STS conventions for content and format. Based on its evaluation and the resolution of RAI 17-7917, Question 15.4.6-7, the staff concludes that Subsection 3.9.7 and Subsection B 3.9.7 are acceptable.

Subsection 3.9.8 Decay Time

The STS Section 3.9 does not include a Specification prohibiting movement of irradiated fuel assemblies in the reactor vessel following a unit shutdown until sufficient time has elapsed since the reactor was last critical to allow for radioactive decay of fission products. This decay time bounds the elapsed time assumed in the control room occupant dose consequence analysis of the fuel handling accident. The applicant elected to not adopt an alternative approach for ensuring the validity of this dose consequence analysis that was approved by the NRC staff in TSTF-51. In that approach, any systems relied upon to mitigate the dose consequences of a fuel handling accident would only be required during movement of "recently" irradiated fuel. "Recently" means a time interval after a fuel assembly was last part of a critical reactor core, until the inventory of radionuclides in the fuel is sufficiently reduced so that acceptable dose consequences are possible without reliance on mitigation systems; such systems must be operable “during movement of ‘recently’ irradiated fuel assemblies.” Implied in this approach (but not explicitly stated in the LCO) is a requirement to delay movement of recently irradiated fuel until the decay time, assumed in the licensing basis fuel handling accident dose consequence analysis, has elapsed. The applicant’s approach of including an explicit LCO on the elapsed time after unit shutdown before allowing movement of irradiated fuel assemblies is more conservative than the STS approach, which permits taking fuel handling accident dose consequence mitigation systems out of service during refueling once the fuel assembly being moved is no longer “recently” irradiated.

The following table lists the RAI question concerning Subsection 3.9.8.

Subsection 3.9.8 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-31.15	133-7978 ML15227A011 Response: ML16036A378	Added Subsection 3.9.8 and Subsection B 3.9.8 on decay time	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

In its response (ML16036A378) to RAI 133-7978, Question 16-31, Sub-question 15, the applicant proposed new Subsection 3.9.8 and associated Bases to prohibit irradiated fuel movement in the reactor vessel in Mode 6, following a unit shutdown until sufficient time has elapsed since the reactor was last critical to allow for radioactive decay of fission products, consistent with the fuel handling accident analyses. The staff reviewed the proposed Specification and Bases and found that they conform to STS conventions for content and format, are consistent with the decay time Specification in the Advanced Passive 1000 (AP1000) plant-specific TS for Vogtle Electric Generation Plant, Units 3 and 4, and are more conservative than STS Mode 6 requirements. Therefore, the staff concludes that RAI 133-7978, Question 16-31, Sub-question 15 is resolved, and that Subsection 3.9.8 and Subsection B 3.9.8 are acceptable.

<u>Conclusion for Section 3.9 and Section B 3.9</u>

The applicant adhered to the general LCO and SR provisions as provided in the CE STS (digital). Therefore, based on the above evaluation, the staff concludes that Section 3.9 and Section B 3.9 are acceptable.

16.4.15 TS Chapter 4.0 Design Features

Section 4.1 Site Location

The staff tracked RAI 154-8064, Question 16-44 as an open item pending receipt and confirmation of a comprehensive and accurate revised response from the applicant, as stated in the beginning of Section 16.4 in the discussion of general matters relevant to one or more DCD Tier 2, Chapter 16 sections. As described in the beginning of Section 16.4, Question 16-44 is resolved

The following tables lists the RAI question concerning Section 4.1.

Section 4.1 Question.Sub-Question No.	NRC Letter No.– RAI No.; ADAMS Accession Nos.	Affected Generic TS or DCD Tier 2 Description	Status	Follow up Question.Sub-Question No.
16-44	154-8064 ML15295A495 Responses: ML16187A252 ML17180A444 ML17236A374 ML17290B218	Use of brackets and identification / enumeration of COL Action Items	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Since Question 16-44 concerns the accuracy and completeness of the list of COL action items in proposed DCD Tier 2, Table 16-1, and not the bracketed placeholder for a description of the site location, the staff concludes that Section 4.1 is acceptable.

