

14 VERIFICATION PROGRAMS

Chapter 14, "Verification Programs," of this safety evaluation report (SER) describes the results of the review by the staff of the U.S. Nuclear Regulatory Commission (NRC or Commission), hereinafter referred to as the staff, of Chapter 14 of the Design Control Document (DCD), for the design certification (DC) of the Advanced Power Reactor 1400 (APR1400), submitted by Korea Electric Power Corporation (KEPCO) and Korea Hydro & Nuclear Power Co., Ltd (KHNP), hereinafter referred to as the applicant or DC applicant. The information provided in Chapter 14 of the APR1400 DCD addresses major phases of the initial test program (ITP), including preoperational tests, initial fuel loading and initial criticality, low-power tests, and power ascension tests. This chapter also describes the bases, processes, and selection criteria used to develop the Tier 1 material, which are to be verified appropriately by inspections, tests, analyses, and acceptance criteria (ITAAC).

This chapter of the SER provides the staff's review of the ITP and the ITAAC for the APR1400 as part of the DC review being conducted by the staff under Title 10 of the *Code of Federal Regulations* (10 CFR), Part 52, "Licenses, Certifications and Approvals for Nuclear Power Plants." The staff conducted this review in accordance with the Standard Review Plan (SRP), NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Light Water Reactor (LWR) Edition," March 2007, Chapter 14.

14.1 Specific Information to be Addressed for the Initial Plant Test Program

Introduction

The APR1400 DCD Tier 2 Section 14.1, "Specific Information to be Addressed for the Initial Plant Test Program," lists the relevant requirements of the applicable regulations and the 12 areas covered by the ITP. There was no combined license (COL) information required in regard to APR1400 DCD Tier 2 Section 14.1.

Evaluation

The staff reviewed conformance of the APR1400 DCD Tier 2 Section 14.1 to Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants," Sections C.I.14.1, "Specific Information to be Addressed for the Initial Plant Test Program," and C.I.14.2, "Initial Plant Test Program," and the introduction section of RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants." RG 1.206, Section C.I.14.1 describes six regulations that address the scope of the ITP. In addition, the introduction section of RG 1.68 references General Design Criteria (GDC) 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," which requires, in part, that structures, systems, and components (SSCs) important to safety shall be tested to quality standards commensurate with the importance of the safety functions to be performed. These seven regulations are referenced in Section 14.2.3 of this SER. Additionally, RG 1.206, Section C.I.14.2, identifies the 12 areas that should be covered by the ITP.

The staff evaluated the APR1400 DCD Tier 2 Section 14.1 and determined that DCD Tier 2 Section 14.1 referenced the regulations identified in Section 14.2.3 of this SER and the 12 areas covered by the ITP listed in Section 14.2.2 of this SER, as described by RG 1.206 and RG 1.68,

with one exception. Specifically, the staff determined that the DC applicant did not include 10 CFR Part 50, Appendix A, GDC 1 as it relates to testing important-to-safety SSCs that are within the scope of the Quality Assurance Program (QAP) and the ITP. In RAI 278-8226, Question 14.02-39 (Agency-Wide Documents Access and Management System (ADAMS) Accession No. ML15303A502), the staff requested that the DC applicant add 10 CFR Part 50, Appendix A, GDC 1 as a regulatory basis for SSCs that should be tested within the scope of the QAP and ITP.

In its January 12, 2016, response to RAI 278-8226, Question 14.02-39 (ML16012A550), the DC applicant proposed to add a reference to 10 CFR Part 50, Appendix A, GDC 1 as it relates to important to safety SSCs in DCD Tier 2 Sections 14.1 and 14.2. The staff determined that the RAI response is acceptable because the proposed change to the DCD will include the seven regulations identified in RG 1.206 and RG 1.68. The staff verified that the proposed change has been incorporated in the APR1400 DCD; therefore, RAI 278-8226, Question 14.02-39 was resolved and closed.

Conclusion

The staff concludes that the information provided in APR1400 DCD Tier 2 Section 14.1 adequately describes the specific information to be addressed for the ITP, and is thus acceptable. All issues relating to this section of the initial test program have been resolved.

14.2 Initial Plant Test Program

14.2.1 Introduction

The APR1400 ITP is intended to verify that the as-built facility configuration and operation complies with the approved plant design and applicable regulations. The ITP consists of preoperational and initial startup testing. Major phases of testing include:

- Preoperational Tests – The preoperational tests are conducted following the completion of construction but before fuel loading.
- Initial Fuel Loading – Initial fuel loading starts after completion of the preoperational testing.
- Initial Criticality and Low-Power Tests – The initial criticality phase of the startup test program confirms that criticality is achieved in a safe and controlled manner. Following initial criticality, a series of low-power physics tests are performed to verify selected core design parameters.
- Power-Ascension Tests – A series of power ascension tests is conducted to bring the reactor to full power.

The scope of the ITP, as well as the general plans for accomplishing the test program, is described to demonstrate that due consideration has been given to matters that normally require advance planning.

The technical aspects of the ITP are described to show that: (1) the test program adequately verifies the functional requirements of plant SSCs; and (2) the sequence of testing is such that the safety of the plant does not depend on untested SSCs. In addition, the measures are described to ensure that: (1) the ITP is accomplished with adequate numbers of qualified personnel; (2) adequate administrative controls will be established to govern the initial test program; (3) the test program is used, to the extent practicable, to train and familiarize the plant's operating and technical staff in the operation of the facility; and (4) the adequacy of plant operating and emergency procedures is verified, to the extent practicable, during the period of the ITP.

The staff reviewed the DC applicant's ITP in accordance with the guidance in RG 1.206 Section C.I.14, dated June 2007; SRP Section 14.2, "Initial Plant Test Program – Design Certification and New License Applicants," dated March 2007; and RG 1.68 dated June 2013.

14.2.2 Summary of Application for DCD Section 14.2

The DC applicant provided specific information which addressed the ITP in 12 different subsections: (1) summary of test program and objectives; (2) organization and staffing; (3) test procedures; (4) conduct of test program; (5) review, evaluation, and approval of test results; (6) test records; (7) test program conformance with NRC Regulatory Guides (RG); (8) utilization of reactor operating and testing experience in developing the plant ITP; (9) trial use of plant operating and emergency procedures; (10) initial fuel loading and initial criticality; (11) ITP schedule and sequence; and (12) individual test descriptions.

14.2.3 Regulatory Basis for DCD Section 14.2

The relevant requirements of the Commission regulations for the initial plant test program, and the associated acceptance criteria, are specified in Section 14.2 of NUREG-0800, "Standard Review Plan for Nuclear Power Plants," (SRP). Interfaces with other SRP sections can also be found in SRP Section 14.2. The applicable regulatory requirements are as follows:

- 10 CFR 30.53(c) which requires that each licensee (defined as an entity licensed to receive and possess byproduct material in this context) perform, or permit the Commission to perform, tests of radiation detection and monitoring instruments.

In nuclear power plants, radiation detection and monitoring instruments are used for ambient monitoring related to worker radiation protection, effluent monitoring, automatic initiation of features to mitigate accidental releases of radioactive materials, and automatic initiation of engineered safety features to minimize the consequences of design-basis accidents. Application of 10 CFR 30.53(c) to the ITP ensures that the capabilities to perform these functions are adequately verified initially and that deficiencies are identified and corrected. This provides increased assurance of reliable radiation detection/monitoring and instrument response to any detected adverse radiological conditions.

- 10 CFR 50.34(b)(6)(iii) which requires plans for preoperational testing and initial operations.
- 10 CFR 50.43(e) which has additional requirements for DC applicants that propose nuclear reactor designs that differ significantly from light-water reactor designs that were

licensed before 1997, or use simplified, inherent, passive, or other innovative means to accomplish their safety functions. These requirements include demonstrating the safety of the design through means such as testing, analysis, experience and data, as applicable.

- 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records," which requires important-to-safety SSCs be tested under both the QAP and the ITP.
- Appendix B to 10 CFR Part 50, Criterion XI, "Test Control," which requires test controls for safety related SSCs under the scope of the QAP and ITP.
- Appendix J to 10 CFR Part 50, which requires Type A, B and C preoperational leakage rate tests of the primary containment and related systems and components that penetrate the primary containment pressure boundary as specified in Section III.A, "Leakage Testing Requirements."

The primary reactor containment provides a barrier against the release of fission products after accidents. The extent of overall containment leakage at pressures associated with accident conditions affects the public dose and environmental damage consequences of accidents. Application of Appendix J to the ITP ensures that the containment performs as a leakage barrier as specified in the design and as assumed/credited in safety analyses that evaluate the public dose and environmental consequences of design basis accidents.

- 10 CFR 52.79(a)(28) which requires plans for preoperational testing and testing during initial operations. For COL applications under 10 CFR Part 52, the applicant must describe the ITP, in accordance with 10 CFR 52.79(a)(28). The requirements in 10 CFR 52.47 do not require a DC applicant to submit an ITP. However, DC applications should include proposed testing activities for the ITP to support the COL applications.
- 10 CFR Part 52, Subpart A, Subpart B, and Subpart C which requires inspections, tests, analyses, and acceptance criteria (ITAAC). Although the ITAAC review is conducted in Section 14.2, ITP tests are often used as the basis for ITAAC, so the relationship between the ITP and the ITAAC is addressed in this section of the SER where pertinent.

14.2.4 Technical Evaluation for DCD Tier 2 Subsections 14.2.1 through 14.2.12

14.2.4.1 DCD Tier 2 Subsection 14.2.1, Summary of Test Program and Objectives

Introduction

The APR1400 DCD Tier 2 Subsection 14.2.1 describes the ITP that is performed during the initial startup of the APR1400 plant and identifies general prerequisites and specific objectives for each phase. The ITP commences with the completion of construction and installation and ends with the completion of power ascension testing. The ITP consists of preoperational tests and initial startup tests following in four phases:

Phase I: Preoperational Testing

Phase II: Fuel loading and post-core hot functional testing

Phase III: Initial criticality and low-power physics testing
Phase IV: Power ascension testing

The purpose of these tests is to demonstrate that the facility operates in accordance with its design during steady-state conditions and, to the extent practicable, during anticipated transients.

Evaluation

The staff reviewed conformance of APR1400 DCD Tier 2 Subsection 14.2.1 to the guidance in SRP Section 14.2.II.1, "Summary of Test Program and Objectives"; RG 1.206, Section C.I.14.2.1, "Summary of Test Program and Objectives"; and the general guidelines and applicable regulatory positions in RG 1.68. RG 1.206, Section C.I.14.2.1, states in part, that, "the applicant should describe major phases of the initial test program as well as the general prerequisites and specific objectives to be achieved for each phase."

The staff confirmed that the DC applicant described the summary of the ITP and included a description of the objectives of each of the appropriate major phases of the test program in Subsection 14.2.1 of the APR1400 DCD.

RG 1.68, Appendix A, "Initial Test Program," identifies the major phases of the ITP which include: (1) Preoperational Testing, (2) Initial Fuel Loading and Pre-Criticality Testing, (3) Initial Criticality Testing, (4) Low-Power Testing, and (5) Power-Ascension Testing. RG 1.206, Section C.I.14.2.1 provides that the COL applicant should address major phases of the initial test program as well as the general prerequisites and specific objectives to be achieved for each phase. The staff noted that the applicant's proposed test program provided the following phases and objectives:

- Phase I – Preoperational Testing

Demonstrate that structures, systems, and components (SSCs) operate in accordance with design operating modes throughout the full design operating range. Preoperational testing provides reasonable assurance that systems and equipment perform in accordance with the safety analysis report.

- Phase II – Fuel Loading and Post-Core Hot Functional Testing

Provide a systematic process for safely accomplishing and verifying the initial fuel loadings. Provide additional assurance that plant systems necessary for normal plant operation function as expected and to obtain performance data on core-related systems and components.

- Phase III – Initial Criticality and Low-Power Physics Testing

Provide reasonable assurance that initial criticality is achieved in a safe and controlled manner. Substantiate that the Safety Analysis and Technical Specifications assumptions and limits have been met. Demonstrate that core characteristics are within the expected limits and provide data for benchmarking the design methodology used for predicting the core characteristics later in the life of the plant.

- Phase IV – Power Ascension Testing

Demonstrate that the facility operates in accordance with its design during steady-state conditions and, to the extent practicable, during anticipated transients.

The staff finds that the applicant has adequately identified and described the major phases of the ITP because: (1) the DC applicant included the major phases identified in RG 1.68, and (2) the DC applicant adequately described the general prerequisites and specific objectives to be achieved for each phase, consistent with RG 1.206.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.1 adequately describes the activities related to the phases of the ITP: (1) preoperational testing; (2) fuel loading and post-core hot functional testing; (3) initial criticality and low power physics testing; and (4) power ascension testing, and is therefore acceptable. All issues relating to this section of the ITP have been resolved.

14.2.4.2 DCD Tier 2 Subsection 14.2.2, Organization and Staffing

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.2, "Organization and Staffing," the DC applicant stated that the staff responsibilities, authorities and personnel qualifications for performing the APR1400 ITP are the responsibility of the COL applicant.

Evaluation

The staff reviewed conformance of APR1400 DCD Tier 2 Subsection 14.2.2 to the guidance in RG 1.206, Section C.I.14.2.2, "Organization and Staffing"; SRP Section 14.2.II, "Acceptance Criteria," Section 3.A, "Management Organizations," and Section 3.D, "Staff Responsibilities, Authorities and Qualifications"; and RG 1.68, Section C.6, "Participation of Plant Operating and Technical Staff." In APR1400 DCD Tier 2 Subsection 14.2.2, the DC applicant stated that the site-specific organization, the participation of staff in the test program, and the training program are all the responsibility of the COL applicant. The staff finds that because staffing will be determined by the COL applicant and is, thus, outside the scope of DC, it is acceptable to defer responsibility for the site-specific organization to the COL applicant. The staff confirmed that the COL applicant's responsibility to develop the site-specific organization and staffing levels for implementation of the ITP is captured in COL item 14.2(1) in APR1400 DCD Tier 2 Subsection 14.2.13.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.2 adequately describes the activities related to the organization and staffing for the ITP, and is thus acceptable. The staff also concludes that because staffing will be determined by the COL applicant and is, thus, outside the scope of DC, it is acceptable to defer responsibility for the site-specific organization to the COL applicant.

14.2.4.3 DCD Tier 2 Subsection 14.2.3, Test Procedures

Introduction

In APR1400 DCD Tier 2 Subsection 14.2.3, "Test Procedures," the DC applicant provided guidelines for the development of test procedures, including format requirements, adherence to applicable RGs, and provisions for review and approval by responsible personnel. In general, testing during all phases of the ITP is conducted using detailed, step-by-step written procedures to control the conduct of each test. Such test procedures specify testing prerequisites, describe desired initial conditions, include appropriate methods to direct and control test performance (including the sequencing of testing), and specify acceptance criteria by which the test is to be evaluated, and provide for or specify the format by which data or observations are to be recorded.

Evaluation

The staff reviewed the conformance of the APR1400 DCD Tier 2 Subsection 14.2.3 with the guidance in RG 1.68, Section C.4, "Procedures," and SRP Section 14.2. The staff notes that the DC applicant followed the guidance of the SRP and provided the controls to develop test procedures. The DC applicant provided for detailed procedure guidelines and procedures used to develop the test procedures, a minimum set of topic areas to be included in each procedure, and the reference materials to be used in the preparation of each test procedure.

The APR1400 DCD Tier 2 Subsection 14.2.3 indicates that a COL applicant is responsible for providing site-specific controls for the review and approval of test procedures for preoperational and startup tests. Additionally, the DC applicant stated that the submittal by the COL applicant of applicable procedures and guidelines to the staff for review will be conducted as described in APR1400 DCD Tier 2 Subsection 14.2.11, "Test Program Schedule." The APR1400 DCD Tier 2 Subsection 14.2.3, states, in part, that "the plant operator provides reasonable assurance for preparation and designates the approval process for Phases I through IV test procedures...[T]est procedures are based on the requirements of system designers and applicable NRC Regulatory Guides (RGs)." The staff finds that because site specific controls for the review and approval of test procedures will be determined by the COL applicant and is, thus, outside the scope of DC, it is acceptable to defer responsibility for the control of site-specific ITP test procedures to the COL applicant. The DCD discussion is also acceptable because it references the need to account for system design and directs the COL applicant to use NRC guidance. The staff confirmed that the COL applicant's responsibility for site-specific preoperational and startup test specifications and test procedures is captured in COL items 14.2(2) and COL 14.2(3) in APR1400 DCD Tier 2 Subsection 14.2.13.

However, the staff identified that additional information was needed regarding the startup administrative manual (SAM). In RAI 91-7867, Question 14.02-8 (ML16182A597), the staff requested that the DC applicant place the SAM on the docket.

In its June 30, 2016, revised response to RAI 91-7867, Question 14.02-8 (ML16182A597), the DC applicant submitted an initial copy of the SAM. The staff reviewed the initial copy of the SAM and determined that it provided the framework for the COL applicants to develop their own SAM to conduct the ITP; however, the staff determined that it did not address all of the DC

applicant's administrative control responsibilities in accordance with the guidance of SRP Section 14.2.

In follow up RAI 513-8663, Question 14.02-67 (ML16221A563), the staff requested that the DC applicant address bullet items A through D identified in SRP Section 14.2.II.3, "Initial Test Program Administrative Procedures," related to the DC applicant's administrative control responsibilities for completing the SAM, including the administrative controls for the list of test abstracts in the APR1400 DCD Tier 2 Section 14.2. The staff also requested that the DC applicant add the list of test abstracts included in APR1400 DCD Tier 2 Section 14.2 to the SAM. In its response to RAI 513-8663, Question 14.02-67 (ML17034A412), the DC applicant proposed to add to the SAM, the administrative control responsibilities referenced in SRP Section 14.2.II.3 for the DC applicant. In addition, the DC applicant proposed to reference the list of ITP test abstracts for the preoperational, post core hot functional, low power physics, and power accession test phases in the SAM. The staff reviewed the proposed changes and determined that the DC applicant did not reference the Initial Fuel Load Test, Post Core Ex-Core Neutron Flux Monitoring System Test, and the Initial Criticality Test in the SAM.

In its revised response to RAI 513-8663, Question 14.02-67, (ML17155A000), the DC applicant proposed to update the SAM to include the Initial Fuel Load Test, the Post Core Ex-Core Neutron Flux Monitoring System Test, the Initial Criticality/Low Power Physics Test, and all other added tests and changes that have been incorporated into the APR1400 DCD Tier 2 Section 14.2. The staff determined that the proposed change provides that the SAM includes the test abstracts of SSCs that will be tested in the ITP per the guidance in RG 1.68, Appendix A, Section A-2, "Initial Fuel Loading and Pre-Critical Tests," and Section A-3; "Initial Criticality." Therefore, RAI 513-8663, Question 14.02-67 and RAI 91-7867, Question 14.02-8 were resolved and closed.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.3 adequately describes the guidelines for the development of test procedures for the ITP, and is thus acceptable. The staff also concludes that because site-specific administrative procedures to be developed by the COL applicant will govern the development of test procedures, it is acceptable to defer responsibility for the site-specific preoperational and startup test procedures to the COL applicant. All issues relating to this section of the initial test program have been resolved.

14.2.4.4 DCD Tier 2 Subsection 14.2.4, Conduct of Test Program

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.4, "Conduct of Test Program," the DC applicant stated that the COL applicant is responsible for planning and conducting the ITP. The DC applicant also provided the format of the administrative procedures that will be used to conduct the initial test program. This section describes the administrative controls that govern the conduct of the test program. This description includes the administrative controls used to ensure that necessary prerequisites are satisfied for each major phase and for individual tests. The administrative controls pertaining to adherence to approved test procedures during the

conduct of the test program, as well as the methods for effecting changes to approved test procedures, are described.

Evaluation

The staff reviewed the conformance of APR1400 DCD Tier 2 Subsection 14.2.4 to the guidance in RG 1.206, Section C.I.14.2.4, "Conduct of Test Program"; SRP Sections 14.2.II and 14.2.II.3; and RG 1.68, Position C.2, "Prerequisites for Testing." The staff finds that the DC applicant followed the guidance of the SRP, RG 1.206, and RG 1.68 in that APR1400 DCD Tier 2 Subsection 14.2.4 states that the COL applicant is responsible for the planning and the conduct of the initial test programs. Also, the DC applicant stated that the startup test group will conduct the initial test program in accordance with administrative procedures and requirements. In addition, the DC applicant included specific direction that the COL applicant's procedures will: (1) define the format and content of startup test procedures, and (2) define the review and approval process for both initial procedures and subsequent revisions or changes, consistent with Section C.I.14.2.4 of RG 1.206. The staff confirmed that the COL applicant's responsibility for site-specific preoperational and startup test specifications and test procedures is captured in COL items 14.2(2) and COL 14.2(3) in APR1400 DCD Tier 2 Subsection 14.2.13.