Section 4.2 Reactor Core

Section 4.2 is consistent with the format and content of STS Section 4.2, with APR1400 design-specific values for the number of fuel assemblies, full strength control rod assemblies, and part strength control rod assemblies in the reactor core; and other design-specific design information. Therefore, the staff concludes that Section 4.2 is acceptable.

Section 4.3 Fuel Storage

The following table lists the RAI questions concerning Section 4.3.

Section 4.3 Question.Sub-Question No.	NRC Letter No.– RAI No.; ADAMS Accession Nos.	Affected Generic TS or DCD Tier 2 Description	Status	Follow up Question.Sub-Question No.
16-1.1	93-8075 ML15295A320 Response: ML15236A367	4.3.1.1.b	CU	16-150.4
16-1.2	93-8075 ML15295A320 Response: ML15236A367	4.3.1.1.e, 4.3.1.1.f	CU	16-150.4
16-24.14	120-7977 ML15209A000 Responses: ML16050A530 ML17191B261	3.7.16 – Address bracketed provisions in STS B 3.7.16 – Provide basis information from the criticality analyses 4.3.1.1 – Revise to reflect the NRC approved SFP storage configuration	CU	16-150.4

Section 4.3 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-150.4A	481-8546 ML16133A271 Response: ML16187A207	4.3.1.1.b – revised to capture assumptions of the SFP criticality analyses 4.3.1.1.e – revised to reflect the NRC approved SFP storage configuration 4.3.1.1.f – revised to reflect the NRC approved SFP storage configuration	CC	
16-150.4B 16-150.4C 16-150.4D	481-8546 ML16133A271 Response: ML16187A207	4.3 – added new Figure 4.3-1 showing the physical layout of the spent fuel storage racks B 3.7.16 Background – revised to include discussion of minimum boron concentration assumed in the SFP criticality analyses B 3.7.16 References – added technical report for the SFP criticality analyses to the list of references	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

Section 4.3, in general, is consistent with the format and content of STS Section 4.3, with APR1400 design-specific requirements applicable to the new and spent fuel assembly storage facilities. However, some of those requirements in the CE STS are placed within brackets indicating their reliance on a plant-specific configuration that was previously approved by the NRC staff.

In RAI 93-8075 (ML15295A320), Question 16-1, the applicant was requested to address this NRC approved configuration. In its response (ML15236A367) to Question 16-1, the applicant proposed to revise Subsection 4.3.1.1 to capture the results of the SFP criticality analysis, in particular, the credited minimum boron concentration used therein. The staff, however, could not fully assess these proposed changes at the time without having conforming changes to Subsection 3.7.16 available for review. These proposed changes to Subsection 4.3.1.1 were later superseded by the applicant's response (ML16187A207) to RAI 481-8546, Question 16-150, Sub-question 4, which is described in Section 16.4.12 of this SER in the evaluation of Subsection 3.7.16.

Based on its review and the above discussion, the staff concludes that Section 4.3 is acceptable.

Chapter 4.0 Conclusion

The staff reviewed Chapter 4.0 and determined that it is consistent with CE STS Chapter 4.0 and satisfies paragraph (4) of 10 CFR 50.36(c). Therefore, the staff concludes that Chapter 4.0 is acceptable.

16.4.16 TS Chapter 5.0 Administrative Controls

TS Chapter 5.0 Administrative Controls ─ Section 5.1 Responsibility; Section 5.2 Organization; Section 5.3 Unit Staff Qualifications; and Section 5.4 Procedures

The GTS Sections 5.1, 5.2, 5.3, and 5.4 are identical to the STS Sections 5.1, 5.2, 5.3, and 5.4. Therefore, they are acceptable.

TS Chapter 5.0 Administrative Controls ─ Section 5.5 Programs and Manuals

1. The following program and manual subsections are identical to the corresponding STS Section 5.5 program and manual subsections. Therefore, they are acceptable.

   5.5.1 Offsite Dose Calculation Manual (ODCM),

   5.5.2 Primary Coolant Sources Outside Containment,

   5.5.3 Post-Accident Sampling,

   5.5.4 Radioactive Effluents Controls Program,

   5.5.5 Component Cyclic or Transient Limit,

   5.5.6 Pre-Stressed Concrete Containment Tendon Surveillance Program,

   5.5.7 Reactor Coolant Pump Flywheel Inspection Program, and

   5.5.8 Inservice Testing Program

2. *Subsection 5.5.9 Steam Generator (SG) Program*

The following table lists the RAI questions concerning Subsection 5.5.9.

Subsection 5.5.9 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
5.4.2.2-3.f	299-8310 ML15314A024 Response: ML16062A276	5.5.9.c, 5.5.9.d, changed “tube repair criteria” to “tube plugging criteria” for consistency within GTS, and with STS and TSTF-510	CC	
5.4.2.2-3.g	299-8310 ML15314A024 Response: ML16062A276	5.5.9.d – removed deviations from TSTF-510 phrasing	CC	

Subsection 5.5.9 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
5.4.2.2-6.a 5.4.2.2.6.b 5.4.2.2-6.c	494-8620 ML16160A379 Responses: ML16187A148 ML16208A488	B 3.4.17 ASA section first paragraph – changed primary to secondary leakage assumption to that for both SGs – 2.27 L/min (0.6 gpm) for MSL break	CC	
16-23.23	119-7976 ML15226A542 Response: ML15265A596	3.4.17, 5.5.9 – Adopted TSTF-510	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Changes to Subsection 5.5.9 were made to incorporate TSTF-510, “Revision to Steam Generator Program Inspection Frequencies and Tube Sample Selection,” Revision 2, as previously described in Section 16.4.9 in the evaluation of Subsection 3.4.17 and the applicant’s response (ML15265A596) to RAI 119-7976, Question 16-23, Sub-question 23; and the applicant’s response (ML16062A276) to RAI 299-8310, Question 5.4.2.2-3, Sub-questions a, b, and c.

Based on its review, and finding that Subsection 5.5.9 conforms to the STS and TSTF-510, the staff concludes that Subsection 5.5.9 is acceptable.

3. The following program subsections are identical to the corresponding STS Section 5.5 program subsections. In addition, Subsection 5.5.11 is consistent with the APR1400 design of ESF ventilation systems. Therefore, these program subsections are acceptable.

    5.5.10 Secondary Water Chemistry Program

    5.5.11 Ventilation Filter Testing Program (VFTP)

4. *Subsection 5.5.12 Explosive Gas and Storage Tank Radioactivity Monitoring Program*

The following table lists the RAI question concerning Subsection 5.5.12.

Subsection 5.5.12 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-53	180-8059 ML15252A584 Response: ML15321A500	5.5.12.b – revised whole body exposure limit to less than “0.5 rem to any individual in an unrestricted area, in the event of an uncontrolled release of the tanks' contents,” consistent with STS 5.5.12.b	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Based on its review, and finding that Subsection 5.5.12 conforms to the corresponding STS Section 5.5 program subsection, the staff concludes that Subsection 5.5.12 is acceptable.

5. *Subsection 5.5.13 Diesel Fuel Oil Testing Program*

The following table lists the RAI questions concerning program Subsection 5.5.13.

Subsection 5.5.13 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
9.5.4-12.1	355-8438 ML15362A446 Response: ML16064A044 ML16201A211	5.5.13c – revised to state, "Total particulate concentration of the stored fuel oil in storage tanks and day tanks is ~~<~~ ≤ 10 mg/l when tested every 31 days." to be consistent with DCD Tier 2, Section 9.5.4	CC	
16-54	180-8059 ML15252A584 Response: ML15321A500	5.5.13c – revised the total particulate concentration limit for the fuel oil to be "≤ 10 mg/l" consistent with STS 5.5.13c and DCD Tier 2, Section 9.5.4.5	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

See Section 9.5.4 of this SER for a discussion of the concerns and resolution of RAI 355-8438, Question 9.5.4-12, regarding clarification of paragraph 5.5.13c to be consistent with STS and DCD Section 9.5.4.5, which is revised to reference SR 3.8.1.5 and SR 3.8.3.5 for removal of accumulated moisture and sediment.