Conclusion

The staff determined that the APR1400 DCD Tier 2 Subsection 14.2.4 describes the activities related to review, evaluation, and approval of test results for the initial test program, and is thus acceptable. The staff also concludes that, because the conduct of the test program will be completed by the COL applicant, it is acceptable to defer responsibility for the development of detailed administrative procedures to the COL applicant. All issues relating to this section of the initial test program have been resolved.

14.2.4.5 DCD Tier 2 Subsection 14.2.5, Review, Evaluation, and Approval of Test Results

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.5, "Review, Evaluation, and Approval of Test Results," the DC applicant stated that the COL applicant is responsible for the site-specific administrative procedures for review and approval of test results.

This section describes the specific controls to be established for the review, evaluation, and approval of test results for each major phase of the program by appropriate personnel and/or organizations. This description includes specific controls to be established to ensure notification of affected and responsible organizations or personnel when test acceptance criteria are not met, as well as the controls established for corrective actions and retests, as required.

Evaluation

The staff reviewed conformance of the APR1400 DCD Tier 2 Subsection 14.2.5 to the guidance in RG 1.206, Section C.I.14.2.5, "Review, Evaluation and Approval of Test Results"; SRP Sections 14.2.II, and 14.2.II.3, Subsection F, "Review, Evaluation and Approval of Test Results"; and RG 1.68, Section C.9, "Test Reports." The staff finds that the DC applicant followed the

guidance of the SRP, RG 1.206, and RG 1.68 in that APR1400 DCD Tier 2 Subsection 14.2.5 states that:

The COL applicant is to review and evaluate individual test results in a test report made available to NRC personnel after preoperational and startup tests are completed. The specific test acceptance criteria for determining success or failure of a test shall be included in the test report approval of the test results. The test report should also include test results associated with any license conditions in the plant specific Initial Test Program (COL 14.2(7)).

The COL applicant's responsibility to review and evaluate individual test results is captured in COL item 14.2(7) in DCD Tier 2 Subsection 14.2.13. The staff finds that the APR1400 DCD Tier 2 Subsection 14.2.5 included specific direction for the COL applicant to review, evaluate, and approve test records in accordance with RG 1.206, Section C.I.14.2.5.

Conclusion

The staff concludes that the information provided in APR1400 DCD Tier 2 Subsection 14.2.5 adequately describes the activities related to review, evaluation, and approval of test results for the initial test program, and is thus acceptable. The staff finds that all issues relating to this section of the initial test program have been resolved.

Also, the staff concludes that, because review and approval of the test results will be completed by the COL applicant, it is acceptable to defer responsibility for the development of detailed administrative procedures for the review and approval of test results to the COL applicant.

14.2.4.6 DCD Tier 2 Subsection 14.2.6, Test Records

Introduction

In APR1400 DCD Tier 2 Subsection 14.2.6, "Test Records," the DC applicant provided a description of the controls that will be implemented to maintain initial test program records.

Evaluation

The staff reviewed the conformance of APR1400 DCD Tier 2 Subsection 14.2.6 to the guidance in RG 1.68, Section C.9. The APR1400 DCD Tier 2 Subsection 14.2.6 states that the official copy of each test procedure and the information specifically called for in the test procedure shall be retained for the life for the plant by the COL applicant consistent with the guidance of RG 1.28. However, RG 1.28 only covers preoperational tests under the ITP, not startup tests.

In the review of APR1400 DCD Tier 2 Subsection 14.2.6, the staff determined that the information provided in APR1400 DCD Tier 2 Subsection 14.2.6 was inadequate. In RAI 91-7867, Question 14.02-5 (ML15201A768), the staff requested the DC applicant to revise APR1400 DCD Tier 2 Subsection 14.2.6 to address retention of startup testing procedures and startup test results as part of the plant's historical records in accordance with RG 1.68.

In its June 30, 2016, response to RAI 91-7867, Question 14.02-5 (ML16182A597), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.6 to state that the

preoperational and startup test procedures and test results are to be retained for the life of the plant by the COL applicant.

The staff determined that this change to the APR1400 DCD Tier 2 Subsection 14.2.6 meets RG 1.68, Section C.9 because it describes retention of startup test procedures and startup test report results; therefore, it is acceptable. The staff verified the proposed change has been incorporated in the APR1400 DCD; therefore, RAI 91-7867, Question 14.02-5 was resolved and closed. In addition, the staff confirmed that the COL applicant's responsibility for retaining preoperational and startup test procedures and results is captured in COL items 14.2(2) and COL 14.2(3) in APR1400 DCD Tier 2 Subsection 14.2.13.

Conclusion

The staff concludes that the information provided in APR1400 DCD Tier 2 Subsection 14.2.6 adequately describes protocols pertaining to the disposition of test procedures and test data following completion of the test program, and is thus acceptable. All issues relating to this section of the initial test program have been resolved.

14.2.4.7 DCD Tier 2 Subsection 14.2.7, Conformance of Test Programs with NRC Regulatory Guides

Introduction

In APR1400 DCD Tier 2 Subsection 14.2.7, "Conformance of Test Programs with Regulatory Guides," the DC applicant references APR1400 DCD Tier 2 Subsection 1.9.1 and Table 1.9-1, "APR1400 Conformance with NRC Regulatory Guides," which provide a list of specific RGs related to testing and testing programs. This section also references Table 14.2-7, "Conformance Matrix of RG 1.68 Appendix A versus Individual Test Descriptions," which cross-references the matrix of the applicable guidance in RG 1.68 Appendix A to the test descriptions listed in DCD Tier 2 Subsection 14.2.12 to demonstrate compliance with RG 1.68.

Evaluation

The staff reviewed conformance of APR1400 DCD Tier 2 Subsection 14.2.7 to the guidance in SRP Section 14.2.II.2, "Test Program's Conformance with Regulatory Guides"; RG 1.20, "Comprehensive Vibration Assessment Programs for Internals during Preoperational and Initial Startup Testing," Regulatory Position C.1.4, "Non-Prototype Category I"; and the general guidelines and applicable regulatory positions in RG 1.68.

SRP Section 14.2 states, in part, that the DC or COL applicant should establish and describe an ITP that is consistent with the regulatory positions outlined in RG 1.68. SRP Section 14.2 also includes a list of RGs that provide more detailed information pertaining to the testing. RG 1.68, Appendix A, references a set of supplemental regulatory guides that provide guidance for particular tests during the preoperational and initial startup phases. The supplemental RGs contain additional information to help determine if performance of the tests in the proposed manner will likely accomplish the objectives of certain plant tests.

In the APR1400 DCD Tier 2 Subsection 14.2.7, the DC applicant referenced Table 1.9-1, which lists RGs utilized for the development of the APR1400 ITP. In addition, Table 14.2-7 lists the system test descriptions that conform to RG 1.68, Appendix A. The staff reviewed the

aforementioned tables to ensure that the applicable RGs were included in the development of the ITP. For those instances in which the DC applicant determined that RGs were not applicable to the APR1400 design or where exceptions to RGs were proposed, the staff reviewed the DC applicant's justification for the exception to ensure that the test program scope remained sufficient. The APR1400 DCD Tier 2 Subsections 14.2.7.1.1 through 14.2.7.1.13 provide exceptions and/or clarifications between the proposed ITP, as described in 14.2.12, to the regulatory positions in RG 1.68. In most cases, the exceptions provide bases as to why the APR1400 will not be tested as described in RG 1.68 due to differences in the design.

The staff reviewed the APR1400 DCD Tier 2 Subsections 14.2.7.1.1 through 14.2.7.1.13 and concluded that the proposed exceptions and/or clarifications were acceptable because the principal design criteria established in Appendix A to 10 CFR Part 50 are met, except as described below. The staff identified the following areas where additional information was needed.

The staff determined that in Table 14.2-7, the DC applicant did not reference APR1400 DCD Tier 2 Subsections 14.2.12.1.2, "Reactor Coolant System Test," and 14.2.12.1.37, "Safety Depressurization and Vent System Test." Therefore, testing of the reactor coolant gas vent system using vent valves for a number of major reactor coolant system (RCS) components (e.g., reactor vessel upper head vent valves, pressurizer vent valves, etc.) in the RCS was not referenced to the appropriate testing guidance in RG 1.68. In RAI 91-7867, Question 14.02-2 (ML15201A768), the staff requested that the DC applicant add APR1400 DCD Tier 2 Subsections 14.2.12.1.2 and 14.2.12.1.37 to row 1.a.2.h of Table 14.2-7. In addition, the staff requested the DC applicant to verify if other APR1400 test abstract subsections are correctly referenced in Table 14.2-7 for conformance with RG 1.68, Appendix A.

In its response to RAI 91-7867, Question 14.02-2 (ML15343A502), the DC applicant proposed to revise Table 14.2-7 to add references to the APR1400 DCD Tier 2 Subsections 14.2.12.1.2 and 14.2.12.1.37 and verified that no other test abstract subsections were missing. The staff determined that this response adequately addressed the staff's requested revisions to meet RG 1.68, Appendix A, related to the list of tests and is acceptable. The staff verified that the proposed change has been incorporated in the APR1400 DCD; therefore, RAI 91-7867, Question 14.02-2 was resolved and closed.

In the APR1400 DCD Tier 2 Subsection 14.2.7.1.13, "Reference Section C, Regulatory Position 4," which discussed exceptions to RG 1.68, Regulatory Position C.4, the DC applicant states:

This section requires inclusion of acceptance criteria that account for uncertainties. The test summaries in Subsections 14.2.12.2.1 and 14.2.12.1.46 are essential to the demonstration of conformance to the requirements for structures, components, and features important to safety.

In its review, the staff determined that the DC applicant should provide additional information on what uncertainties, if any, should be included in the test acceptance criteria related to the APR1400 DCD Tier 2 Subsections 14.2.12.1.46 and 14.2.12.2.1. The DC applicant also needed to describe any exceptions from the guidance in RG 1.68, Regulatory Position C.4 it is taking regarding these test abstracts. The staff requested this information in RAI 91-7867, Question 14.02-6 (ML15201A768).

In its December 9, 2015, response to RAI 91-7867, Question 14.02-6 (ML15343A502), the DC applicant provided the following response:

Uncertainties include the design value that should be met to satisfy the safety analysis assumption and to maintain the safety related function(s). These values will be included in each specific test procedure acceptance criteria, such as the design flowrate of the pump, response time of the valve, actuation setpoint of the control system, etc. However, the exact value to be used in the procedure will be provided by the COL applicant. Test plans for 14.2.12.1.46, "Pre-Core Hot Functional Test Controlling Document," and 14.2.12.2.1, "Post-Core Hot Functional Test Controlling Document" are the controlling documents for all the pre-core and post-core evolutions and plans. Therefore, these two procedures do not include the design related uncertainties.

The staff determined that the DC applicant's response is acceptable because design related uncertainties are specific to each COL site and will be included in the COL's site specific test procedures and test plans. Therefore the design related uncertainties are not included in the APR1400 DCD Tier 2 Section 14.2 test abstracts. Based on the above, RAI 91-7867, Question 14.02-6 was resolved and closed.

In RAI 91-7867, Question 14.02-9 (ML15201A768) and RAI 187-8101, Question 14.02-10 (ML15292A501), the staff requested the DC applicant to revise APR1400 DCD, Table 1.9-1 to include individual ITP tests to conform to the guidance in RG 1.20. For a non-prototype plant like the APR1400, the DC applicant should consider adding two tests which include the Internals Vibration Monitoring System Test in APR1400 DCD Tier 2 Subsection 14.2.12.1.41 and the Nuclear Steam Supply System (NSSS) Integrity Monitoring System Test in APR1400 DCD Tier 2 Subsection 14.2.12.4.18.

In its response to RAI 91-7867, Question 14.02-9 (ML15240A044) and in its response to RAI 187-8101, Question 14.02-10 (ML16142A015), the DC applicant stated that the comprehensive vibration assessment program (CVAP) is used to verify the structural integrity of the reactor internals for flow-induced vibration prior to commercial operation. Since an analysis program and an inspection program are being implemented for the APR1400 and the results are being assessed in those programs, implementation of a vibration measurement program is not necessary in accordance with RG 1.20. The DC applicant stated that the reactor internal vibration test is excluded from CVAP because the APR1400 is classified as a non-prototype category I plant in accordance with the guidance provided in RG 1.20. This is also stated in APR1400 DCD Tier 2 Subsection 14.2.7.1.6.

The DC applicant also noted that the Nuclear Instrument Monitoring System (NIMS) (which includes the Internal Vibration Monitoring System (IVMS), Loose Parts Monitoring System (LPMS), and the Acoustic Leak Monitoring System (ALMS)) is used to verify the proper operation of vibration monitoring of these systems and that test results are used to establish alarm set-points and to evaluate the adequacy of system design parameters. Also, most of the NIMS is non-safety-related (e.g., except for LPMS, which is designed to meet RG 1.33). The DC applicant also noted that none of the preoperational test and startup tests are needed for the DC applicant's commitments to vibration monitoring in RG 1.20. Therefore, since the system tests for IVMS, LPMS, and ALMS are not related to RG 1.20 testing, it is not necessary to

include reference to APR1400 DCD Tier 2 Subsections 14.2.12.1.41, 14.2.12.1.42, 14.2.12.1.43 or 14.2.12.4.18 in Table 1.9.1 for RG 1.20 applicability.

The staff reviewed the DC applicant's response to RAI 91-7867, Question 14.02-9 and RAI 187-8101, Question 14.02-10. In accordance with the guidance of RG 1.20, the vibration measurement program can be omitted for non-prototype category I reactors if an inspection program is implemented. The DC applicant stated that it will satisfy the commitment for CVAP by implementing an inspection program that provides for inspection of the reactor internals as described in APR1400 DCD Tier 2 Section 3.9. The staff determined that although APR1400 DCD Tier 2 Subsections 14.2.12.1.41, "Internals Vibration Monitoring System Test," 14.2.12.1.42 "Loose Parts Monitoring system," 14.2.12.1.43, "Acoustic Leak Monitoring System Test, and 14.2.12.4.18, "Baseline Nuclear Steam Supply System Integrity Test," include some IVMS test monitoring activities, these tests are not required meet the guidance in RG 1.20. Therefore, RAI 91-7867, Question 14.02-9 and RAI 187-8101, Question 14.02-10 were resolved and closed.

Conclusion

The staff concludes that the information provided in APR1400 DCD Tier 2 Subsection 14.2.7 adequately describes the conformance of KHNP's test programs with NRC regulatory guides, and is therefore acceptable.

14.2.4.8 DCD Tier 2 Subsection 14.2.8, Use of Reactor Operating and Test Experience in the Development of the Initial Test Program

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.8, "Use of Reactor Operating and Testing Experience in the Development of Initial Test Program," the DC applicant discusses the COL applicant's ability to use relevant operating and testing experiences gained from previous successful startups. This section states that the COL applicant is to describe its program for reviewing available information on reactor operating and testing experiences and discusses how it used this information in developing the initial test program.

Evaluation

The staff reviewed conformance of the APR1400 DCD Tier 2 Subsection 14.2.8 to the guidance in SRP Section 14.2.II.3.G, "Utilization of Reactor Operating and Testing Experiences in Development of Test Program," and the general guidelines and applicable regulatory positions in RG 1.68 and RG 1.20.

In the APR1400 DCD Tier 2 Subsection 14.2.8, the DC applicant noted that a COL applicant would have the benefit of experience acquired with the successful and safe startup of the reference plant, Shin-Kori Nuclear Unit 3 (SKN #3) APR1400 plant. The reactor operating and testing experience gained from the reference plant and other reactor types is factored into the design and test system information for plant equipment and systems that are demonstrated during the preoperational and startup test programs.

Upon review of APR1400 DCD Tier 2 Subsection 14.2.8, the staff identified the following areas where additional information is needed. A description of the specific issues identified by the staff is as follows:

In APR1400 DCD Tier 2 Subsection 14.2.8.1, "First-of-a-kind Tests," Revision 0, the DC applicant stated, in part, that:

First-of-a-kind (FOAK) tests are defined as new, unique, or special tests for new design features in plants. The functional testing requirements necessary to verify FOAK test performance should be identified if these design features are used in the APR1400 in the United States. These tests are performed only for the first plant.

The APR1400 is not a first-of-a-kind plant since it is preceded by Shin-Kori Units 3&4 (SKN3&4) in Korea, which are scheduled to begin commercial operation. Therefore, FOAK testing and operational data will be available prior to the APR1400 in the United States.

The staff determined that the first APR1400 plant built in the USA will not be a prototype plant with FOAK tests per the regulations in 10 CFR 50.2, "Prototype Plant," and 10 CFR 50.43(e). However, the staff does not accept the DC applicant's position that the first APR1400 plant built in South Korea is a FOAK plant. As such, the DC applicant cannot take credit for prototype plant test that occurred at SKN #3 in South Korea.

In RAI 91-7867, Question 14.02-7 (ML15201A768), the staff requested that the DC applicant revise the APR1400 DCD Tier 2 Subsection 14.2.8.1 to be consistent with 10 CFR 50.2, 10 CFR 50.43(e), Revision 4 to RG 1.68, Section C.7, "Trial Testing of Plant Emergency, Operating and Surveillance Test Procedures," RG 1.68, Appendix A, Section A-6, "First-of-a-Kind (FOAK) Testing," and Section A-7, "Design Qualification Tests for Advanced Reactors."

In its June 30, 2016, response to RAI 91-7867, Question 14.02-7 (ML16182A597), the DC applicant proposed to revise the APR1400 DCD Tier 2 Subsection 14.2.8.1 by deleting the references to SKN #3 being a prototype plant and to refer to Palo Verde Nuclear Generation Station (PVNGS) Unit 1, as the prototype plant of the APR1400 for the vibration monitoring system and the natural circulation test. The staff reviewed the proposed DCD revision and determined that it is acceptable because PVNGS Unit 1 and the APR1400 design both have the same number of fuel assemblies, enrichment and almost the exact same core thermal power (APR1400 thermal power = 3983 MWt, PVNGS Unit 1 core thermal power = 3990 MWt). In accordance with RG 1.20, the first APR1400 built in the USA will be a non-prototype Category I plant. The APR1400 does not have any FOAK tests. The staff determined that the DC applicant's response and the proposed update to the APR1400 DCD Tier 2 Subsection 14.2.8.1 meets the guidance in RG 1.20 and RG 1.68 for non-prototype plants and it is acceptable. The staff verified that the proposed changes have been incorporated in the APR1400 DCD; therefore, RAI 91-7867, Question 14.02-7 was resolved and closed.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.8 adequately describes the activities related to the review of relevant operating and testing experiences gained from previous successful startups, and is therefore acceptable.

14.2.4.9 DCD Tier 2 Subsection 14.2.9, Trial Use of Plant Operating and Emergency Procedures

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.9, "Trial Use of Plant Operating and Emergency Procedures," the DC applicant described the COL applicant's responsibilities related to development of plant procedures, as well as a description of how, and to what extent, the plant operating, emergency, and surveillance procedures are tested during the initial test program.

Evaluation

The staff reviewed conformance of APR1400 DCD Tier 2 Subsection 14.2.9 to the guidance in SRP Section 14.2.II.3.H, "Trial Use of Plant Operating and Emergency Procedures," and RG 1.68, Section C.7. SRP Section 14.2 indicates that the DC or COL applicant should incorporate, to the extent practicable, plant operating, emergency, and surveillance procedures into the test program, or otherwise verify these procedures through use during the test program. The APR1400 DCD Tier 2 Subsection 14.2.9 indicates that the COL applicant is to provide a schedule for the development of plant procedures, as well as a description of how, and to what extent, the plant operating, emergency, and surveillance procedures are use-tested during the initial test program.

Additionally SRP Section 14.2 indicates the DC or COL applicant should provide additional operator training and participation based on the performance and evaluation of the test results of certain initial tests, and that an acceptable program will satisfy the criteria described in Three Mile Island (TMI) Action Plan Item I.G.1 of NUREG-0660 and NUREG-0737. The staff noted that APR1400 DCD Tier 2 Subsection 14.2.9 states that the COL applicant is to identify the operator training to be conducted as part of the low-power testing program related to the resolution of TMI Action Plan Item I.G.1, as described in: (1) NUREG-0660 – NRC Action Plans Developed as a Result of the TMI-2 Accident, Revision 1, August 1980 and (2) NUREG-0737 – Clarification of TMI Action Plan Requirements. The staff confirmed that the COL applicant's responsibility for identifying the specific operator training to be conducted as part of the low-power testing program related to the resolution of TMI Action Plan Item I.G.1 is captured in COL item 14.2(12) in APR1400 DCD Tier 2 Subsection 14.2.13.

The staff finds that it is acceptable to defer the review of the trial use of operating and emergency procedures to the COL phase, because the development of operating and emergency procedures will depend upon detailed plant-specific design information. The staff also finds that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.9 adequately describes that the schedule for the development of the plant operating and emergency procedures will allow sufficient time for trial use of these procedures during the initial test program as appropriate and to the extent possible, and is thus acceptable. The staff confirmed that the COL applicant's responsibility for the trial use of plant operating and emergency procedures is captured in COL item 14.2(11) in APR1400 DCD Tier 2 Subsection 14.2.13.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.9 adequately addresses the trial use of plant operating and emergency procedures. All issues relating to this section of the initial test program have been resolved.

14.2.4.10 DCD Tier 2 Subsection 14.2.10, Initial Fuel Loading and Initial Criticality

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.10, "Initial Fuel Loading and Initial Criticality," the DC applicant stated that initial fuel loading and initial criticality will be performed in a controlled manner during the startup test program. The minimum initial conditions for the core and the criteria for the safe loading of fuel are specified. Criteria are also specified for a safe and controlled approach to criticality.

Evaluation

The staff reviewed the conformance of the APR1400 DCD Tier 2 Subsection 14.2.10 to the guidance in SRP Section 14.2.II.4.A, "Initial Fuel Loading/Initial Criticality/Low Power /Power Ascension Testing," and RG 1.68, Appendix A, Sections A-2 and A-3. As stated in the regulatory guidance, initial fuel loading and pre-critical tests should: (1) ensure safe initial core loading, (2) ensure that provisions are in place to maintain shutdown margin, and (3) ensure that the facility is in a final state of readiness to achieve criticality and perform low-power testing.

In the APR1400 DCD Tier 2 Subsection 14.2.10, the DC applicant provided five Subsections: 14.2.10.1, "Initial Fuel Loading"; 14.2.10.1.1, "Safe Loading Criteria"; 14.2.10.1.2, "Fuel Loading Procedure"; 14.2.10.2, "Initial Criticality"; and 14.2.10.2.1, "Safe Criticality Criteria," which addressed RG 1.68, Appendix A, Section A-2, and Section A-3.

Initial Fuel Loading

The DC applicant included provisions for initial fuel loading prerequisites. The staff noted that these provisions included Technical Specifications compliance, use of approved plant procedures, proper verification of water level and chemistry, continuous area radiation monitoring, and calibration and response of nuclear instrumentation. The staff verified that the DC applicant identified those prerequisites necessary for safe initial fuel loading in accordance with RG 1.68 and SRP Section 14.2.

The staff finds that the DC applicant provided an adequate description of the prerequisites for initial fuel load, and is thus acceptable.

Safe Loading Criteria

The DC applicant described the criteria that require fuel loading operations to stop, which include if: (1) the neutron count rate from either temporary nuclear channel unexpectedly doubles during any single loading step, and (2) the neutron count rate on any individual nuclear channel increases by a factor of 5 during any single loading step excluding an anticipated change due to detector/source.

The staff finds that the DC applicant provided an adequate description of the safety criteria for halting fuel loading operations, and is thus acceptable

Fuel Loading Procedure

The DC applicant describes the applicable precautions and limitations, prerequisites, initial conditions, and the necessary procedural steps that will be included in the initial fuel loading procedure.

The staff finds that the DC applicant provided an adequate description of the procedural steps for initial fuel load, and is thus acceptable

Initial Criticality

In the APR1400 DCD Tier 2 Subsection 14.2.10, the DC applicant described the controls to be used for controlled approach to criticality. These controls include the use of approved plant procedures, use of an orderly combination of control element assembly withdrawal and boron concentration reduction, and monitoring of the core response. The DC applicant included provisions for initial criticality prerequisites.

The staff finds that the DC applicant provided an adequate description of the controls to be implemented during the initial approach to criticality, and is thus acceptable.

Safe Criticality Criteria

The DC applicant provided the criteria for a safe approach to criticality. The staff noted the criteria included that the Technical Specifications are met, a sustained start up rate not in excess of one decade per minute, and a minimum of one decade per minute overlap is observed between the startup and log safety channels of the ex-core nuclear instruments.

The staff finds that the DC applicant provided an adequate description of the process to provide reasonable assurance of a safe approach to criticality, and is thus acceptable.

Conclusion

The staff concludes that the information provided in APR1400 DCD Tier 2 Subsection 14.2.10 adequately describes the minimum initial conditions for the core and the criteria for the safe loading of fuel and the criteria for providing a safe and controlled approach to criticality, and is thus acceptable. The staff finds that all issues relating to this section of the ITP have been resolved.

14.2.4.11 DCD Tier 2 Subsection 14.2.11, Test Program Schedule

Introduction

In the APR1400 DCD Tier 2 Subsection 14.2.11, the DC applicant stated that the scheduling of individual tests or test sequences will be established so that systems and components that are required to prevent or mitigate the consequences of postulated accidents are tested prior to fuel loading. Tests that require a substantial core power level for proper performance will be performed at the lowest power level commensurate with obtaining acceptable test data. In

addition, the DC applicant stated that the COL applicant is to specify the testing sequence to provide reasonable assurance that safety of the plant is not compromised during the test program and to provide reasonable assurance that the conduct of a specific test does not place the plant in a condition for which untested systems would be relied on for safety.

Evaluation

The staff reviewed conformance of APR1400 DCD Tier 2 Subsection 14.2.11 to the guidance in RG 1.206, Section C.I.14.2.11, "Test Program Schedule"; RG 1.68, Section C.5, "Schedule"; and SRP Section 14.2.II and Subsection 14.2.II.3.C, "Test Program Schedule and Sequence." RG 1.68 states that sufficient time should be scheduled to perform an orderly and comprehensive testing, providing for a minimum time of approximately 9 months for conducting the preoperational testing phase, and a minimum time of approximately 3 months for conducting the initial startup testing phase. In addition, SRP Section 14.2 states, in part, that the safety of the plant should not depend entirely on the performance of untested systems, components, or features.

In the APR1400 DCD Tier 2 Subsection 14.2.11, the DC applicant states that it is the responsibility of the COL applicant to develop a test program that considers the following components:

- The COL applicant should allow at least 9 months for conducting preoperational testing.
- The COL applicant should allow at least 7 months for conducting startup testing, including fuel loading, low-power tests, and power-ascension tests.
- Approved test procedures should be in a form suitable for review by regulatory inspectors at least 60 days prior to their intended use or at least 60 days prior to fuel loading for fuel loading and startup test procedures.

The staff finds that the APR1400 DCD Tier 2 Subsection 14.2.11 included specific direction for the COL applicant to develop a test program that allocates sufficient time to perform orderly and comprehensive testing. The staff confirmed that the COL applicant's responsibility for the test program schedule is captured in COL item 14.2(13) in APR1400 DCD Tier 2 Subsection 14.2.13. In addition, the staff finds that the APR1400 DCD Tier 2 Subsection 14.2.11 is acceptable because it provides that the COL applicant will schedule tests so that systems and components that are required to prevent or mitigate the consequences of postulated accidents are tested prior to fuel loading. Additionally, the APR1400 DCD provides that the COL applicant's test schedule and sequence of testing is to ensure that tests that require a substantial core power level for proper performance will be performed at the lowest power level commensurate with obtaining acceptable test data.

Conclusion

The staff concludes that the information provided in the APR1400 DCD Tier 2 Subsection 14.2.11 adequately describes the test program schedule. All issues relating to this section of the ITP have been resolved.

14.2.4.12 DCD Tier 2 Subsection 14.2.12, Individual Test Descriptions

Introduction

The APR1400 DCD Tier 2 Subsection 14.2.12 contains individual preoperational and startup test abstracts. Each abstract identifies test objectives, prerequisites for conducting testing, test methods, test data requirements, and acceptance criteria for successful completion of the tests. The minimum test requirements are generally based on system or component functional design requirements that were used in the safety analysis. Detailed preoperational and startup test procedures will be developed using these test abstracts.

Evaluation

The staff reviewed conformance of the APR1400 DCD Tier 2 Subsection 14.2.12, "Individual Test Descriptions," to the guidance in SRP Section 14.2.II.5, "Individual Test Descriptions/Abstracts," and the general guidelines and applicable regulatory positions in RG 1.68. RG 1.68, Appendix A addresses the specific tests required for each of the five phases of the initial test program, which are: (1) preoperational testing; (2) initial fuel loading and pre-criticality testing; (3) initial criticality testing; (4) low-power testing; and (5) power ascension testing.

In the APR1400 DCD Tier 2 Subsection 14.2.12 the staff identified 135 preoperational tests, 11 post core load hot functional tests, 6 low power tests, and 26 power ascension tests. For each of the test abstracts, the staff reviewed the test objectives, test prerequisites, test methods, data requirements, and acceptance criteria to verify conformance with NRC regulatory guidance. From the start of the review in March 2015 until October 2015, the staff reviewed these tests and identified the same generic issues with the format and descriptions for all 178 listed tests and a failure to follow the guidance of RG 1.68, Appendix A for SSCs that should be tested.

This resulted in staff issuing a large number of RAI questions (90). Since the issues applied to all of Section 14.2, on October 8, 2015, the staff held a conference call with the DC applicant and requested the DC applicant to revise all of APR1400 DCD Tier 2 Section 14.2. The staff suspended issuing any new RAIs and asked the DC applicant to delay responding to currently issued RAIs until the tests referenced in each RAI question were revised. During the call discussion, the DC applicant provided a sample revision which staff agreed was much improved and followed the guidance of RG 1.68. The DC applicant provided the revised Section 14.2 on February 24, 2016 (ML16056A002). The revised Section 14.2 served as a new starting point, still as APR1400 DCD, Revision 0, for the review.

The revised DCD Tier 2 Subsection 14.2.12 included 139 preoperational tests, 11 post-core hot functional tests, 6 low power physics tests and 26 power ascension tests, 182 tests total. The DC applicant also upgraded each test description with new objectives, prerequisites, test methods, data requirements and acceptance criteria.

In its submittal of APR1400 DCD Tier 2 Section 14.2, Revision 3, the DC applicant revised DCD Tier 2 Subsection 14.2.12 to include 154 preoperational tests, 11 initial fuel loading and post-core hot functional tests, 7 initial criticality and low-power physics tests, and 27 power ascension tests. The staff reviewed the new tests and the upgrades to each test description and determined that the proposed changes to the APR1400 DCD Tier 2 Subsection 14.2.12 meets

the guidance in RG 1.68, Appendix A for the list of APR1400 tests that should be included in the ITP.

For those aspects of the APR1400 DCD Tier 2 Subsection 14.2.12 for which no RAIs were necessary, the staff determined the DC applicant provided an adequate test program to address those specific functions. The staff also verified that the tests are appropriately sequenced so that plant safety is never entirely dependent on the performance of untested SSCs. The staff also determined, using applicable guidance, that the test descriptions: (1) contained appropriate content for the descriptions of test objectives, test prerequisites, test methods, data requirements and acceptance criteria, and (2) were acceptable because they were consistent with the general guidelines and applicable regulatory positions contained in RG 1.68.

For some aspects of the APR1400 DCD Tier 2 Subsection 14.2.12, the staff determined that additional information was required to complete its review. The discussion below first addresses those RAIs that are not specific to an ITP phase. Then the discussion addresses RAIs specific to an ITP phase (pre-operational tests, post-core hot functional tests, low power physics tests, and power ascension tests).

Radiation Protection System

RG 1.68 provides guidance on initial tests that are acceptable to staff as part of the ITP. RG 1.68, Appendix A provides guidance on the types of tests that should be included as part of the ITP. Various radiation-protection-related items that RG 1.68 states should be tested were not addressed in the ITP for the APR1400 design. These included the following:

1. Testing of laboratory equipment used to analyze or measure radiation levels and radioactivity concentrations (see RG 1.68, Appendix A, Section A-1.k item 3).
2. Testing for leakage control and detection for the chemical and volume control system (CVCS) and testing of the gaseous systems for leak detection or equivalent testing (see RG 1.68, Appendix A, Section A-1.l).
3. Testing of components to control the temperature of the steam generator blowdown system (SGBS), as discussed in APR1400 DCD Tier 2 Subsection 10.4.8, to protect the steam generator blowdown resin beds, preventing a sudden loss of resin bed efficiency and the release of radioactivity above established limits and contamination of otherwise clean portions of plant systems (see RG 1.68, Appendix A, Section A-1.k and A-1.m).

In RAI 281-8232, Question 14.02-54 (ML15306A018), the staff requested the DC applicant provide the above tests in the ITP or justify an alternative.

In its June 30, 2016, response to RAI 281-8232, Question 14.02-54 (ML16182A588), the DC applicant provided that the COL applicant is to develop the test program of laboratory equipment used to analyze or measure radiation levels and concentrations. Therefore, the list of COL items in APR1400 DCD Tier 2 Subsection 14.2.13 will be revised to add a requirement that the COL applicant develop the appropriate test program for the subject equipment.

The staff reviewed the proposed change and determined that the COL applicant's responsibility to develop the test program of personnel monitors, radiation survey instruments, and laboratory

equipment is captured in COL item 14.2(16) as requested in RAI 281-8232, Question 14.02-54. The staff also verified that the proposed changes have been incorporated in the APR1400 DCD.

In addition, the DC applicant indicated that testing for leakage control and detection for the CVCS and gaseous rad-waste systems are not necessary, since the accident source term does not enter into these systems as a result of the accident due to containment isolation. The staff determined that the DC applicant's response is acceptable because the CVCS and gaseous rad-waste systems can be isolated during an accident, if necessary. Additionally, the containment isolation valve is tested in DCD Tier 2 Subsection 14.2.12.1.124; thus the staff concluded that the DC applicant's explanation for not performing leak test detection of CVCS and gaseous rad-waste systems is consistent with the testing guidance in RG 1.68, Appendix A, Section A-5, "Power Ascension Tests," Test Item n, for radiation leakage testing, and Test Item z, related to independent laboratory testing.

The staff determined that the DC applicant did not provide an adequate response to the third item requested RAI 281-8232, Question 14.02-54, because the response did not discuss the testing of isolation features of the SGBS based on resin bed temperature and radioactivity.

In RAI 277-8227, Question 14.02-38 (ML15303A462), the staff requested additional information about the objectives of the test, test methods and acceptance criteria for the preoperational testing plan for the SGBS to evaluate the plan in accordance with RG 1.68 Appendix A, Section A-1.k, "Radiation Protection Systems," and Section A-1.m, "Radioactive Waste Handling and Storage Systems."

In its June 30, 2016, response to RAI 277-8227, Question 14.02-38 (ML16182A554), the DC applicant proposed expanding the APR1400 DCD Tier 2 Subsection 14.2.12.1.66 with a new list of test objectives explicitly addressing valve operation, actuation signals, alarms, status lights, and flow path for secondary water processing. The DC applicant also proposed adding a list of acceptance criteria based on the specific design attributes described in APR1400 DCD Tier 2 Subsection 10.4.8, "Steam Generator Blowdown System." In addition, the DC applicant proposed removing the resin regeneration requirement from the test plan since resin regeneration is not an SGBS function. Lastly, the DC applicant proposed to include testing of the SGBS valves used to control the temperature in the resin beds and the potential release of radioactivity.

The staff determined that these changes to the APR1400 DCD Tier 2 Subsection 14.2.12.1.66 are acceptable because the DC applicant updated the preoperational test objectives and acceptance criteria for the SGBS consistent with the guidance in RG 1.68, Appendix A, Section A-1.m related to testing steam generator blowdown. Specifically, APR1400 DCD Tier 2 Subsection 14.2.12.1.66 was updated to include six new SGBS test objectives and test acceptance criteria, including lists of several components (e.g., valves, interlocks, alarms, status lights, ESFAS and DPS response signals, etc.) which are functionally tested. Additionally, the staff determined that testing of the automatic isolation function due to high temperature will be performed consistent with the regulatory guidance in RG 1.68, Appendix A, Section A-1.k, which states that the temperature of the steam generator blowdown system should be monitored to protect resin beds from excessive temperature, which could damage them and result in an unacceptable radioactive release or contamination event. The staff verified that the proposed

changes have been incorporated into the APR1400 DCD. Therefore, RAI 277-8227, Question 14.02-38 and RAI 281-8232, Question 14.02-54 were resolved and closed.

In addition to this, the staff identified a list of systems, components, and features for which the ITP should demonstrate that systems and components used to process, store, and release liquid, gaseous, and solid radioactive wastes are functionally operable and can achieve design flow rates. The staff issued RAI 284-8234, Question 14.02-65 (ML15306A358) requesting this information.

In its June 17, 2016, response to RAI 284-8234, Question 14.02-65 (ML16169A374), the DC applicant proposed revisions to APR1400 DCD Tier 2 Subsections 14.2.12.1.65, 14.2.12.1.66, 14.2.12.1.67, 14.2.12.1.99, 14.2.12.1.104, and 14.2.12.1.105 to address preoperational testing of off-gas monitors; radiation monitors; isolation features for the SGBS, including thermal protection of demineralizer resin beds; automatic isolation features for ventilations systems; ventilation system gaseous effluent radiation release limits; diversion of exhaust flows; gas, liquid and solid rad-waste systems; and waste process systems, including testing of mobile process equipment carrying radioactive fluids.

The staff reviewed the DC applicant's response to RAI 284-8234, Question 14.02-65 and determined that the DC applicant provided the requested information, consistent with the guidance in RG 1.68, with one exception. Namely, the DCD applicant failed to address testing of: (1) the isolation features for the SGBS based on the presence of radioactivity and (2) thermal protection of the demineralizer beds. The APR1400 DCD Tier 2 Subsection 10.4.8 also mentions these two features. However, the testing of these two features was addressed in the DC applicant's June 30, 2016, response to RAI 277-8227, Question 14.02-38 (ML16182A554) in its discussion of the test objectives, methods, and acceptance criteria for the SGBS. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 284-8234, Question 14.02-65 was resolved and closed.

Reactor Coolant Pump Tests

The staff determined that the APR1400 DCD Tier 2 Subsection 14.2.12 did not include sufficient information regarding testing for the reactor coolant pumps (RCPs). In RAI 279-8175, Question 14.02-42 (ML15303A547) the staff requested that the DC applicant discuss testing performed for RCP components, including the pump, motor, and associated power sources. In addition the staff requested the DC applicant to discuss the performance of motor current, motor power, pump motor vibration, motor stator temperature, and proper transfer from variable speed startup preoperational test for the RCPs.

In its June 15, 2016, response to RAI 279-8175, Question 14.02-42 (ML16167A540), the DC applicant stated that the revised Section 14.2 submitted on February 24, 2016 (ML16056A002) provided extensive updates to preoperational, post core hot functional and power ascension tests in APR1400 DCD Tier 2 Subsections 14.2.12.1.1, 14.2.12.1.2, 14.2.12.1.56, 14.2.12.1.136, 14.2.12.1.137, 14.2.12.2.2, and 14.2.12.4-18 for the RCP motors; the RCP Vibration Monitoring System; Pre-Core and Post-Core NSSS Integrity Monitoring; and many other RCS components. The DC applicant also stated that the variable speed startup operation and the over-speed trip function of the RCP motor are not applicable to the APR1400 design. The staff determined that the revisions to the aforementioned test included adequate testing for the motor current, motor power, pump motor vibration, and motor stator temperature, to verify acceptable RCP pump and

motor performance; therefore, the DC applicant's response is acceptable. Based on the above, RAI 279-8175, Question 14.02-42 was resolved and closed.

Additionally, the staff determined that the APR1400 DCD Tier 2 Subsection 14.2.12 did not include sufficient information regarding the important-to-safety functions of the RCPs. In RAI 279-8175, Question 14.02-41 (ML15303A547), the staff requested the DC applicant to provide additional information related to preoperational test methods in APR1400 DCD Tier 2 Subsections 14.2.12.1.2 and/or 14.2.12.1.7 to address important-to-safety functions related to the RCPs.

In its July 12, 2016, response to RAI 279-8175, Question 14.02-41 (ML1619A348), the DC applicant summarized extensive revisions to APR1400 DCD Tier 2 Subsections 14.2.12.1.2, 14.2.12.1.7, 14.2.12.1.43, 14.2.12.1.136, 14.2.12.1.137, 14.2.12.2.2, and 14.2.12.4.18 related to testing RCP seal pressure and temperature; RCP seal injection performance, including RCP seal filters; RCP vapor seals; RCP seal differential pressure alarms; operational checks for CVCS auxiliary charging pumps and discharge check valves; the acoustic lead rate monitoring system; and pre-core and post-core NSSS integrity monitoring, that were included in the revised Section 14.2 submitted on February 24, 2016 (ML16056A002).

The DC applicant also stated that the instrumentation calibration for RCP bearing metal temperature, oil flow and pressure, oil levels, cooling water flow and temperatures are included in prerequisites 2.2 and 2.3 for the RCS test (14.2.12.1.2). The acceptance criteria for performing the initial run of the RCPs (test method 3.4) with RCP bearing metal temperature detectors, oil flow and pressure, oil levels within design limits, and normal operating ranges are included in acceptance criteria 5.11 of the RCS Test (14.2.12.1.2).

The staff determined that the DC applicant's response to RAI 279-8175, Question 14.02-41 was acceptable because it included an adequate description of the test to be implemented for the important-to-safety functions, noted in the paragraph above, in accordance with 10 CFR Part 50, Appendix A, GDC 1. The staff also determined that the DC applicant appropriately updated APR1400 DCD Tier 2 Subsection 14.2.12 with vibration monitoring of the RCP seal shaft and frame as part of the tests described in Subsections 14.2.12.2.2 and 14.2.12.4.18. The staff determined that the DC applicant's response and changes to these tests meet 10 CFR Part 50, Appendix A, GDC 1 and the guidance in RG 1.68 and is, therefore, acceptable. RAI 279-8175, Question 14.02-41 was resolved and closed.