Based on its review, and finding that program Subsection 5.5.13 conforms to the corresponding STS Section 5.5 program subsection, the staff concludes that Subsection 5.5.13 is acceptable.

6. The following program subsections are identical to the corresponding STS Section 5.5 program subsections. Therefore, these program subsections are acceptable.

   5.5.14 Technical Specifications (TS) Bases Control Program

   5.5.15 Safety Function Determination Program (SFDP)

   5.5.16 Containment Leakage Rate Testing Program

   5.5.17 Battery Monitoring and Maintenance Program

   5.5.18 Control Room Envelope (CRE) Habitability Program

7. *Subsection 5.5.19 Setpoint Control Program*

The following table lists the RAI questions concerning program Subsection 5.5.19.

Subsection 5.5.19 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-55.2	180-8059 ML15252A584 Response: ML15321A500	5.5.19 – Added STS 5.5.19 paragraphs e and f	CC	
16-55.3	180-8059 ML15252A584 Response: ML15321A500	5.5.19 – Add list of reports that constitute the setpoint methodology	CU	16-221
16-221	509-8951 ML16214A101 Response: ML16312A524	5.5.19 – Listed the setpoint methodology reports in paragraph b to conform to the presentation precedent of the AP1000 and ESBWR GTS.	CC	

Status Codes:
CU Closed Unresolved (has follow up question) CC Closed Confirmed
RC Resolved Confirmatory

The technical reports for the setpoint methodology, as listed in Subsection 5.5.19 at the staff's request, are:

> ARP1400-F-C-NR-14001-P, Rev. 2, "CPC Setpoint Analysis Methodology for APR1400," November 2017
>
> APR1400-Z-J-NR-14004-P, Rev. 2, "Uncertainty Methodology and Application for Instrumentation," January 2018
>
> APR1400-Z-J-NR-14005-P, Rev. 2, "Setpoint Methodology for Safety-Related Instrumentation," January 2018

See Chapter 7 of this SER for the staff's evaluation of the setpoint methodology. Pending issuance of the final revision of these documents, and acceptance of the setpoint methodology by the staff, Subsection 5.5.19 was tracked as an open item. Based on the staff's acceptance of the setpoint methodology, as described in Chapter 7 of this SER, the staff concludes that Subsection 5.5.19 is acceptable.

Conclusion for Section 5.5

Based on its review and the above evaluation, the staff concludes that Section 5.5 is acceptable.

TS Chapter 5.0 Administrative Controls ─ Section 5.6 Reporting Requirements

1. *Subsection 5.6.1 Annual Radiological Environmental Operating Report*

The following table lists the RAI question concerning Subsection 5.6.1.

Subsection 5.6.1 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-56	1809-8059 ML15252A584 Response: ML15321A500	5.6.1 – Revised to include STS 5.6.1 Note regarding allowance for a single submittal for multiple unit stations for the Annual Radiological Environmental Operating Report	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Since Subsection 5.6.1 is identical to STS Subsection 5.6.1, it is acceptable.

2. *Subsection 5.6.2 Radiological Effluent Release Report*

The following table lists the RAI question concerning Subsection 5.6.2.

Subsection 5.6.2 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-56	1809-8059 ML15252A584 Response: ML15321A500	5.6.2 – Revised to include STS 5.6.2 Note regarding allowance for a single submittal for multiple unit stations for the Radiological Effluent Release Report	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Since Subsection 5.6.2 is identical to STS Subsection 5.6.2, it is acceptable.