Piping System Tests

The staff was not able to determine whether the DC applicant identified which specific systems are included in the ITP, and whether, as stated in SRP Section 3.9.2, "Dynamic Testing and Analysis of Systems, Structures, and Components," testing is conducted on all American Society of Mechanical Engineer (ASME) Class 1, 2, and 3 piping systems. In RAI 151-8078, Question 03.09.02-3 (ML15234A007), the staff requested the DC applicant to: (1) provide a listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program, and (2) provide the list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position. The staff further requested the APR1400 DCD Tier 2 Section 14.2 be revised to clarify the scope of the ITP.

In its October 7, 2016, response to RAI 151-8078, Question 03.09.02-3 (ML16281A442), the DC applicant stated that the listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program will be at the detailed design phase after the piping physical layout is designed, and will be included in the test procedure, which the COL applicant is responsible for developing. Additionally, the DC applicant stated that the list of snubbers on systems that are subjected to sufficient thermal movements from cold to hot position will be provided at the detailed design phase after the piping analyses and supports design are completed and will also be included in the test procedure, which the COL applicant is responsible for developing. The DC applicant proposed to add a COL item to APR1400 DCD Tier 2 Subsection 14.2.13 and Table 1.8-2 to address the COL applicant developing a test procedure to include a listing of high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program as described in APR1400 DCD Tier 2 Subsection 3.9.2.1. Additionally, the DC applicant proposed to revise Subsection 3.9.2.1 to indicate that the list of snubbers that are subjected to sufficient thermal movements from cold to hot position, will be provided as a part of the test procedure, which is the responsibility of the COL applicant.

The staff finds that it is acceptable to defer the list of high- and moderate-energy piping systems and snubbers to the COL application phase, because the development of the piping physical layout, piping analyses and supports will depend upon detailed plant-specific design information. In addition, the staff confirmed that the COL applicant's responsibility to develop the test procedure including a listing of the high- and moderate-energy piping systems is captured in COL item 14.2(4) in APR1400 DCD Tier 2 Subsection 14.2.13. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 151-8078, Question 03.09.02-3, regarding APR1400 DCD Chapter 14.2 was resolved and closed. Additional concerns regarding piping systems are address in the Chapter 3 SER, Subsection 3.9.2.

Additionally, in RAI 151-8078, Question 03.09.02-4, the staff requested the DC applicant to provide a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under the steady-state and operational transient conditions anticipated during service.

In its response to RAI 151-8078, Question 03.09.02-4 (ML16084A989), the DC applicant stated that a listing of the different flow modes will be provided at the COL applicant's detailed design phase since the flow modes and their results on the piping systems are determined after the piping analyses are completed. The DC applicant proposed to add a COL item to Table 1.8-2 to address the COL applicant developing a test procedure to include a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program as described in APR1400 DCD Tier 2 Subsection 3.9.2.1.

The staff determined that because a listing of the different flow modes will be determined by the COL applicant and is, thus, outside the scope of DC, it is acceptable to defer to the COL applicant for the descriptions of vibration, thermal expansion, and dynamic effects testing as described in the guidance found in RG 1.20 and RG 1.68, Appendix A, Section A-1a, "Reactor Coolant System," and Section A-5, "Power Ascension Tests," Test Item o. The staff confirmed

that the COL applicant's responsibility to develop the test procedure including a listing of the different flow modes is captured in COL item 14.2(5) in APR1400 DCD Tier 2 Subsection 14.2.13. The staff verified that the proposed change has been incorporated into the APR1400 DCD. Therefore, RAI 151-8078 Question 03.09.02-4 was resolved and closed.

Pressurizer Surge Line Tests

NRC Bulletin (BL) 88-11, "Pressurizer Surge Line Stratification Test," and SRP Section 3.12, "ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and Their Associated Supports," discuss the potential for stresses induced by thermal stratification in the pressurizer (PZR) surge line (SL). In particular, BL 88-11 requested the establishment of a program that would monitor the PZR SL for the effects of thermal stratification beginning with hot functional testing (HFT). APR1400 DCD Tier 2 Subsection 3.12.5.10 states the APR1400 conforms with BL 88-11, but the APR1400 DCD did not include the description of a test program to implement monitoring of the PZR SL consistent with BL 88-11 and SRP Sections 3.12 and 14.2 (as was included in other DC applications that have been reviewed and approved by the NRC.) Therefore, in RAI 70-8027, Question 03.12-3 (ML15196A596), the staff requested the following from the DC applicant:

1. According to BL 88-11, thermal stratification occurs in the PZR SL during heat up, cool down and steady state operation of the plant. The staff requested that the DC applicant discuss whether a monitoring or test program is planned to verify the design transients used in the structural design of the SL or how this verification will take place. The staff asked the DC applicant to describe the test program for the PZR SL and its implementation consistent with BL 88-11 and SRP Section 3.12, that will demonstrate that stratification temperature measurements for the APR1400 PZR SL will be within acceptable analyzed limits, that there will not be unanalyzed thermal cycles, and that the piping thermal deflections result in no adverse consequences (such as contacting the pipe whip restraints). In addition, add or provide a technical justification for not including HFT activities in DCD Tier 2, "Initial Plant Test Program," to monitor the PZR SL stratification, which should continue at least during the first cycle of plant operation.
2. Given the PZR SL monitoring is the responsibility of the COL applicant, please discuss in future DCD revisions, the COL applicant responsibilities. Specifically, APR1400 DCD, Table 1.8.2 and Subsections 3.12.7 and 14.2.13 should be updated to identify COL items for PZR SL monitoring.

In its March 23, 2016, response to RAI 70-8027, Question 03.12-03 (ML16083A396), the DC applicant proposed to add APR1400 DCD Tier 2 Subsection 14.2.12.1.140, "Pre-Core Pressurizer Surge Line Stratification Test," which included acceptance criteria 5.1 which states, "Verification that surge line temperatures are within design limits."

The staff reviewed the test objectives, prerequisites, test methods, data required, and acceptance criteria in the proposed test abstract. The staff determined that the DC applicant's response and proposed update to the APR1400 DCD Tier 2 Subsection 14.2.12.1.140 to monitor PZR surge line temperatures meets the testing guidance in NRC BL 88-11 and RG 1.68, Appendix A, Section A-1.j, "Instrumentation and Control Systems"; which requires the implementation of a program to confirm pressurizer surge line integrity. The staff verified that the proposed change has been incorporated into the APR1400 DCD.

Additionally, the staff reviewed the DC applicant's response to RAI 70-8027, Question 03.12.03 and determined that the DC applicant did not add anything to require a power ascension test. The staff determined that the DC applicant should add more information to APR1400 DCD Tier 2 Subsection 14.2.12.4.18, "NSSS Monitoring System Test," to address testing during the first cycle of plant operation (i.e., hot functional and power ascension testing portions of the ITP).

The DC applicant provided a supplemental response in its response to RAI 70-8027, Question 03.12-03 (ML16251A336). The DC applicant proposed to add APR1400 DCD Tier 2 Subsection 14.2.12.4.27, "Fatigue Monitoring System Test," which includes monitoring the fatigue usages for the early identified locations, including the PZR SL, which will experience thermal stratification. The staff determined that this response is acceptable because it satisfies the requirement for the implementation of a program to monitor the effects of thermal stratification on pressurizer surge line integrity in accordance with testing guidance in BL 88-11 and RG 1.68, and it addresses testing during the first cycle of plant operation. The staff verified that the proposed change has been incorporated into the APR1400 DCD.

The DC applicant also stated that the COL applicant's responsibilities for implementing the PZR SL monitoring program are captured in a COL item in APR1400 DCD Tier 2 Subsection 3.12.8. Therefore, RAI 70-8027, Question 03.12-03 regarding APR1400 DCD, Chapter 14.2 was resolved and closed. Additional concerns regarding piping systems and piping supports are addressed in the Chapter 3 SER, Section 3.12.

Incorporation of Operating Experience

The staff determined that certain information necessary for the staff to make a finding in accordance with 10 CFR 52.47(a)(22), that operating experience insights have been incorporated into the design, had not been included in the APR1400 DCD Tier 2 Subsection 14.2.12. In RAI 151-8078, Question 03.09.02-12 (ML15234A007), the staff requested that the DC applicant justify not including a vibration assessment for the shutdown cooling and other emergency core cooling systems (ECCS) lines, given operating experience at the similar PVNGS plant where a flow-excited acoustic resonance was experienced in the shutdown cooling system, resulting in leaking and failure of an isolation valve.

In its October 23, 2015, response to RAI 151-8078, Question 03.09.02-12 (ML15296A568), the DC applicant stated that:

Vibration assessment for the shutdown cooling system lines is not required for the APR1400 based on the operating experience insights from the PVNGS plant and the OPR1000.

Palo Verde Unit 1 experienced extensive outages or periods of low power operation during the first half of 2006 due to excessive vibration levels in the Unit 1 Train A Shutdown Cooling System (SCS) suction line. Arizona Public Service Company (APS) conducted extensive investigations to determine the source of the SCS suction line vibrations and to determine the reasons for the increased vibration levels. APS concluded that the vibration was flow induced and was caused by coupling between an excitation source, vortex shedding in

the SCS suction line tee due to RCS flow over the SCS suction nozzle, and an acoustic resonator. After evaluating many options, APS resolved the problem by moving the SCS suction line isolation valve SI-V651 nearer to the RCS hot leg. The new location of the SCS suction line isolation valve SI-V651 is 11 feet from the RCS nozzle compared to the original location which was approximately 52.5 feet from the nozzle.

The SCS suction line designs of the OPR1000 and APR1400 are similar to the PVNGS plant SCS suction line re-design. Specifically, the SCS suction line diameters (16 inches) and hot leg diameters (42 inches) of the OPR1000 and APR1400 are the same as those of the PVNGS plant. The locations of the SCS suction line isolation valves SI-V651/V652 are 11 feet 4 inches from the RCS nozzle for the OPR1000 and 12 feet 8 inches from the RCS nozzle for the APR1400. All locations are similar to the new location of SI-V651 in the PVNGS plant. In addition, an excessive vibration in the SCS suction line has not been reported in any of the OPR1000 plants. Therefore, based on the design configuration and similar plant operating experience, the possibility of excessive vibration levels in the SCS suction line experienced in the PVNGS plant Unit 1 SCS Train A is very low for the APR1400 and inclusion in the vibration assessment program is not necessary.

The staff determined that the DC applicant included an appropriate basis for not including a vibration assessment in its response based on OPR1400 operating experience and based on similarities between the APR1400 design and the PVNGS re-design, which was intended to address the operating issues previously experienced at PVNGS. Therefore, the DC applicant's response related to operational experience for vibration assessment of the shutdown cooling system and ECCS in similar reactor designs meets 10 CFR 52.47(a)(22). Based on the above, RAI 151-8078, Question 03.09.02-12 was resolved and closed.

Initial Fuel Loading/Inverse Count Ratio Tests

RG 1.68 provides guidance on initial fuel load and initial criticality tests in Appendix A, Section A-2 and Section A-3; and guidance on initial fuel load and initial criticality test procedures in Appendix C, "Preparation of Procedures," Section C-2, "Fuel Loading," and Section C-3, "Initial Criticality Procedures." However, the APR1400 DC application did not include any initial fuel load/initial criticality tests to conform to the guidance in RG 1.68, which specifies the following tests:

- Initial Fuel Loading, to establish prerequisites and conditions for initial fuel loading and procedures to ensure safe loading.
- Inverse Count Ratio or 1/M Plot Test for Fuel Loading, for verification of sub-criticality during fuel loading.
- Initial Criticality, to describe the procedure for achieving initial criticality in a controlled manner.

RAI 524-8697, Question 14.02-69 requested that the DC applicant revise the APR1400 DCD to include tests for initial fuel load/initial criticality.

In its response to RAI 524-8697, Question 14.02-69 (ML17201Q505), the DC applicant proposed the addition of two new tests:

- DCD Tier 2 Subsection 14.2.12.2.1, “Initial Fuel Loading”
- DCD Tier 2 Subsection 14.2.12.3.1, “Initial Criticality”

The DC applicant stated that the inverse count ratio or 1/M plot test does not warrant a separate test since it is a continual process that is implemented during initial fuel load and initial criticality. Therefore, the inverse count ratio or 1/M plot test will be described as part of the initial fuel loading process and as part of the initial criticality process.

The DC applicant also proposed to update APR1400, DCD Tables 14.2-2 and 14.2-3 to incorporate the new tests and titles added to the ITP and update Table 14.2-7 to incorporate initial fuel loading and initial criticality tests.

The staff reviewed the proposed updates to the APR1400 DCD Tier 2 Section 14.2 related to initial fuel loading and initial criticality tests and determined that the proposed changes provide assurance that the facility is in a final state of readiness to achieve initial criticality. Additionally, the proposed changes provide that: (1) design, analytical models, and assumptions used in the safety analyses for the facility are confirmed and (2) operability of plant systems and design features that could not be completely tested during the preoperational test phase are confirmed in accordance with the guidance found in RG 1.68, Appendix A, Subsections A-2, and A-3. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 524-8697, Question 14.02-69, was resolved and closed.

Emergency Response Data System

The staff determined that the APR1400 DCD Tier 2 Section 14.2 did not include sufficient detail regarding testing of the emergency response data system (ERDS). In RAI 281-8232, Question 14.02-49 (ML15306A018), the staff requested the following:

1. Update APR1400 DCD, Chapters 11 and 12 to specify which radiation monitors are responsible for transmitting the ERDS parameters required in 10 CFR Part 50, Appendix E.
2. Include a test in the applicable initial test program to ensure that each of these radiation monitors are accurately transmitting data to the ERDS and the ERDS is accurately providing the correct data.
3. 10 CFR Part 50, Appendix E, Section VI.2.a(i), identifies that reactor coolant radioactivity monitors should be included as monitors that send a signal via ERDS. It was unclear which monitors identified are meeting this function. The staff asked the DC applicant to indicate which monitors are being relied on to perform this function and describe how the monitors provide reactor coolant radioactivity levels. As an alternative, the DC applicant was requested to add a new monitor(s) and describe how reactor coolant radioactivity levels are measured.

In its July 6, 2016, response to RAI 281-8232, Question 14.02-49 (ML16188A428), the DC applicant stated that Subsections 11.5.2.2.e, "Containment air monitors (RE-039A and 040B)," and 11.5.2.2.g, "Condenser vacuum pump vent effluent monitor (RE-063)," were revised to state that the monitors transmit the radiation signals to the ERDS as proposed in the response to RAI 131-8087 Question 11.05-1 via KHNP letter MKD/NW-16-0480L (ML16132A380). In addition the DC applicant proposed to revise Subsection 11.5.2.2.5.m, "Main steam line area and N-16 radiation monitors (RE-217, 218, 219, and 220)," to state that these monitors transmit the radiation signals to the ERDS. The staff verified that the proposed changes to DCD Tier 2 Subsections 11.5.2.2.5.e, 11.5.2.2.5.g, and 11.5.2.2.5.m have been incorporated into the APR1400 DCD.

The staff determined that 10 CFR Part 50, Appendix E, Section VI.2.a(i), indicates that containment radiation level is one of the parameters required to be monitored by the ERDS. Therefore, the containment upper operating area monitors (RE-233A and RE-234B) should be included as monitors that transmit signals to the ERDS because the purpose of RE-233A and RE-234B is to identify containment high range radiation levels during accident conditions, as required by 10 CFR 50.34. Additionally, 10 CFR Part 50, Appendix E, Section VI.2.a(i), indicates that reactor coolant radioactivity monitors should be included as monitors that send a signal via ERDS. It was unclear which of the monitors identified are meeting this function. The staff asked the DC applicant to indicate which monitor is being relied on to perform this function and describe how it is being relied on to provide reactor coolant radioactivity levels.

In its December 9, 2016, revised response to RAI 281-8232, Question 14.02-49 (ML16344A487), the DC applicant proposed to revise Subsections 11.5.2.3.5.h, "CVCS letdown monitor and CVCS gas stripper effluent monitor (RE-204 and 265)," to indicate that the reactor coolant radioactivity monitor located in the letdown line of CVCS (RE-204) transmits a radiation signal to the ERDS. The DC applicant also proposed to revise Subsection 12.3.4.1.5.a, "Safety-related area monitors (RE-231A, 232B, 241A, 242B, 233A, and 234B)," to indicate that the containment upper operating area monitors (RE-233A, RE-234B) transmit radiation signals to the ERDS.

The staff determined that the DC applicant's response was not acceptable. 10 CFR Part 50, Appendix E, Section VI, specifies that numerous radiation monitoring system parameters should be transmitted to the ERDS (and therefore to the NRC). These are reactor coolant, containment, condenser air removal, effluent radiation, and process radiation monitor levels. However, many of the process and effluent radiation monitors discussed in APR1400 DCD Tier 2 Section 11.5 were not listed in the RAI response as sending a signal to ERDS. The staff determined that the RAI response and the APR1400 DCD should be updated to include these monitors as monitors that transmit data via ERDS or the RAI response should be updated to provide justification for why it is acceptable for these process and effluent monitors to not transmit data to ERDS.

In its revised response to RAI 281-8232, Question 14.02-49 (ML7223B357), the DC applicant proposed to update APR1400 DCD, Chapters 11 and 12 to specify that all radiation process and effluent monitors (gaseous and liquid), the containment air monitor, the main control room (MCR) air intake monitors, gaseous radwaste system exhaust monitor, main steam line monitors, and containment upper operating area monitors (RE-233A and RE-234B), transmit radiation signals to the licensing entity via the ERDS. The staff determined that the DC

applicant's response provided that the radiation monitoring system parameters, as required per 10 CFR Part 50, Appendix E, Section VI, will be transmitted to the ERDS.

Additionally, in its July 6, 2016, response to RAI 281-8232, Question 14.02-49 (ML16188A428), the DC applicant stated that the signals from the RMS monitors stated above are sent to the gaseous process effluent radiation monitoring and sampling system (PERMSS). The gaseous PERMSS communicates with the information processing system (IPS) to transmit these parameters to ERDS. The IPS receives these parameters via unidirectional communication and transmits these parameters to the ERDS. The communication test between the gaseous PERMSS and the IPS is performed at the manufacturer's facility during the factory acceptance testing (FAT). The communication test between the IPS and the ERDS is performed at the site during the initial test period. Since the manufacturer for the gaseous PERMSS has not been determined for APR1400, the DC applicant states that the test method for the communication between the gaseous PERMSS and IPS cannot be determined at this time. Therefore, the communication test between the gaseous PERMSS and the ERDS will be performed by the COL applicant. The DC applicant proposed to add a COL item to ensure that the COL applicant will perform the appropriate interface testing of the PERMSS with ERDS.

It was unclear to the staff how tests between the radiation monitors and the plant information processing system will be done at the manufacturer's facility and why this testing does not need to be performed at the reactor site. The staff requested the DC applicant to provide a justification or revise the RAI response, as appropriate.

In its revised response to RAI 281-8232, Question 14.02-49 (ML7223B357), the DC applicant revised the response to specify that since the manufacturers for the RMS have not been determined; the communication test between the radiation monitoring systems (both the PERMSS and ARMS), the information processing system, and the ERDS will be performed by the COL applicant, instead of at the manufacturers facility as the previous revision of the response indicated.

The staff determined that it is acceptable to defer the responsibility for testing the communication between radiation monitors and the plant information processing system to the COL applicant, as the manufacturer for the APR1400 RMS has not yet been determined. The COL applicant's responsibility to perform the appropriate interface testing of the PERMSS and ARMS monitors with ERDS is captured in the proposed COL item 14.2(14). Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 281-8232, Question 14.02-49, was resolved and closed.

Natural Circulation Test (First-of-a-Kind Test)

In APR1400 DCD Tier 2 Subsection 14.2.12.4.22, "Natural Circulation Test (First-of-a-Kind Test)," Revision 0, the DC applicant described the test methodology that would be used for the Natural Circulation FOAK test. The staff requested additional information regarding this FOAK test in RAI 384-8100, Question 05.04.07-3 (ML16032A106) and RAI 528-8709, Question 14.02-70 (ML16319A333). In its response to RAI 384-8100, Question 05.04.07-03 (ML16077A291) and RAI 528-8709, Question 14.2-70 (ML17034A399), the applicant provided acceptable responses to the staff's RAIs.

Subsequently, however, the applicant submitted APR1400 DCD Tier 2 Section 14.2, Revision 1, (ML17096A392), which deleted APR1400 DCD Tier 2 Subsection 14.2.12.4.22, because testing to verify the design heat removal, boron mixing plant cool down/depressurization, and stable natural circulation conditions are maintained was already performed at PVGNS Unit 1, which is the prototype plant for the APR1400 design. RG 1.68 Appendix A, Section A-4, "Low Power Tests," Test Item t, provides that comparison of the plant's reactor coolant system hydraulic data to a reference prototype plant of similar design and configuration is an acceptable means for verification of natural circulation. The DC applicant collected operating experience data from PVGNS Unit 1. Therefore the staff finds the DC applicant's justification for not performing this test on the first APR1400 plant built in the USA is acceptable.