3. *Subsection 5.6.3 CORE OPERATING LIMITS REPORT (COLR)*

The following table lists the RAI question concerning Subsection 5.6.3:

Subsection 5.6.3 **Question.Sub-Question No.**	**NRC Letter No.–RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-59	189-8057 ML15245A387 Responses: ML15315A035 ML16162A792	5.6.3 list of LCOs referencing COLR to reflect renumbering of Subsections 3.1.3 to 3.1.12 as Subsections 3.1.2 to 3.1.11	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Since Subsection 5.6.3 is identical to STS Subsection 5.6.3, it is acceptable.

4. The following report subsections are identical to the corresponding STS Section 5.6 report subsections. Therefore, these report subsections are acceptable.

5.6.4 RCS PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

5.6.5 Accident Monitoring Report

5.6.6 Tendon Surveillance Report

5. *Subsection 5.6.7 Steam Generator Tube Inspection Report*

The following table lists the RAI questions concerning Subsection 5.6.7:

Subsection 5.6.7 **Question.Sub-Question No.**	**NRC Letter No.– RAI No.; ADAMS Accession Nos.**	**Affected Generic TS or DCD Tier 2 Description**	**Status**	**Follow up Question.Sub-Question No.**
16-57	180-8059 ML15252A584 Response: ML15321A500	Justified omission of an item “i” from 5.6.7 because APR1400 has no approved SG tube repair methods	CC	
5.4.2.2-3.a	299-8310 ML15314A024 Response: ML16062A276	5.6.7.b	CC	
5.4.2.2-3.b	299-8310 ML15314A024 Response: ML16062A276	5.6.7.d	CC	
5.4.2.2-3.c	299-8310 ML15314A024 Response: ML16062A276	5.6.7.h	CC	

Status Codes:
RC Resolved Confirmatory CC Closed Confirmed

Changes to Subsection 5.6.7 were made to incorporate TSTF-510, “Revision to Steam Generator Program Inspection Frequencies and Tube Sample Selection,” Revision 2, as previously described in Section 16.4.9 of this SER in the evaluation of Subsection 3.4.17 and the applicant’s response (ML15265A596) to RAI 119-7976, Question 16-23, Sub-question 23; and the applicant’s response (ML16062A276) to RAI 299-8310, Question 5.4.2.2-3, Sub-questions a, b, and c. Based on its review and the applicant’s responses, the staff concludes that Subsection 5.6.7 is acceptable.

Section 5.6 Conclusion

Based on its review, the staff concludes that Section 5.6 is acceptable.

TS Chapter 5.0 Administrative Controls ─ Section 5.7 High Radiation Area

Since Section 5.7 is identical to STS Section 5.7, it is acceptable.

Chapter 5.0 Conclusion

The staff reviewed Chapter 5.0 and determined that it is consistent with STS Chapter 5.0 and satisfies paragraph (5) of 10 CFR 50.36(c). Therefore, the staff concludes that Chapter 5.0 is acceptable.

16.5 Combined License Information Items

A concise list of the COL action items is provided in the beginning of Section 16.4 of this SER, and is based on the resolution of RAI 154-8064, Question 16-44, which was tracked as an open item. Based on the review of Revision 3 of DCD Chapter 16 and part 4 of the DC application, the staff has confirmed that all COL action items are (1) properly identified in the GTS and Bases, and described in Table 16-1; and (2) provided with adequate guidance in Table 16-1 and, if warranted, in appropriate reviewer's notes for completion by a COL applicant. Therefore, RAI 154-8064, Question 16-44, is resolved and closed.

16.6 Conclusion

Based on its review of the proposed APR1400 GTS and GTS Bases, the staff concludes that the proposed GTS and GTS Bases are consistent with the regulatory guidance contained in the STS and STS Bases. The proposed GTS and GTS Bases contain design-specific parameters and additional requirements considered appropriate by the staff. The staff concludes that the proposed GTS and GTS Bases comply with the requirements of 10 CFR 50.34, 10 CFR 50.36 and 10 CFR 50.36a, and adequately support the conclusion that unit operation in accordance with the proposed GTS provides reasonable assurance of adequate protection of public health and safety. Therefore, the proposed GTS and GTS Bases are acceptable.