Control Rod Drive System

The staff determined that the DC applicant needed to provide sufficient acceptance criteria to ensure adequacy of the test results in relation to the control rod drive system (CRDS) for the tests described in the APR1400 DCD Tier 2 Subsections 14.2.12.1.27, "Digital Rod Control System," 14.2.12.1.36, "Control Element Drive Mechanism Cooling System Test," 14.2.12.1.54, "Pre-Core Control Element Drive Mechanism Performance Test," and 14.2.12.2.4, "Post-Core Control Element Drive Performance Test." The staff requested this information in RAI 136-8081, Question 04.06-02 (ML15227A013).

Additionally, in RAI 136-8081, Question 04.06-02, the staff asked questions related to DCD Tier 2 Subsection 14.2.12.2.4 regarding measurement of RCS temperature and pressure, examination of insertion and withdrawal times of the control element assemblies (CEAs), and measurement of control element drive assembly (CEDM) coil resistance.

In its September 14, 2015, response (ML15257308), the DC applicant proposed updates to the APR1400 DCD Tier 2 Subsections noted in RAI 136-8081, Question 04.06-02, with clearer and more complete acceptance criteria. The proposed revisions to the APR1400 DCD include: (1) deleting reference to APR1400 DCD Tier 2 Subsections 4.6.1 and 4.6.2 from APR1400 DCD Tier 2 Subsection 14.2.12.1.27 as these subsections do not apply to the preoperational test described in APR1400 DCD Tier 2 Subsection 14.2.12.1.27; (2) adding alarm setpoints and the interlock design of the CEDM cooling subsystem to APR1400 DCD Tier 2 Subsection 9.4.6.2.1.3 and adding indication and alarm of the CEDM cooling subsystem to APR1400 DCD Tier 2 Subsection 9.4.6.5.1; (3) adding the CEDM coil temperature acceptance limit to APR1400 DCD Tier 2 Subsection 14.2.12.1.54; (4) adding CEA withdrawal speed and CEDM coil resistance to the data requirements; and (5) clarifying the acceptance criteria in APR1400 DCD Tier 2 Subsection 14.2.12.2.4 to state that CEA withdrawal speed meets APR1400 DCD Tier 2 Subsection 4.3.1.7. The staff reviewed the DC applicant's response and proposed revision to the APR1400 DCD and determined that the changes to the APR1400 DCD satisfy the guidance found in RG 1.68, Appendix A, Section A-1.b, "Reactivity Control Systems," Section A-2, and Section A-3 because the changes incorporate sufficient acceptance criteria to ensure that the functional design requirements covered by these tests will be verified before startup. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 136-8081, Question 04.06-02 was resolved and closed.

14.2.4.12.1 Preoperational Tests

The following is a list of “Phase I: Preoperational Testing” abstracts described in APR1400 DCD Tier 2 Subsections 14.2.12.1.1 through 14.2.12.1.153:

- 14.2.12.1.1 *Reactor coolant pump motor initial operation test*
- 14.2.12.1.2 *Reactor coolant system test*
- 14.2.12.1.3 *Pressurizer pilot-operated safety relief valve test*
- 14.2.12.1.5 *Chemical and volume control system letdown subsystem test*
- 14.2.12.1.6 *Volume control tank subsystem test*
- 14.2.12.1.7 *Chemical and volume control system charging subsystem test*
- 14.2.12.1.8 *Chemical addition subsystem test*
- 14.2.12.1.9 *Reactor drain tank subsystem test*
- 14.2.12.1.10 *Equipment drain tank subsystem test*
- 14.2.12.1.11 *Boric acid batching tank subsystem test*
- 14.2.12.1.12 *Concentrated boric acid subsystem test*
- 14.2.12.1.13 *Reactor makeup subsystem test*
- 14.2.12.1.14 *Holdup subsystem test*
- 14.2.12.1.15 *Boric acid concentrator subsystem test*
- 14.2.12.1.16 *Gas stripper subsystem test*
- 14.2.12.1.17 *Boronometer subsystem test*
- 14.2.12.1.18 *Process radiation monitor subsystem test*
- 14.2.12.1.19 *Gas stripper effluent radiation monitor subsystem test*
- 14.2.12.1.20 *Shutdown cooling system test*
- 14.2.12.1.21 *Safety injection system test*
- 14.2.12.1.22 *Safety injection tank subsystem test*
- 14.2.12.1.23 *Engineered safety features – component control system test*
- 14.2.12.1.24 *Plant protection system test*
- 14.2.12.1.25 *Ex-core neutron flux monitoring system test*
- 14.2.12.1.26 *Fixed in-core nuclear signal channel test*
- 14.2.12.1.27 *Digital rod control system test*
- 14.1.12.1.28 *Reactor regulating system test*
- 14.2.12.1.29 *Steam bypass control system test*
- 14.2.12.1.30 *Feedwater control system test*
- 14.2.12.1.31 *Core operating limit supervisory system test*
- 14.2.12.1.32 *Reactor power cutback system test*
- 14.2.12.1.33 *Fuel storage and handling system test*
- 14.2.12.1.34 *Auxiliary feedwater system test*
- 14.2.12.1.35 *Reactor coolant system hydrostatic test*
- 14.2.12.1.36 *Control element drive mechanism cooling system test*
- 14.2.12.1.37 *Reactor coolant gas vent system test*
- 14.2.12.1.38 *Containment spray system test*
- 14.2.12.1.39 *Integrated engineered safety features / loss of power test*
- 14.2.12.1.40 *In-containment water storage system test*
- 14.2.12.1.41 *Internals vibration monitoring system test*
- 14.2.12.1.42 *Loose parts monitoring system test*
- 14.2.12.1.43 *Acoustic leak monitoring system test*
- 14.2.12.1.44 *Information processing system and qualified information and alarm system test*
- 14.2.12.1.45 *Turbine generator building open cooling water system test*

14.2.12.1.46 *Pre-core hot functional test controlling document*
 14.2.12.1.47 *Pre-core instrument correlation*
 14.2.12.1.48 *Remote shutdown console test*
 14.2.12.1.49 *Diverse protection system test*
 14.2.12.1.50 *Pre-core test data record*
 14.2.12.1.51 *Pre-core reactor coolant system expansion measurements*
 14.2.12.1.52 *Pre-core reactor coolant and secondary water chemistry data*
 14.2.12.1.53 *Pre-core pressurizer performance test*
 14.2.12.1.54 *Pre-core control element drive mechanism performance test*
 14.2.12.1.55 *Pre-core reactor coolant system flow measurements*
 14.2.12.1.56 *Pre-core reactor coolant system heat loss measurement*
 14.2.12.1.57 *Pre-core reactor coolant system leak rate measurement*
 14.2.12.1.58 *Pre-core chemical volume control system integrated test*
 14.2.12.1.59 *Pre-core safety injection check valve test*
 14.2.12.1.60 *Pre-core boration / dilution measurements*
 14.2.12.1.61 *Downcomer feedwater system water hammer test*
 14.2.12.1.62 *Main turbine systems test*
 14.2.12.1.63 *Main steam safety valve test*
 14.2.12.1.64 *Main steam isolation valves and MSIVBVs test*
 14.2.12.1.65 *Main steam system test*
 14.2.12.1.66 *Steam generator blowdown system test*
 14.2.12.1.67 *Main condenser and condenser vacuum systems test*
 14.2.12.1.68 *Feedwater system test*
 14.2.12.1.69 *Condensate system test*
 14.2.12.1.70 *Turbine steam seal system test*
 14.2.12.1.71 *Circulating water system test*
 14.2.12.1.72 *Steam generator hydrostatic test*
 14.2.12.1.73 *Heater drains system test*
 14.2.12.1.74 *Chilled water system test*
 14.2.12.1.75 *Essential service water system test*
 14.2.12.1.76 *Component cooling water system test*
 14.2.12.1.77 *Spent fuel pool cooling and cleanup system test*
 14.2.12.1.78 *Turbine generator building closed cooling water system test*
 14.2.12.1.79 *Condensate storage system test*
 14.2.12.1.80 *Normal lighting system test*
 14.2.12.1.81 *Emergency lighting system test*
 14.2.12.1.82 *Compressed air system test*
 14.2.12.1.83 *Process sampling system test*
 14.2.12.1.84 *Heat tracing system test*
 14.2.12.1.85 *Fire protection system test*
 14.2.12.1.86 *Emergency diesel generator mechanical system test*
 14.2.12.1.87 *Emergency diesel generator electrical system test*
 14.2.12.1.88 *Emergency diesel engine fuel oil system test*
 14.2.12.1.89 *Alternate AC source system test (mechanical)*
 14.2.12.1.90 *Alternate AC source system test (electrical)*
 14.2.12.1.91 *Containment polar crane test*
 14.2.12.1.92 *Fuel handling area cranes test*
 14.2.12.1.93 *Reactor containment building HVAC system test*
 14.2.12.1.94 *Reactor containment purge HVAC system test*

14.2.12.1.95 *Control room area HVAC system test*
 14.2.12.1.96 *Turbine generator building HVAC system test*
 14.2.12.1.97 *Emergency diesel generator area HVAC system test*
 14.2.12.1.98 *Fuel handling HVAC system test*
 14.2.12.1.99 *Compound building HVAC system test*
 14.2.12.1.100 *Balance of control room HVAC system test*
 14.2.12.1.101 *Hydrogen mitigation system test*
 14.2.12.1.102 *Containment hydrogen recombiner system test*
 14.2.12.1.103 *Liquid waste management system test*
 14.2.12.1.104 *Solid waste management system test*
 14.2.12.1.105 *Gaseous waste management system test*
 14.2.12.1.106 *Process and effluent radiological monitoring system test*
 14.2.12.1.107 *Area radiation monitoring system test*
 14.2.12.1.108 *4,160V Class 1E auxiliary power system test*
 14.2.12.1.109 *480V Class 1E auxiliary power system test*
 14.2.12.1.110 *Unit main power system test*
 14.2.12.1.111 *13,800V non-Class 1E auxiliary power system test*
 14.2.12.1.112 *4,160V non-Class 1E auxiliary power system test*
 14.2.12.1.113 *480V non-Class 1E auxiliary power system test*
 14.2.12.1.114 *Non-Class 1E dc power systems test*
 14.2.12.1.115 *Class 1E dc power systems test*
 14.2.12.1.116 *Offsite power system test*
 14.2.12.1.117 *Balance-of-plant piping thermal expansion measurement test*
 14.2.12.1.118 *Balance-of-plant piping vibration measurement test*
 14.2.12.1.119 *Containment integrated leak rate test and structural integrity test*
 14.2.12.1.120 *Fuel transfer tube functional test and leak test*
 14.2.12.1.121 *Equipment hatch functional test and leak test*
 14.2.12.1.122 *Containment personnel airlock functional test and leak test*
 14.2.12.1.123 *Containment electrical penetration assemblies test*
 14.2.12.1.124 *Containment isolation valves leakage rate test*
 14.2.12.1.125 *Loss of instrument air test*
 14.2.12.1.126 *Mid-loop operations verification test*
 14.2.12.1.127 *Seismic monitoring instrumentation test*
 14.2.12.1.128 *Auxiliary steam system test*
 14.2.12.1.129 *Containment isolation valves test*
 14.2.12.1.130 *Post-accident monitoring instrumentation test*
 14.2.12.1.131 *Electrical and I&C equipment areas HVAC system test*
 14.2.12.1.132 *Auxiliary building controlled area HVAC system test*
 14.2.12.1.133 *Auxiliary building clean area HVAC system test*
 14.2.12.1.134 *Leakage detection system test*
 14.2.12.1.135 *Leakage control and detection of system outside of containment*
 14.2.12.1.136 *RCP vibration monitoring system*
 14.2.12.1.137 *NSSS integrity monitoring system (pre-core)*
 14.2.12.1.138 *Core protection calculator system test*
 14.2.12.1.139 *Diverse indication system test*
 14.2.12.1.140 *Pre-core pressurizer surge line stratification test*
 14.2.12.1.141 *Local of vital equipment*
 14.2.12.1.142 *Access to vital equipment*

- 14.2.12.1.143 *Equipment to permit observation of abnormal presence or activity of persons or vehicles*
- 14.2.12.1.144 *Vehicles barrier system to protect against the design basis threat vehicle bombs*
- 14.2.12.1.145 *Vital areas with active intrusion detection systems*
- 14.2.12.1.146 *Security alarm annunciation and video assessment information*
- 14.2.12.1.147 *Location and equipment of the central and secondary alarm stations*
- 14.2.12.1.148 *Secondary security power supply system*
- 14.2.12.1.149 *Intrusion detection and assessment systems*
- 14.2.12.1.150 *Equipment and emergency exits*
- 14.2.12.1.151 *Security communication systems*
- 14.2.12.1.152 *Bullet-resisting barriers*
- 14.2.12.1.153 *Security alarm devices and transmission lines*

In comparing the APR1400 preoperational tests to the preoperational testing recommended in RG 1.68, Appendix A, Section 1, the staff identified several areas where additional information was required to complete its review, as discussed below.

14.2.12.1.3 Pressurizer Pilot-Operated Safety Relief Valve Test

In RAI 233-8244, Question 05.02.02-5 (ML15296A004), the staff noted that GDC 30 requires the RCS pressure boundary be designed, fabricated, erected and tested to the highest quality standards practical. Application of GDC 30 provides assurance that the RCS pressure boundary will have an extremely low probability of failure due to manufacturing or design defects. The staff requested the DC applicant define the complete pre-service or preoperational test to be performed on the pressurizer pilot operated safety relief valves (POSRVs) and update APR1400 DCD Tier 2 Section 14.2 accordingly.

In its June 30, 2016, response to RAI 233-8244, Question 05.02.02-5 (ML16182A585), the DC applicant proposed to update APR1400 DCD Tier 2 Subsection 14.2.12.1.3, "Pressurizer Pilot-Operated Safety Relief Valve Test," with the following additional test method and data requirement items:

TEST METHOD

- ...
- 3.3 *Determine opening dead times, stroke times and closing times*
- ...

DATA REQUIRED

- ...
- 4.3 *Opening dead times, stroke times and closing times*
- 4.4 *Lead detection temperatures*

The staff determined that the DC applicant's proposed changes provide for adequate testing of the POSRVs' function to ensure integrity of the pressure boundary in accordance with the guidance in RG 1.68. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 233-8244, Question 05.02.02-5 was resolved and closed.

14.2.12.1.7 Chemical and Volume Control System Charging Subsystem Test

The staff identified that a number of non-safety related risk significant SSCs that are important-to-safety, including the Auxiliary Charging Pump (ACP) and the ACP Discharge Check Valve, were not included in the ITP tests. In RAI 278-8226, Question 14.02-40 (ML15303A502), the staff requested the DC applicant to provide test methods and acceptance criteria for all non-safety-related risk significant SSCs that are also considered important to safety and identify these in APR1400 DCD, Table 17.4-1 and include them within the scope of the ITP in APR1400 DCD Tier 2 Section 14.2.

In its June 30, 2016, response to RAI 278-8226, Question 14.02-40 (ML16182A545), the DC applicant identified that ACP and ACP discharge check valve are to be tested as part of the ITP and proposed changes to APR1400 DCD Tier 2 Subsection 14.2.12.1.7, "Chemical and Volume Control System Charging Subsystem Test," to include the test objectives, method, and acceptance criteria for the preoperational tests performed to verify proper operation of the ACP and the flow path to the RCP seals through the ACP discharge check valve.

The staff determined that the proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.7 to include tests for the ACP and ACP discharge valve provide that the important-to-safety components in the CVCS are tested as required by 10 CFR Part 50, Appendix A GDC 1 and in accordance with the guidance in RG 1.68, Section B, "Discussion." The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 278-8226, Question 14.02-40 was resolved and closed.

14.2.12.1.18 Process Radiation Monitor Subsystem Test

In RAI 285-8202, Question 14.02-66 (ML15306A468), the staff requested an explanation for an inconsistency in the acceptance criteria of APR1400 DCD Tier 2 Subsection 14.2.12.1.18, "Process Radiation Monitor Subsystem Test." The acceptance criteria references APR1400 DCD Tier 2 Subsection 9.3.4.5.6, which directs the reader to the Boronmeter topic instead of 9.3.4.5.5.2, "Process Radiation Monitor."

In its May 19, 2016, response to RAI 285-8202, Question 14.02-66 (ML16142A012), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.18, Acceptance Criteria 5.1, to reference the correct APR1400 DCD Tier 2 Subsection 9.3.4.5.5.2. The staff determined the proposed change identifies the correct APR1400 DCD Tier 2 Subsection and is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 285-8282, Question 14.02-66 was resolved and closed.

14.2.12.1.20 Shutdown Cooling System Test; 14.2.12.1.21 Safety Injection System Test

In APR1400 DCD, Chapter 1, Table 1.9.1 and APR1400 DCD Tier 2 Subsection 14.2.7.3, the DC applicant commits to regulatory guidance in RG 1.79, "Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors."

The staff determined that since the DC applicant committed to RG 1.79, more information should be added to APR1400 DCD Tier 2 Subsections 14.2.12.1.20 and 14.2.12.1.21. Specifically, the prerequisite sections should be updated to state that "vent valves should be closed before starting these ECCS pumps" since RG 1.79, "Prerequisite Section C," states that

“vent valves should be closed before starting ECCS pumps.” The staff also determined that additional information was needed on non-condensable gas intrusion into the ECCS. In RAI 91-7867, Question 14.02-3 (ML15201A768), the staff asked for an engineering evaluation for non-condensable gas intrusion into ECCS and prerequisite test checks to verify vent valves are closed before starting the ECCS pumps consistent with the prerequisite section of RG 1.79.

In its August 26, 2016, response to RAI 91-7867, Question 14.02-3 (ML16239A430), the DC applicant provided a detailed summary on how gas accumulation would be managed in the ECCS. The DC applicant’s response included a list of potential pathways for gas intrusion in the APR1400 safety injection system (SIS) and shutdown cooling system (SCS), which make up the ECCS, and SIS and SCS design features to prevent or control gas accumulation to acceptable levels in order to maintain system operability. Thus, the staff finds that the DC applicant has adequately addressed the staff’s concerns regarding non-condensable gas intrusion into the ECCS.

The DC applicant also proposed to update the prerequisite section in APR1400 DCD Tier 2 Subsections 14.2.12.1.20 and 14.2.12.21 to include verification that the SCS and SIS are vented and the vent valves are closed before starting the SIS or SCS. The pre-operational test procedure for the ECCS will describe the criteria for determining the amount of gas that would be considered acceptable rather than including this information in the ITP. The staff determined that this response meets the guidance in RG 1.79, Regulatory Position C and is acceptable. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 91-7867, Question 14.02-3 was resolved and closed.

14.2.12.1.23 Engineered Safety Features – Component Control System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.23 provides a preoperational test for the Engineered Safety Feature – Component Control System (ESF-CCS). In RAI 198-8208, Question 14.02-20 (ML15245A5456), the staff requested additional information regarding the objectives, prerequisites, test methods, and acceptance criteria to determine whether this test meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50.

In its August 17, 2016, response to RAI 198-8208, Question 14.02-20 (ML16230A479), the DC applicant proposed to revise test plans for ESF-CCS to include: the basis for conducting the ESF-CCS test, test objectives for the ESF-CCS, component operation within the ESF-CCS, inter-cabinet interfaces with digital instrumentation and control (I&C) that need to be met, enhanced prerequisites for ESF-CCS components, enhanced test method steps, more detailed tests for ESF-CCS divisions, more detail on ESF actuation signals generated by the Plant Protection System (PPS), more detail on loss-of-offsite power and emergency diesel generator (EDG) sensor inputs to the ESF-CCS, use of the Diverse Protection System (DPS) to generate diverse actuations signals, manual controls for ESF plant components, ESF-CCS transfer controls from the MCR to the Remote Shutdown Room (RSR), and enhanced electrical independence tests for each ESF-CCS division. Additionally the DC applicant proposed to upgrade the acceptance criteria for each ESF-CCS division to align with the corresponding test objective and test method. This was done so that the test acceptance criteria confirm that no unexpected interactions with other safety divisions occur.

Based on the DC applicant’s proposed changes, the staff determined that the initial tests for the ESF-CCS are adequate to verify the as-built and as-installed equipment meet the functional

requirements for the ESF-CCS in conformance with the requirements of Criterion XI of Appendix B to 10 CFR Part 50 and with RG 1.68, Appendix A, Section A-1, "Engineered Safety Features." The staff verified that the proposed changes have been incorporated into the APR1400 DCD. As such, RAI 198-8208, Question 14.02-20 was resolved and closed.

14.2.12.1.24 Plant Protection System Test; 14.2.12.1.138 Core Protection Calculator System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.24, provides the initial test for the PPS. In RAI 198-8208, Question 14.02-21 (ML15254A546), the staff determined that additional information is required regarding the objectives, prerequisites, test methods, and acceptance criteria to determine whether this test meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50.

In its response to RAI 198-8208, Question 14.02-21 (ML16174A465), the DC applicant stated that information requested in RAI 198-8208, Question 14.02-21 was included in the revised APR1400 DCD Tier 2 Section 14.2 submitted on February 24, 2016, (ML16056A002). The DC applicant's response also provided additional clarification on the objectives, prerequisites, test methods, and acceptance criteria that were revised in the APR1400 DCD Tier 2 Section 14.2 submitted in February 2016. The staff reviewed the DC applicant's response and determined that clarification on the following items was needed: (1) the DC applicant's deletion of verification of the interlock functions and demonstration of redundancy, electrical independence, coincidence, and fail safe on loss of power, (2) which test would verify the operation of the Core Protection Calculator System (CPCS), (3) why it would not be practical to complete the response time verification from sensor input to actuated equipment in a single test, (4) verification of the as-installed PPS system, and (5) use of the term "should be" in acceptance criteria as opposed to the term "is." The staff found that except for the requested clarifications, the response was acceptable because the proposed changes provided that testing required to demonstrate that PPS SSCs will perform satisfactorily in service in accordance with Criterion XI, "Test Control," of Appendix B to 10 CFR Part 50. The staff verified that the proposed changes have been incorporated into the APR1400 DCD.

The DC applicant provided a revised response to RAI 198-8208, Question 14.02-21 (ML16270A372). In reviewing the DC applicant's revised response, the staff noted that the DC applicant proposed to: (1) revise the test objectives in APR1400 DCD Tier 2 Subsection 14.2.12.1.24 to include testing of the interlock functions, redundancy, and electrical independence within the PPS and (2) revise the term "should be" to "is" or "are" to provide a more definitive requirement for the as-installed system to meet the acceptance criteria. With the exception of the two issues identified below, the staff determined that the proposed changes satisfied the requirements of Criterion XI of Appendix B to 10 CFR Part 50 because the changes provide that testing is performed to demonstrate that PPS SSCs will perform satisfactorily. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. The two issues identified by the staff are:

- 1) For the CPCS test in 14.2.12.1.138, where are redundancy and independence of the as-installed CPCS verified?
- 2) Item (3)(j) of the RAI response does not address the staff's questions from the previous supplemental response request. Specifically, why can't the design accommodate a

single test to verify response time for each reactor trip (RT) and ESF function? Why is overlap testing required? Per IEEE Std 338-1987, "the response time test should include as much of each safety system, from sensor input to actuated equipment, as is practicable in a single test. Where it is not practical to simultaneously test the entire set of equipment from sensor to actuated equipment in one test, verification of system response time shall be accomplished by measuring the response times of discrete portions of the system and showing that the sum of all the response times is within limits of the overall system requirement." For the response time testing, does the RT trip path include the CPCS?

In its response to RAI 198-8208, Question 14.02-21 (ML16354B588), the DC applicant stated that it doesn't want to do response time testing in a single test because it would be more efficient and beneficial for maintenance purposes to have a modular testing methodology rather than one single test methodology for measuring the system response time.

The staff determined that the DC applicant's response to perform modular testing is an acceptable method to meet Criterion XI of Appendix B to 10 CFR Part 50 and RG 1.68, Appendix A, Section A-1.j because if there are response time delays beyond the expected response time, the DC applicant can determine which portion of the system resulted in the additional delays.

The DC applicant also proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.138 to provide the details relating to the CPCS redundancy and independence testing which meet the guidance of RG 1.68 for the CPCS system. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 198-8208, Question 14.02-21, was resolved and closed.

14.2.12.1.25 Ex-Core Neutron Flux Monitoring System

The APR1400 DCD Tier 2 Subsection 14.2.12.1.25 provides the preoperational test for the Ex-Core Neutron Flux Monitoring System (ENFMS). The staff determined that additional information is required to determine whether this test meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50. Therefore, in RAI 198-8208, Question 14.02-22 (ML15254A546), the staff requested that the DC applicant provide clarification for the objectives, prerequisites, and how electrical independence is verified.

In its response to RAI 198-8208, Question 14.02-22 (ML16334A537), the DC applicant stated that APR1400 DCD Tier 2 Subsection 14.2.12.1.25 will be updated with the following additions: The DC applicant will: (1) add Subsection 7.2.1.1.c to the Acceptance Criteria to verify the functional performance of all channels of the ENFMS and add the completion of the ENFMS FAT as a prerequisite in the test plan, and (2) add an objective, test method and acceptance criteria to verify electrical independence between the safety and non-safety related channels of the ENFMS.

The staff determined the DC applicant's response is acceptable because it provides the appropriate test objectives, prerequisites and electrical independence test requirements needed for adequate testing of the ENFMS. The proposed changes satisfy Criterion XI of Appendix B to 10 CFR Part 50 and are in accordance with the guidance found in RG 1.68, Appendix A,

Section A-1.j. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-22 was resolved and closed.

14.2.12.1.26 Fixed In-Core Nuclear Signal Channel Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.26 describes the initial test for the fixed in-core nuclear instrumentation system. The staff requested additional information to determine whether this test meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50. Therefore, in NRC RAI 198-8208, Question 14.02-23 (ML15254A546), the staff requested that the DC applicant clarify the objectives of the test by providing verification of the proper operation of both the in-core instrumentation and core exit thermocouple (CET) and to add a test prerequisite specifying verification of the location of each in-core detector or justify why it is not needed.

In its response to RAI 198-8208, Question 14.02-23 (ML16182A569), the DC applicant stated:

As the title of FSAR Tier 2, Section 14.2.12.1.26 implies, item 1.2 is to verify the proper amplifier operation inside FIDAS cabinet itself, but does not include the verification of CET (Core Exit Thermocouple) itself, which are addressed in the post-core and power ascension test stages. Instead, as specified in items 1.3 and 1.4 of amended Section 14.2.12.2.26 that was submitted to the staff (ref. KHNP submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003), only the cable continuity and insulation resistance of the interface cables related with CET and in-core detectors is to be verified. In addition, the coverage of verification is clearly specified in item 1.1 and 1.2 of amended Section 14.2.12.2.26.

Additionally, the DC applicant stated the following:

Each in-core instrumentation (ICI) assembly is assembled such that five in-core detectors are located by equal distance from ICI bullet nose with the allowance of +/- 1 inch, which is ensured by the quality control program required by the procurement specification and administered by the vendor at the time of manufacturing. Verifying that the detectors are positioned correctly within the ICI bullet nose assembly is not an attribute that would be performed by the licensee after receipt of the equipment. Unlike in-core detector testing and core performance testing where it is important to assure that the ICI bullet nose is in the proper location within the fuel assembly, the Fixed In-Core Nuclear Signal Channel Test is performed by injecting test signals to ensure proper circuit processing. Based on this justification, it is not necessary to add a prerequisite to specify that the proper location of each in-core detector is to be verified in 14.2.12.1.26.

The staff reviewed the DC applicant's response and determined that it was not clear what the "fixed in-core nuclear signal channel instrumentation" is since this terminology is not used in Chapter 7. DCD Tier 2 Subsection 7.7.1.1.g states, "The signals from the fixed in-core neutron flux detector assemblies are processed by the fixed in-core detector amplifier system (FIDAS) and are sent to the IPS for monitoring and display. The IPS performs the background, beta decay delay, and Rhodium depletion compensation using in-core nuclear instrumentation signal

processing programs.” The staff asked the DC applicant to modify the APR1400 DCD such that both sections of the APR1400 DCD are consistent. Additionally, the staff reviewed APR1400 DCD Tier 2 Subsection 14.2.12.4.16, “In-Core Detector Test,” and determined that the justification for not verifying the proper location of each in-core detectors as a prerequisite was not clear. The staff asked the DC applicant to clarify which test within the ITP would verify the detectors are positioned correctly within the ICI bullet nose assembly.

In its revised response to RAI 198-8208, Question 14.02-23 (ML17082A452), the DC applicant stated that the terminology “Fixed in-core nuclear signal channel instrumentation” in APR1400 DCD Tier 2 Subsection 14.2.12.1.26, Prerequisite 2.2 would be revised to “Fixed in-core nuclear instrumentation signal channel” to be consistent with the terminology in APR1400 DCD Tier 2 Subsection 7.7.1.1.g. Additionally, the DC applicant also clarified why verifying the proper location of each in-core detector is not a prerequisite for APR1400 DCD Tier 2 Subsection 14.2.12.1.26. Specifically, the applicant stated that if a mis-positioning of a detector exists, it can be found during the “In-core Detector Test,” which is described in APR1400 DCD Tier 2 Subsection 14.2.12.4.16. The applicant stated that after the in-core detectors are installed, there is no credible means to check the mis-positioning of the detector before the Power Ascension Test (PAT) stage. During the PAT, mis-positioning of the detector can be found by the “In-core Detector Test” using the neutron flux signals from the in-core detectors. The tests using the power distribution from in-core detector signals (e.g., the Steady State Core Performance Test in APR1400 DCD Tier 2 Subsection 14.2.12.4.10) have a prerequisite for operation of the in-core instrumentation system.

Based on the clarification provided and the identification of other initial tests to verify that in-core detectors are aligned, the staff finds that the verification of proper location of each in-core detector does not need to be a prerequisite for APR1400 DCD Tier 2 Subsection 14.2.12.1.26. The staff determined that the DC applicant’s response related to correct location of the in-core detector meets the guidance in RG 1.68, Appendix A, Section A-1.c, “Reactor Protective System and Engineered Safety Feature Actuation System,” and Appendix C, “Preparation of Procedures.” Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 198-8208, Question 14.02-23, was resolved and closed.

14.2.12.1.28 Reactor Regulating System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.28 describes the preoperational test for the Reactor Regulation System (RRS). In RAI 198-8208, Question 14.02-24 (ML15245A546), the staff requested additional information regarding the prerequisites for the RRS test. Specifically, the staff asked for clarification as to why the RRS test included software installation prerequisites that were not included for all systems that include software.

In its response to RAI 198-8208 Question 14.02-24 (ML16292A856), the DC applicant summarized the following changes to APR1400 DCD Tier 2 Section 14.2:

For the software installation of the Plant Protection System (PPS), the Engineered Safety Features-Component Control System (ESF-CCS), the Fixed In-core Detector Amplification System (FIDAS) and the Reactor Power Cutback System (RPCS), DCD Sections 14.2.12.1.23, 14.2.12.1.24, 14.2.12.1.26 and 14.2.12.1.32 will be revised.

In addition, DCD Section 14.2.12.1 will be revised to add the software installation prerequisite for the following sy[s]tem tests: Boronometer Subsystem (14.2.12.1.17), Process Radiation Monitor Subsystem (14.2.12.1.18), Gas Stripper Effluent Radiation Monitor Subsystem (14.2.12.1.19), Remote Shutdown Console (14.2.12.1.48), Diverse Protection System (DPS) (14.2.12.1.49), Process and Primary Sampling System (14.2.12.1.83), Hydrogen Mitigation System (14.2.12.1.101), Process and Effluent Radiological Monitoring System (14.2.12.1.106), Area Radiation Monitoring System (14.2.12.1.107), Seismic Monitoring Instrumentation System (14.2.12.1.127), Core Protection Calculator System (CPCS) (14.2.12.1.138), and the Diverse Indication System (DIS) (14.2.12.1.139).

The staff determined that the DC applicant's proposal to include software installation as prerequisites for all the systems that contain software meets 10 CFR 52.47(a)(2) for installation of I&C systems and the guidance in RG 1.68, Regulatory Guidance Position C.2, "Prerequisites for Testing," Appendix A, Section A-1.j because the changes ensure that the appropriate prerequisites are met. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.2-24 was resolved and closed.

14.2.12.1.29 Steam Bypass Control System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.29, "Steam Bypass Control System Test," describes the initial test for the Steam Bypass Control System (SBCS). APR1400 DCD Tier 2 Subsection 7.7.1.1.d describes the three signals generated for the two different modes of operation for the SBCS control of the turbine bypass valve, including the modulation mode, the quick opening mode, and a valve permissive signal mode. The staff reviewed the test methods specified in Item 3.0 of this test and could not determine where all the different modes of operation for the turbine bypass valves are tested. In RAI 198-8208, Question 14.02-25 (ML15254A546), the staff requested the DC applicant modify this test to include testing of the SBCS for all the modes described in APR1400 DCD Tier 2 Subsection 7.7.1.1.d.

In its revised response to RAI 198-8208, Question 14.02-25 (ML16174A465), the DC applicant updated the test methods in APR1400 DCD Tier 2 Subsection 14.2.12.1.29 to verify that the SBCS ITP tests the two different modes (the modulation mode and the quick opening mode) and the three types of control signals, i.e. the modulation signal, the quick opening signal, and the valve permissive signal. The staff determined the DC applicant's response meets 10 CFR Part 50, Appendix A, GDC 1 and RG 1.68, Appendix A, Section A-1.j and is acceptable because the changes verify the as-installed SBCS components. The NRC verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-25 was resolved and closed.

14.2.12.1.30 Feedwater Control System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.30 provides the preoperational test for the Feedwater Control System (FWCS). In RAI 198-8028, Question 14.02-26 (ML15254A546), the staff requested the DC applicant to modify this test to include testing for the FWCS during all conditions described in APR1400 DCD Tier 2 Subsection 7.7.1.1.c.

In its response to RAI 198-8208, Question 14.02-26 (ML17004A031), the DC applicant proposed changes to the objectives and acceptance criteria in APR1400 DCD Tier 2 Subsection 14.2.12.1.30, "Feedwater and Auxiliary Feedwater Systems Test" to address the staff's concerns. The DC applicant also explained how the testing of the FWCS across all plant conditions is covered by several tests, identified the test associated with each plant condition, and proposed a change to APR1400 DCD Tier 2 Subsection 14.2.12.4.3, "Control Systems Checkout Test" to clearly describe that a test is performed to verify the flow percentage.

The staff determined that the DC applicant's response and proposed revisions to the APR1400 DCD provide objectives and acceptance criteria that meet 10 CFR Part 50, Appendix A, GDC 1 and the guidance in RG 1.68, Appendix A, Section A-1.j because the proposed revisions demonstrate the operation of the FWCS controls over the design operating range. The staff verified the proposed changes have been incorporated into the DCD. Therefore, RAI 198-8208, Question 14.02-26 was resolved and closed.

14.2.12.1.32 Reactor Power Cutback System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.32 describes the preoperational test for the Reactor Power Cutback System (RPCS). In RAI 198-8208, Question 14.02-27 (ML15254A546), the staff determined that these RPCS functions should be verified in this test and should be identified as test objectives. The corresponding test method and acceptance criteria should support demonstrating how these functions are verified in the ITP. The staff requested that the DC applicant modify APR1400 DCD Tier 2 Subsection 14.2.12.1.32 to include this information.

In its response to RAI 198-8028, Question 14.02-27 (ML16313A591), the DC applicant added objectives and prerequisites to APR1400 DCD Tier 2 Subsection 14.2.12.1.32, "Reactor Power Cutback System Test," and updated the prerequisites in APR1400 DCD Tier 2 Subsection 14.2.12.4.6, "Unit Load Rejection Test," to include assurance that the RPCS functions properly.

The staff determined that these updates to the APR1400 DCD Tier 2 Subsections 14.2.12.1.32 and 14.2.12.4.6 are acceptable because the revised test methods provide adequate assurance that the RPCS functions properly, RPCS functions are captured in the test objectives and the test prerequisites define what must be accomplished before the tests are to be conducted. Therefore, the staff finds that the proposed revisions meet 10 CFR Part 50, Appendix A, GDC 1 and the guidance in RG 1.68 Appendix A, Section A-1.j. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-27 was resolved and closed.

14.2.12.1.33 Fuel Storage and Handling System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.33 provides the preoperational tests for the fuel handling and storage systems. In RAI 181-8011, Question 09.01.04-4 (ML15244B159), the staff asked the DC applicant to justify why the APR1400 DCD did not include a static load test at 125 percent rated load and a dynamic load test at 100 percent rated load for the refueling equipment in accordance with RG 1.68 Section A-1.n.

In its response to RAI 181-8011, Question 09.01.04-4 (ML16006A568), the DC applicant proposed adding the requested testing as Step 3.9.4 in APR1400 DCD Tier 2 Subsection 14.2.12.1.33, "Fuel Handling and Storage System Test." The staff determined that by adding

the rated load tests to the APR1400 DCD, the DC applicant's response meets the guidance in RG 1.68, Appendix A, Section A.-1.n, "Fuel Storage and Handling Systems," and is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 181-8011, Question 09.01.04-4 was resolved and closed.

14.2.12.1.34 Auxiliary Feedwater System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.34 provides the initial test descriptions for the Auxiliary Feedwater System (AFWS). In RAI 198-8208, Question 14.02-28 (ML15254A546), the staff requested that the DC applicant identify the test method item that verifies the AFWS response to manual controls, or alternatively that the DC applicant modify APR1400 DCD Tier 2 Subsection 14.2.12.1.34, "Auxiliary Feedwater System," to include this information.

In its response to RAI 198-8208, Question 14.02-28 (ML16182A548), the DC applicant proposed to upgrade DCD Tier 2 Subsection 14.2.12.1.34 with a revised test plan that included several changes to verify the AFWS response to several different manual, simulated and automatic controls. The staff determined that the AFWS test described in the APR1400 DCD Tier 2 Subsection 14.2.12.1.34 meets the guidance in RG 1.68 Appendix A-1.d. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-28 was resolved and closed.

14.2.12.1.37 Reactor Coolant Gas Vent System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.37 provides the initial test descriptions for the Reactor Coolant Gas Vent System (RCGVS). Revision 0 of DCD Tier 2 Subsection 14.2.12.1.37 also included test descriptions for safety depressurization of the RCS. The staff determined that the acceptance criteria were incomplete and also referenced incorrect DCD design sections. In RAI 175-8034, Question 05.04.12-9 (ML15295A499), the staff requested that the DC applicant correct the erroneous references to the acceptance criteria for the RCGVS.

In its response to RAI 175-8034, Question 05.04.12-9 (ML16125A479), the DC applicant clarified that the APR1400 DCD Tier 2 Subsection 14.2.12.1.37 describes RCGVS testing, whereas the APR1400 DCD Tier 2 Subsection 14.2.12.1.3 describes testing of the safety depressurization of the RCS using the POSRVs. The DC applicant revised the title of APR1400 DCD Tier 2 Subsection 14.2.12.1.37 to "Reactor Coolant Gas Vent System Test" and removed references to the POSRVs in the revised Section 14.2 submitted on February 24, 2016 (ML16056A002). The DC applicant also revised the APR1400 DCD Tier 2 Subsection 14.2.12.1.37 to remove incorrect references to other parts of the APR1400 DCD and include acceptance criteria that clearly relate to the test objectives and methods. The staff determined that the revisions to the preoperational test procedures and their acceptance criteria are adequate to verify RCGVS operation; therefore, the staff determined that the response is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 175-8034, Question 05.04.12-9 was resolved and closed.

14.2.12.1.38 Containment Spray System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.38 provides the initial test descriptions for the Containment Spray System (CSS). The Section 5.0, Acceptance Criteria states:

1.1 The containment spray system and containment spray pumps perform as described in Subsection 6.2.2.2.

The staff determined that the test method as written was too vague to meet 10 CFR Part 50, Appendix A, GDC 40 for the Containment Heat Removal System. Therefore, in RAI 19-7899, Question 14.02-01 (ML15152A518), the staff requested that the test method be revised such that the test acceptance criteria in APR1400 DCD Tier 2 Subsection 14.2.12.1.38 have items in the test methods that: (1) verify spray flow under minimum net positive suction head conditions, and (2) verify that static head as measured from the pumps ensures the design assumptions made in APR1400 DCD Tier 2 Subsection 6.2.2.2 remain valid.

In its response to RAI 19-7899, Question 14.02-1 (ML15183A077), the DC applicant made additions to the test methods in APR1400 DCD Tier 2 Subsection 14.2.12.1.38. The staff determined that the proposed revisions are acceptable because the added test items: (1) clarify the CSS system head requirements (i.e. characteristics such as frictional loss terms) and test acceptance criteria for the entire system, and (2) include the static head of the as-built pumps in the test method to meet the test assumptions for the analyses in Chapter 6 of the APR1400 DCD. Therefore, the staff concludes that the DC applicant meets the containment spray testing guidance in RG 1.68, Appendix A, Section A-1.i, "Integrity of Systems Outside of Containment that Contain Radioactive Material for BWRs and PWRs." The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 19-7899, Question 14.02-1 was resolved and closed.

14.2.12.1.39 Integrated Engineered Safety Features / Loss of Power Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.39 provides the initial test descriptions for the integrated Engineering Safety Features (ESF)/loss of power test. In RAI 198-8208, Question 14.02-29 (ML15254A546), the staff requested the DC applicant demonstrate how the ESF-CCS functions that mitigate loss of power to Class 1E buses are verified. In addition, the staff requested that the DC applicant demonstrate which test method verifies the test objective of demonstrating electrical redundancy, independence, and load group assignment.

In its response to RAI 198-8208, Question 14.02-29 (ML16230A478), the DC applicant proposed changes to the test methods and acceptance criteria in APR1400 DCD Tier 2 Subsection 14.2.12.1.39 to verify ESF-CCS functions, electrical redundancy, independence and load group assignment, and EDG full load capability.

Based on the DC applicant's proposed changes, the staff determined the integrated ESF/loss of power test is adequate to verify the as-built and as-installed equipment to meet RG 1.68, Appendix A, Section A-1.j, and the requirements of Criterion XI of Appendix B to 10 CFR Part 50. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. As such, the staff determined that the issues identified in RAI 198-8208, Question 14.02-29 were resolved and closed.

14.2.12.1.41 Internals Vibration Monitoring Systems Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.41 provides the initial test descriptions for the Internals Vibration Monitoring System (IVMS). In RAI 198-8208, Question 14.02-30

(ML15254A546), the staff requested the DC applicant justify why operation of the ENFMS is not a prerequisite for the IVMS Test.

In its response to RAI 198-8208, Question 14.02-30 (ML16292A856), the DC applicant included the following:

Neutron flux signals from ENFMS are not needed to check the IVMS function for preoperational testing; rather, simulated neutron flux signals are used in accordance with Section 14.2.1.1 which states that simulated signals or inputs are used to demonstrate the full range of the systems that are used during normal operation.

and

The acceptance criterion 5.2 in KHNP submittal MKD/NW-16-0156L for test plan 14.2.12.1.41 states that all 12 channels of ex-core signals are received at the IVMS system as described in the related design specification... In performing the test, the 12 channels of the ex-core simulated signals are generated from signal generators and transmitted by injecting into the Fiber Optic Transmitter (FOT) of the ENFMS and not directly into the IVMS.

The staff determined that the DC applicant response provides adequate justification for why operation of ENFMS is not a prerequisite for the IVMS test and meets the testing guidance for nuclear instrumentation in RG 1.68, Appendix A, Section A-1.j, "Instrumentation and Control"; therefore, it is acceptable. RAI 198-8208, Question 14.02-30 was resolved and closed.

14.2.12.1.48 Remote Shutdown Console Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.48 describes the remote shutdown console test which verifies the capability to shut down the reactor from the remote shutdown console. In RAI 198-8208, Question 14.02-37 (ML15254A546), the staff requested the DC applicant to demonstrate how the manual controls in the MCR are verified in the ITP to meet the requirements of Criterion XI of Appendix B to 10 CFR Part 50.

In its response to RAI 198-8208, Question 14.02-37 (ML16174A465), the DC applicant stated that verifying the manual controls to control safety-related equipment required to shut down the reactor are described in each test description in the APR1400 DCD Tier 2 Subsection 14.2.12. APR1400 DCD Tier 2 Subsection 14.2.1 will be revised to include the description that testing of manual controls for the capability to shut down the reactor will be performed from the MCR for safety-related equipment.

The staff determined that it was not clear where manual controls to control safety-related equipment are verified in this section. For example, it was not clear which test verifies the operation of the diverse manual ESF actuation (DMA). Further, there was no integrated test of the MCR manual controls (similar to the APR1400 DCD Section 14.2.12.48, Objective 1.2, "To determine transfer of control occurs and that the plant can be cooled down from the remote shutdown console") to verify that the plant can be cooled down.

In Revision 1 of the APR1400 DCD Tier 2, Section 14.2.12.1.23, the applicant added Objective 1.8, "To verify the interface of the diverse manual ESF actuation (DMA) switches, for each ESF component with a DMA interface, including correct ESF component response." Based on this

addition, the staff finds that this test is sufficient to meet the guidance of RG 1.68 for verifying the operation of the DMA switches.

After further discussions with the applicant, the staff determined that although the DC applicant will not perform an integrated test of the MCR manual controls, the controls for each system and component are tested from MCR individually as specified in APR1400 DCD Tier 2, Section 14.2.12. In addition, the integrated system design (i.e., hardware, software, procedure and personnel elements) is evaluated in accordance with NUREG-0711, Human Factors Verification and Validation, to verify that the integrated system design supports the safe operation of the plant. NUREG-0711, Section 11.4.3.3 specifies that the simulators which represents the as-built human-system interfaces (HSI) can be used as a testbed for the evaluation of the integrated system design. Thus the staff determined that the DC applicant's proposal meets the requirements of Criterion XI of Appendix B to 10 CFR Part 50; therefore it is acceptable. The staff verified the proposed changes have been incorporated into the DCD. Therefore, RAI 198-8208, Question 14.02-37 was resolved and closed.

14.2.12.1.49 Diverse Protection System Test

In RAI 198-8208, Question 14.02-31 (ML15245A546), the staff requested the DC applicant justify why all the automatic functions performed by the Diverse Protection System (DPS) were not verified in the DPS test described in APR1400 DCD Tier 2 Subsection 14.2.12.1.49. The objective of this test is to verify the proper operation of the DPS. However, the test methods for this test only verified the operation of the reactor trip switchgear system (RTSS) trip circuit breaker and operation of the alternate auxiliary feedwater actuation signals using simulated input signals. It was not clear to the staff whether the simulated signals will be injected into the DPS. The staff requested the DC applicant to clarify this in the test methods description of this subsection. In addition, APR1400 DCD Tier 2 Section 7.8 and the referenced technical reports identified additional automatic safety actuation signals performed by the DPS. The staff requested the DC applicant to justify why these functions are not verified in this preoperational test.

In its response to RAI 198-8208, Question 14.02-31 (ML16173A245), the DC applicant summarized the major DPS automatic actuation signal functions from DCD Tier 2 Subsection 7.8.1.1, such as the generation of reactor trip signal, turbine trip signal, auxiliary feedwater actuation signal (AFAS), and safety injection actuation signal (SIAS), that would be added to APR1400 DCD Tier 2 Subsection 14.2.12.1.49. The DC applicant also determined that additional clarifications pertaining to the DPS signals, in particular the turbine trip signal, and other editorial changes should be made to enhance the ITP.

The staff determined that the proposed revisions to the APR1400 DCD Tier 2 Subsection 14.2.12.1.49 are acceptable to verify the operation of the DPS. However, it was unclear to the staff whether the operation of the diverse indication system (DIS) and diverse manual switches (DMA) were included in this test. The staff requested that the DC applicant submit a supplemental response to clarify if these two items are included in this test or whether other tests covers the operation of these items.

In its revised response to RAI 198-8208, Question 14.02-31 (ML1628A223), the DC applicant clarified that the ITP for the DMA switches is addressed in APR1400 DCD Tier 2 Subsection 14.2.12.1.23 (as shown in the proposed markups in the response to RAI 198-8208, Question

14.02-20 (ML16230A478)). The DC applicant also clarified that the ITP for the DIS is addressed in APR1400 DCD Tier 2 Subsection 14.2.12.1.139 as shown in the revised APR1400 DCD Tier 2 Section 14.2 submitted on February 24, 2016 (ML16056A002). Based on the above clarification and the review of the DIS and DPS ITPs included in the revised APR1400 DCD Tier 2 Section 14.2, which address all of the functions of the DPS; the staff finds that the response meets the guidance in RG 1.68, Appendix A, Section A-1.j and is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-31 was resolved and closed.

14.2.12.1.53 Pre-Core Pressurizer Performance Test

In RAI 198-8208, Question 14.02-32 (ML15254A546), the staff requested the DC applicant demonstrate how the operation of the low-level interlock is verified in the pre-core pressurizer performance test described in APR1400 DCD Tier 2 Subsection 14.2.12.1.53.

In its response to RAI 198-8208, Question 14.02-32 (ML16173A245), the DC applicant stated that:

All interlocks related to the pressurizer pressure and level are verified by decreasing and increasing the pressurizer pressure and level through the pre-core pressurizer performance test as specified in 14.2.12.1.53. Specifically, the pressurizer low-level interlock signal, which is the pressurizer low level heater cutoff signal, turns all pressurizer heaters off. Once pressurizer level drops below the pressurizer low level heater cutoff setpoint (as specified in test method 3.6), verification of the interlock is made by operator actions in attempts to turn all heaters on manually with the pressurizer low-level interlock signal activated. If all the heaters are not able to be turned on at these conditions, the pressurizer low-level interlock signal is considered valid. Additionally, DCD Tier 2 14.2.12.1.53, test method 3.6 will be revised to clarify the specified level for the verification.

The staff determined that the proposed changes to the APR1400 DCD Tier 2 Subsection 14.2.12.1.53 clearly indicate that the pressurizer level should be set below the low-level interlock set point for this test, which allows for the verification of the operation of the low-level interlock. As such, the staff determined that the pre-core pressurizer performance test described in the APR1400 DCD Tier 2 Section 14.2.12.1.53 meets 10 CFR Part 50, Appendix A, GDC 1; Criterion XI of Appendix B to 10 CFR Part 50; and RG 1.68, Appendix A, Section A-1.a and Section A-1.j. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-32 was resolved and closed.

14.2.12.1.54 Pre-Core Control Element Drive Mechanism Performance Test

In RAI 198-8208, Question 14.02-33 (ML15254A546), the staff requested the DC applicant demonstrate how the test objective to verify proper operation and sequencing of the CEDM is accomplished in the pre-core CEDM performance test described in APR1400 DCD Tier 2 Subsection 14.2.12.1.54.

In its response to RAI 198-8208, Question 14.02-33 (ML16173A245), the DC applicant stated that:

During the pre-core Control Element Drive Mechanism (CEDM) performance test in Tier 2, Section 14.2.12.1.54, the functions of the digital rod control system (DRCS) and the CEDM without CEA extension shaft are tested to verify that the CEDM operates in the proper power sequence with four CEDM coils for CEA insertion and withdrawal. In every insertion/withdrawal step operation, the sequence of the CEDM coil power for each CEDM is monitored by the power regulator of the DRCS power cabinets. The test includes a check to ensure that the DRCS trouble alarm is actuated if abnormal CEDM power is sensed or CEDM motion is stopped. The recorded CEDM coil trace is also used to verify that the coil traces for withdrawal and insertion motion occur in the proper sequence. Verification of the proper sequencing will be added to the Acceptance Criteria in the ITP for 14.2.12.1.54.

For the proper operation of the regulating control groups, the out-of-sequence alarm is provided by the NSSS application program of the IPS. The out-of-sequence alarm, which is different than the above mentioned DRCS trouble alarm, is tested in Tier 2, Section 14.2.12.2.4 with the manual individual operation of each individual CEA when the other CEAs are positioned at the bottom of the core. For clarification, the out-of-sequence alarm test will be added to Tier 2, Section 14.2.12.2.4.

The staff evaluated the proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.54 to add proper sequencing of the CEDM as an acceptance criterion and clarify that the direct current voltage across the shunt indicates the CEDM coil power trace and the proposed changes to APR1400 DCD Tier 2 Subsection 14.2.12.2.4 to add an out-of-sequence alarm test. The staff determined that the above proposed revisions provide for verification of proper operation and sequencing of the CEDM. As such, the staff determined that the pre-core CEDM performance test described in DCD Tier 2 Subsection 14.2.12.1.54 is acceptable to verify the as-installed CEDM meets 10 CFR 50, Appendix A, GDC 1 and the guidance in RG 1.68; Appendix A, Section A-1.b. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-33 was resolved and closed.

14.2.12.1.80 Normal Lighting System Test

To establish compliance with 10 CFR Part 50, Appendix A, GDC 17, the staff issued RAI 280-8220, Question 14.02-44 (ML15306A016), which requested the DC applicant to discuss: (1) how the normal lighting system test verifies that required electrical power supplies and control circuits are available or provide adequate justification that it is not needed and (2) confirm that when testing normal lighting systems, other lighting systems will be de-energized in the rooms.

In its response to RAI 280-8220, Question 14.02-44 (ML16198A009), the DC applicant stated that for the normal lighting system test, the power sources for the lighting distribution panels are energized and the circuit breakers for the panels are closed. This testing configuration verifies that required electrical power supplies and control circuits are available. According to the DC applicant, the normal lighting system is not important to safety and the requirements of GDC 17 and GDC 18 do not apply to this system. The emergency alternating current (ac) lighting system (EDG backed) is always turned on and combines with lighting supplied by non-safety power to provide adequate illumination levels that support operation and maintenance activities

during normal plant operation. Therefore, when testing the normal lighting, only the emergency dc lighting fixtures are not turned on. The DC applicant stated that APR1400 DCD Tier 2 Subsection 14.2.12.1.80 will be revised to incorporate these clarifications.

The staff reviewed the DC applicant's response to RAI 280-8220, Question 14.02-44 and the proposed updates to APR1400 DCD Tier 2 Subsection 14.2.12.1.80. The staff determined that the normal lighting test, as described in the paragraph above, meets the guidance for testing normal lighting in RG 1.68, Appendix A, Section A-1.g, "Electrical Systems," because the proposed change verifies that required electrical power supplies and control circuits are available. The staff agrees that the normal lighting system is not important to safety and therefore is not required to meet the requirements of GDC 17 and GDC 18. As such, the staff determined that the DC applicant's response is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 280-8220, Question 14.02-44 was resolved and closed.

14.2.12.1.81 Emergency Lighting System Test

To establish compliance with 10 CFR Part 50, Appendix A, GDC 17 and GDC 18, the staff issued RAI 280-8220, Question 14.02-45 (ML15306A016), which requested that the DC applicant confirm the ability of the emergency lighting system by simulating a loss of the normal lighting and observing that the emergency system automatically activates. The staff also requested that the DC applicant discuss how this test verifies that required electrical power supplies and control circuits are available or provide adequate justification that it is not needed.

In its response to RAI 280-8220, Question 14.02-45 (ML16198A009), the DC applicant stated, in part that:

The ability of emergency dc lighting system is verified by simulating a loss of the normal lighting and observing that the emergency dc lighting system automatically activates. The emergency ac lighting system is always turned on and combines with the normal lighting system to provide[] adequate illumination levels during normal plant operation. Therefore, a loss of the normal lighting system causing an automatic activation is not simulated in the emergency ac lighting system test. For the emergency lighting system test, the power sources for the lighting distribution panels are energized and the circuit breakers for the panels are closed as stated in DCD Tier 2, Subsection 14.2.12.1.81, Emergency Lighting System Test, 2.0 prerequisites. This test configuration verifies that required electrical power supplies and control circuits are available. DCD Tier 2, Subsection 14.2.12.1.81 will be revised to incorporate the clarification above.

The staff determined that DC applicant response to RAI 280-8220, Question 14.02-45 for testing the emergency lighting system, as described in the paragraph above, is adequate because the proposed change verifies that required electrical power supplies and control circuits are available. The staff also determined that the proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.81 meet the testing guidance for emergency lighting in RG 1.68, Appendix A, Section A-1.g and is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 280-8220, Question 14.02-45 was resolved and closed.

14.2.12.1.84 Heat Tracing System Test

In RAI 57-7965, Question 08.03.01-4 (ML15189A490), the staff requested the DC applicant to identify any safety-related mechanical systems protected by Class 1E sources that require heat tracing and freeze protection to maintain process temperatures. The staff requested that if there are any mechanical systems protected by Class 1E sources that need to be heat traced, the DC applicant should justify why non-Class 1E power is used for the heat tracing circuits. The staff also requested that the DC applicant describe equipment associated with the heat tracing/freeze protection system. Finally, APR1400 DCD Tier 2 Subsection 14.2.12.1.84, "Heat Tracing System Test," does not mention verification of redundancy and electrical independence as acceptance criteria for the heat tracing system test. Therefore, the staff requested the DC applicant to describe how the redundancy and electrical independence will be verified for Class 1E equipment/systems during the initial testing phase.

In its response to RAI 57-7965, Question 08.03.01-4 (ML15231A804), the DC applicant stated:

The heat tracing (HT) system mentioned in DCD Tier 2, Subsection 8.3.1.1.7 does not provide heat tracing or freeze protection for any safety-related piping or equipment. Accordingly, Class 1E power is not provided.

Apart from the heat tracing system mentioned above, there are sample lines for containment air monitors in the process and effluent radiological monitoring system (PERMS; refer to DCD Tier 2, Subsection 11.5.2.2), which are equipped with local heat tracing to which Class 1E power is supplied.

The local heat tracing provided as part of PERMS and the heat tracing test for the sample lines will be performed along with other supporting systems of PERMS. Redundancy and electrical independence of the local heat tracing for PERMS will be verified by reviewing the PERMS detailed design before the initial testing phase for PERMS.

In order to clearly identify the local heat tracing test required for PERMS, KHNP will revise DCD Tier 2, Subsection 14.2.12.1.106.

The staff determined that the DC applicant's response to RAI 57-7965, Question 08.03.01-4 and the proposed revision to the APR1400 DCD Tier 2 Subsection 14.2.12.1.106 meets the testing guidance for heat tracing in RG 1.68, Appendix A, Section A-1.o, "Auxiliary and Miscellaneous Systems," in that the proposed testing demonstrates operability and verifies redundancy and electrical independence of the associated systems. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 57-7965, Question 08.03.01-4 was resolved and closed.

14.2.12.1.85 Fire Protection System Test

As part of RAI 140-8139, Question 09.05.01-33 (ML15295A464), the staff requested the DC applicant to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.85 to state that the initial fire protection system testing will be in accordance the criteria in the codes and standards referenced in DCD Tier 2 Subsection 9.5.1.

In its response to RAI 140-8139, Question 09.05.01-33 (ML15247A253), the DC applicant stated:

Tier 2, Subsection 14.2.12.1.85 will be revised to move the seven items listed under Tier 2, Subsection 14.2.12.1.85, "Fire Protection System Test," Item 3.0, "TEST METHOD," to Item 1.0, "OBJECTIVES" and under Item 3.0, "TEST METHOD," ... the following statement will be added: "Demonstrate that the initial fire protection system testing is in accordance with the criteria in the codes and standards referenced in DCD Tier 2, Subsection 9.5.1, 'Fire Protection Program.'"

The staff determined that this RAI response and the proposed update to APR1400 DCD Section 14.2.12.1.1.85 adequately meets the testing guidance for fire protection in RG 1.68, Appendix A, Section A-1.o because it provides a requirement to verify that the initial fire protection system testing is in accordance with the criteria in the codes and standards referenced in APR1400 DCD, Subsection 9.5.1. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 140-8139, Question 09.05.01-33 was resolved and closed.

14.2.12.1.86 Emergency Diesel Generator Mechanical System Test

In RAI 191-8210, Question 14.02-12 (ML15245A786), the staff requested the DC applicant to upgrade the APR1400 DCD Tier 2 Subsection 14.2.12.1.86 to describe how the test verifies EDG and auxiliary system alarms, interlocks, and control functions and describe how the test demonstrates EDG responses consistent with GDC 17 and GDC 18.

In its response to RAI 191-8210, Question 14.02-12 (ML16180A269), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.86 in its entirety.

The staff reviewed the proposed revision to APR1400 DCD Tier 2 Subsection 14.2.12.1.86 and determined that the proposed revision is acceptable because it: (1) provides an adequate level of detail to ensure that the test verifies EDG and auxiliary system alarms, interlocks, and control functions and (2) describes acceptable EDG responses consistent with GDC 17 and GDC 18 by verifying that onsite power systems provide sufficient capacity and capability. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 191-8210, Question 14.02-12 was resolved and closed.

In addition, in RAI 515-8681, Question 14.02-68 (ML16226A022), the staff requested the DC applicant confirm that 25 consecutive tests without failures is 25 start and load tests, in accordance with IEEE Std. 387-1995 and confirm that the load tests are in accordance with IEEE Std. 387-1995, Section 7.2.1.3, "Rated Load Test."

In its response to RAI 515-8681, Question 14.02-68 (ML16281A240), the DC applicant updated DCD Tier 2 Subsection 14.2.12.1.86, to replace "valid tests" with "valid start and load-run tests." The DC applicant also indicated that the rated load test in accordance with IEEE Std. 387-1995, Section 7.2.1.3 will be performed during site acceptance testing and is not applicable to this preoperational test.

The staff determined that the proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.86 meets the guidance in Section 7.3, "Pre-operational testing," of IEEE Std. 387-1995 by requiring a minimum of 25 valid start and load tests without failure on each installed EDG. Additionally, the staff determined that since IEEE Std. 387-1995 does not require rated load tests for preoperational testing, it is acceptable for the rated load tests to be performed during site acceptance testing. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 515-8681, Question 14.02-68 was resolved and closed.

14.2.12.1.87 Emergency Diesel Generator Electrical System Test

APR1400 DCD Tier 2 Subsection 14.2.12.1.87, "Emergency Diesel Generator Electrical System Test," states that the test demonstrates the following: (1) the ability of each EDG to carry the continuous rated load, (2) the ability of each EDG to attain and stabilize frequency and voltage within the rated limits and time, and (3) each EDG starts automatically on ESFAS signal and/or 4.16 kV bus loss of voltage and the EDG rated voltage and frequency has been attained.

IEEE Std. 387-1995, Section 7.5 and Table 3, "Site Testing," prescribe the load tests that are to be performed during pre-operational testing which include: (1) largest load rejection, (2) design load rejection and (3) endurance and load tests. RG 1.9, which endorses IEEE Std. 387-1995, provides guidance for slow-start, load-run, and fast-start pre-operational tests that should be performed in addition to those in IEEE Std. 387-1995. The staff determined that the DC applicant adequately addressed the IEEE Std. 387-1995 load test requirements and the additional preoperational test guidance set forth in RG 1.9. The staff's further evaluation of conformance to RG 1.9 is in Section 8.3.1 of the SER.

In RAI 191-8210, Question 14.02-13 (ML15245A786), the staff requested the DC applicant revise DCD Tier 2 Subsection 14.2.12.1.87, "EDG Electrical System Test," to add the following two items:

- a. Discuss whether this test verifies that EDG alarms, interlocks, and control functions are as designed and if so, how.
- b. Adequate ventilation is necessary for the operation of EDGs. Discuss how adequate ventilation is verified before performing tests of the EDG.

In its response to RAI 191-8210, Question 14.02-13 (ML16180A269), the DC applicant stated that the testing of EDG alarms, interlocks, and control functions is performed in accordance with APR1400 DCD Tier 2 Subsection 14.2.12.1.86. The testing described in APR1400 DCD Tier 2 Subsection 14.2.12.1.87 is performed when the EDG mechanical system test in APR1400 DCD Tier 2 Subsection 14.2.12.1.86 is completed. The DC applicant also revised APR1400 DCD Tier 2 Subsection 14.2.12.1.87 in its entirety to address how the test verifies the EDG electrical system. To address the staff's question with regard to adequate ventilation for the EDG during operation, the DC applicant stated that the testing of the EDG area HVAC is provided in APR1400 DCD Tier 2 Subsection 14.2.12.1.97, "Emergency Diesel Generator Area HVAC System Test."

The staff determined that the DC applicant's response and the proposed revision to the APR1400 DCD Tier 2 Subsection 14.2.12.1.87 is acceptable because it provides adequate

testing requirements for the EDG electrical system and meets the testing guidance in RG 1.68, Appendix A, Section A-1.g. The DC applicant also adequately clarified how other tests address verification of EDG alarms, interlocks, and control functions and adequate EDG ventilation. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 191-8210, Question 14.02-13 was resolved and closed.

14.2.12.1.88 Emergency Diesel Generator Auxiliary Systems Test

In RAI 191-8210, Question 14.02-14 (ML15245A786), the staff requested the DC applicant to address why the EDG intake air and exhaust gas systems' ability to support full load capacity is not included in APR1400 DCD Tier 2 Subsection 14.2.12.1.88 and to discuss how APR1400 DCD Tier 2 Subsection 14.2.12.1.88 verifies that the starting air system is capable of achieving a single EDG start when the receiver is at the minimum receiver design pressure.

In its response to RAI 191-8210, Question 14.02-14 (ML16190A355), the DC applicant stated that all of the EDG auxiliary systems are included in DCD Tier 2 Subsection 14.2.12.1.86, "EDG Mechanical System Test," except for the emergency fuel oil system. To prevent redundancy in testing, the DC applicant added testing of all support systems, including air intake and exhaust, to APR1400 DCD Tier 2 Subsection 14.2.12.1.86 (see RAI 191-8210, Question 14.02-12 (ML16180A629)). The DC applicant also revised APR1400 DCD Tier 2 Subsection 14.2.12.1.88 in its entirety to only contain the test guidance for the emergency diesel fuel oil system. In response to the staff question on the starting air system, the DC applicant stated that APR1400 DCD Tier 2 Subsection 14.2.12.1.86 will demonstrate that each air receiver is capable of providing five cranking cycles without being recharged, and thus capable of achieving EDG successful starts. According to the DC applicant, no further change to APR1400 DCD Tier 2 Subsection 14.2.12.1.88 is necessary.

The staff reviewed the proposed revisions to APR1400 DCD Tier 2 Subsections 14.2.12.1.86 and 14.2.12.1.88 and determined that this response demonstrates that: (1) the EDG intake air and exhaust gas systems' ability to support full load capacity is tested in APR1400 DCD Tier 2 Subsection 14.2.12.1.86; (2) the EDG fuel oil system is tested in APR1400 DCD Tier 2 Subsection 14.2.12.1.88; and (3) APR1400 DCD Tier 2 Subsection 14.2.12.1.86 verifies that the starting air system is capable of achieving a single EDG start when the receiver is at the minimum receiver design pressure. Based on the above, the staff determined that the DC applicant's proposed revisions are acceptable and meet the testing guidance for EDG sub-systems in RG 1.68, Appendix A, Subsection A-1.g, Item 3. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 191-8210, Question 14.02-14 was resolved and closed.

14.2.12.1.89 Alternate AC Source System Test; 14.2.12.1.90 Alternate AC Source Support Systems Test

The staff determined that the APR1400 DCD Tier 2 Subsections 14.2.12.1.89 and 14.2.12.1.90 did not provide sufficient detail to demonstrate that the alternate ac (AAC) gas turbine generator (GTG) can obtain rated voltage and frequency within 2 minutes after the receipt of a starting signal. In RAI 191-8210, Question 14.02-11 (ML15245A786), the staff requested the DC applicant discuss the specific mechanical and electrical trips, indications, alarms, and number of starts required. Furthermore, the DC applicant was asked to discuss:

- a) how adequate ventilation is assessed,
- b) how the continuous rating is verified,
- c) how the time requirements are verified for reaching required voltage and frequency,
- d) how these tests verify that upon a simulated station blackout (SBO) that the GTG starts from standby to energize the buses,
- e) how these tests demonstrate the capability to reject a loss of the largest single load, and
- f) how these tests demonstrate the ability to synchronize the GTG with offsite power while loaded upon a simulated restoration of offsite power.

In its response to RAI 191-8210, Question 14.02-11, (ML16279A508), the DC applicant proposed to revise in its entirety APR1400 DCD Tier 2 Subsections 14.2.12.1.89 and 14.2.12.1.90 to include: (1) assessment of adequate ventilation; (2) verification of continuous rating; (3) verification of time requirements for reaching required voltage and frequency; (4) verification that upon a simulated SBO that the GTG starts from standby to energize the buses; (5) demonstration of the capability to reject a loss of the largest single load; (6) demonstration of the ability to synchronize the GTG with offsite power while loaded upon a simulated restoration of offsite power; (7) demonstration of the adequacy and operation of the fuel systems; (8) demonstration of the operation of the lube oil and cooling systems; and (9) demonstration of the operation of the exhaust/intake system.

The staff determined that the DC applicant's response to RAI 191-8210, Question 14.02-11 and the proposed revisions to APR1400 DCD Tier 2 Subsections 14.2.12.1.89 and 14.2.12.1.90 related to testing the AAC GTG is acceptable because it addresses the specific concerns raised in the RAI and provides sufficient detail to demonstrate that the AAC GTG can obtain rated voltage and frequency within 2 minutes after the receipt of a starting signal. Based on the above, the staff determined that the proposed revisions to the APR1400 DCD Tier 2 Subsections meet 10 CFR Part 50, Appendix A, GDC 17 and 18, and the guidance in RG 1.68, Appendix A, Section A-1.g, Item 3. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 191-8210, Question 14.02-11 was resolved and closed.

In RAI 529-8711, Question 14.02-71 (ML16319A337), the staff requested the DC applicant discuss how the APR1400 DCD Tier 2 Subsection 14.2.12.1.89 demonstrates that the AAC GTG and its supporting systems can be started, controlled, and monitored from the RSR to cope with an SBO.

In its response to RAI 529-8711, Question 14.02-71 (ML17006A395), the DC applicant proposed to add tests for the AAC GTG and the AAC GTG support systems to APR1400 DCD Tier 2 Subsection 14.2.12.1.89 and 14.2.12.1.90. The staff determined that this response meets 10 CFR 50, Appendix A, GDC 17 and 18, and RG 1.68, Appendix A, Section A-1.g, Item 3, "Emergency or Standby AC Power Supplies," because the proposed change provides that testing will be completed to demonstrate that the AAC GTG and supporting systems can be controlled and monitored from the RSR. Based on the review of the DCD, the staff has

confirmed incorporation of the changes described above; therefore, RAI 529-8711, Question 14.02-71, was resolved and closed.

14.2.12.1.99 Compound Building HVAC System Test; 14.2.12.1.132 Auxiliary Building Controlled Area HVAC System Test

In RAI 281-8232, Question 14.02-47 (ML15306A018), the staff requested the DC applicant to update APR1400 DCD Tier 2 Subsections 14.2.12.1.99, "Compound Building HVAC [Heating, Ventilation and Air Conditioning] System Test," and 14.2.12.1.132, "Auxiliary Building Controlled Area HVAC System Test," to provide for testing to verify the airflow rate acceptance criteria provided in APR1400 DCD, Table 12.2-26. The HVAC system airflow rates provided in this table are airflow rates relied upon to provide reasonable assurance that airborne concentrations remain below derived airborne concentration (DAC) limits.

In its response to RAI 281-8232, Question 14.02-47 (ML16167A537), the DC applicant proposed to add acceptance criteria to APR1400 DCD Tier 2 Subsections 14.2.12.1.99 and 14.2.12.1.132, to ensure that the ITP provides for testing of the Compound Building HVAC system and the Auxiliary Building controlled area HVAC system to maintain exhaust airflow rates from the radiologically controlled rooms at a minimum to the HVAC flows in APR1400 DCD, Table 12.2-26.

The staff determined that the DC applicant's response to RAI 281-8232, Question 14.02-47 and the proposed revision to APR1400 DCD Tier 2 Subsections 14.2.12.1.99 and 14.2.12.1.132 meets the testing guidance in RG 1.68, Appendix A, Section A-1.m because the proposed acceptance criteria verify minimum exhaust airflow rates from these radiologically controlled rooms in accordance with APR1400 DCD, Table 12.2-26 and therefore, is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 281-8232, Question 14.02-47 was resolved and closed.

14.2.12.1.103 Liquid Waste Management System Test; 14.2.12.1.105 Gaseous Waste Management System Test

In RAI 283-8229, Question 14.02-62 (ML15306A269), the staff requested the DC applicant to address why APR1400 DCD Tier 2 Subsections 14.2.12.1.103 and 14.2.12.1.105 did not identify specific test methods or acceptance criteria for SSCs that are non-safety related but risk significant. The staff also requested the following information:

1. Provide a description of what key SSCs would be identified by the Expert Panel for index numbers 184 and 375.
2. Provide a description of the testing method to verify the operation of the Gaseous Radwaste System - Containment Isolation Valve in Subsection 14.2.12.1.105 or wherever applicable.
3. Provide a description of the testing method to verify the operation of 'key SSCs' in the Gaseous Waste Management System in 14.2.12.1.105 or wherever applicable.

4. Provide a description of the testing method to verify the operation of 'key SSCs' in the Liquid Waste Management System in Subsection 14.2.12.1.103 or wherever applicable.
5. Please address these items and provide a markup for the proposed DCD changes.

In its response to RAI 283-8229, Question 14.02-62 (ML16300A432), the DC applicant provided the following:

1. *The Expert Panel considered PRA importance and deterministic method to identify the Key SSCs. The gaseous waste management system (GWMS - 184) and the liquid waste management system (LWMS - 375) were identified by deterministic consideration. These systems are those that are designed to maintain radwaste materials contained within the system boundary to prevent spreading of radwaste materials outside of the defined boundary. As shown in Table 17.4-1, the specific SSCs identified by the Expert Panel for GWMS and LWMS included only the containment isolation valves (Level 2) because GWMS and LWMS are not credited in the PRA model except for the containment isolation valves.*
- 2~4. *As a result of the upgrade effort described in the original response (ref. KHNP submittal MKD/NW-16-0156L "Submittal of Revised DCD Section 14.2 Initial Plant Test Program" dated February 24, 2016; ML16056A003), the contents of Section 14.2.12.1.103 and 14.2.12.1.105 of DCD Tier 2 has been generally enhanced. The preoperational test for liquid and gaseous waste management system has also included the description for testing of the key system control, alarms and indications in accordance with RG 1.68 as required by sub-questions 2 through 4 of this RAI. The revised Sections 14.2.12.1.103 and 14.2.12.1.105 including previous markups are provided in the Attachment for clarity.*

Since the test for the containment isolation valve operation of gaseous radwaste system will be performed in accordance with Section 14.2.12.1.129, Section 14.2.12.1.105 will be revised as indicated in Attachment to this response. Section 14.2.12.1.129 was previously revised to address the CIV, (also submitted by MKD/NW-16-0156L), and is provided in the Attachment for information.

The staff determined that the DC applicant's response and the proposed revisions to APR1400 DCD Tier 2 Subsections 14.2.12.1.103 and 14.2.12.1.105 are acceptable because they: (1) adequately identify the non-safety but risk significant SSCs in the gaseous waste management system (GWMS) and liquid waste management system (LWMS) for the reasons stated by the DC applicant, and (2) provide sufficient test methods and acceptance criteria for SSCs that are non-safety but risk significant. Based on the above, the staff determined that the proposed revisions are acceptable and meet the LWMS and GWMS testing guidance in RG 1.68, Section A-1.m. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 283-8229, Question 14.02-62 was resolved and closed.

Additionally, the staff determined that the test method and acceptance criteria in APR1400 DCD Tier 2 Subsection 14.2.12.1.103 for the LWMS was not fully described. In RAI 194-8172, Question 14.02-17 (ML15246A077), the staff requested the DC applicant to provide verification of manual and automatic response to normal control, alarms, and indication in the acceptance criteria of APR1400 DCD Tier 2 Subsection 14.2.12.1.103.

In its response to RAI 194-8172, Question 14.02-17 (ML16268A001), the DC applicant stated, in part, that:

The LWMS test objectives have been expanded from one general objective to four, more detailed objectives and eight new acceptance criteria have been incorporated. Among various items included in the revised test plan is verification of manual and automatic system controls on key system alarms including high-level alarms associated with liquid tanks and other alarms such as radiation monitor and dual isolation valves, and includes those associated with the Detergent Waste Tank.

If a release from the Detergent Waste Tank exceeds the predetermined setpoint, an alarm is initiated, the discharge valve closes automatically, and the operator manually turns off the detergent waste pump and diverts the flow to the chemical waste tank. Though Section 14.2.12.1.103 does not specifically reference the Detergent Waste Tank liquid effluent release, it is part of the Liquid Waste Management System and is included in the test plan. The test plan is written to test all of the components in the system, including the associated Detergent Waste Tank components. Objectives 1.1, 1.2, and 1.3, Test Methods 3.1, 3.3, 3.5, and 3.6, and Acceptance Criteria 5.2, 5.5, 5.6 and 5.7 were written in general terms and also encompasses the process to adequately test the Detergent Waste Tank portion of the system.

The staff reviewed the DC applicant response and proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.103 and determined that it meets the guidance for testing the LWMS in RG 1.68, Appendix A, Section A.1.m because the changes provide an acceptable test method and acceptance criteria for the LWMS, including the Detergent Waste Tank. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 194-8172, Question 14.02-17 was resolved and closed.

The staff concluded that the test method provided in APR1400 DCD Tier 2 Subsection 14.2.12.1.103 for testing the features of the LWMS did not test the system as a whole as it did not functionally test the radiation detector. In RAI 283-8229, Question 14.02-63 (ML15306A269), the staff requested the DC applicant to address the use of a radiation source in testing the system features, control alarms, indicating instrumentation, and status lights are functional for the LWMS.

In its response to RAI 283-8229, Question 14.02-63 (ML16279A542), the DC applicant provided the following:

Since the LWMS discharge radiation monitor is considered as a part of the Process and Effluent Radiological Monitoring System (PERMS), the test for the radiation monitor, including the functionality of the detector, alarms, status lights,

etc., will be performed in accordance with Section 14.2.12.1.106. The DCD Section 14.2.12.1.103 pertains to the verification that the LWMS discharge valve closes and pump operation stops upon receipt of a high radiation signal from the radiation monitors. One of the changes proposed in the referenced upgrade of 14.2.12.1.103 was to include a reference to Section 14.2.12.1.106 in the ITP related to the test method of the radiation monitor.

A radiation check source cannot be used to verify the monitor alarm setpoint and radiation level indication. Verification of the alarm setpoint and radiation level indication will normally be accomplished periodically using an appropriate calibration source. A simulated radiation signal will be used to replicate the radiation level required to test the BOP ESFAS signals and RMS alarm functionality. Since the LWMS radiation monitors are tested with a radiation check source as part of an ITAAC, they do not need to be re-tested with a radiation check source as part of the ITP. DCD Tier 2, Subsection 14.2.12.1.106 will be revised to consistently refer to a simulated signal that is to be used for the testing of the radiation monitors.

The staff originally determined that LWMS radiation monitors should be tested with a radiation check source under both the ITAAC and the ITP preoperational test; therefore, this test would be performed and counted once under both the ITAAC and the ITP preoperational test. However, after further discussion with the DC applicant, the staff determined that it was acceptable to use a simulated source during preoperational testing as long as the LWMS radiation monitors are tested with a radiation check source prior to fuel load. The staff determined that since the LWMS radiation monitors are tested with a radiation check source as part of an ITAAC, RAI 283-8229, Question 14.02-63, was resolved and closed. The staff verified that the proposed changes have been incorporated into the APR1400 DCD.

14.2.12.1.104 Solid Waste Management System Test

In RAI 193-8181, Question 14.02-16, the staff requested the DC applicant to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.104 acceptance criteria to include verification of manual and automatic response to normal control, alarms, and indications for the solid waste management system (SWMS).

In its response to RAI 193-8181, Question 14.02-16 (ML16168A467), the DC applicant proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.104 to add a cross reference to DCD Table 11.4-6 where the following indications from the Rad-Waste Storage Room were added to the test:

1. *Tank level, tank pressure, and demineralized water inlet flow rate of the Low-Activity Spent Resin Bed.*
2. *Tank level of the Spent Resin Long-Term Storage Tank.*
3. *High alarms for tank level of the Low-Activity Spent Resin Tank and Spent Resin Long-Term Storage Tank.*

The staff determined that the proposed revision to APR1400 DCD Tier 2 Subsection 14.2.12.1.104 is acceptable because it provides acceptance criteria for the verification of

manual and automatic response to normal control, alarms and indications for the SWMS. Based on the above, the staff determined that the proposed DCD revision meets RG 1.68, Appendix A, Section A-1.m. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 193-8181, Question 14.02-16 was resolved and closed.

14.2.12.1.105 Gaseous Waste Management System Test

The staff concluded that the test method provided in APR1400 DCD Tier 2 Subsection 14.2.12.1.105 for testing the features of the GWMS did not test the system as a whole as it did not functionally test the radiation detector. In RAI 283-8229, Question 14.02-64 (ML15306A269), the staff requested the DC applicant to address the use of a radiation source in testing the system features, controls alarms, indicating instrumentation, and status lights for the GWMS to verify that they are functional.

In its response to RAI 283-8229, Question 14.02-64 (ML16279A542), the DC applicant stated:

Since the GRS [Gaseous Radiation System] discharge radiation monitor is considered a part of the Process and Effluent Radiological Monitoring System (PERMS), the test for the radiation monitor, including the functionality of the detector, alarms, status lights, etc., will be performed in accordance with Section 14.2.12.1.106. DCD Section 14.2.12.1.105 pertains to the verification that the GRS discharge valve closes upon receipt of a high radiation signal from the radiation monitors. One of the changes proposed in the referenced upgrade of 14.2.12.1.105 was to include a reference to Section 14.2.12.1.106 in the ITP related to the test method of the radiation monitor.

A radiation check source cannot be used to verify the monitor alarm setpoint and radiation level indication. Verification of the alarm setpoint and radiation level indication will normally be accomplished periodically using an appropriate calibration source. A simulated radiation signal will be used to replicate the radiation level required to test the BOP ESFAS signals and RMS alarm functionality. Since the GRS radiation monitors are tested with a radiation check source as part of an ITAAC, they do not need to be re-tested with a radiation check source as part of the ITP.

The staff originally determined that GRS radiation monitors should be tested with a radiation check source under both the ITAAC and the ITP preoperational test; therefore, this test would be performed and counted once under both the ITAAC and the ITP preoperational test. However, after further discussion with the DC applicant, the staff determined that it was acceptable to use a simulated source during preoperational testing as long as the GRS radiation monitors are tested with a radiation check source prior to fuel load. The staff determined that since the GRS radiation monitors are tested with a radiation check source as part of an ITAAC, RAI 283-8229, Question 14.02-64, was resolved and closed. The staff verified that the proposed changes have been incorporated into the APR1400 DCD.

In RAI 192-8180, Question 14.02-15, the staff requested the DC applicant revise the APR1400 DCD Tier 2 Subsection 14.2.12.1.105 to include verification of manual and automatic response to normal control, alarms, and indications.

In its response to RAI 192-8180, Question 14.02-15 (ML160098A297), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.105 to include: (1) verification of automatic valve operation upon the receipt of a high-high oxygen concentration signal and a high radiation signal, and (2) an additional test objective to correspond with the upgraded test method and acceptance criteria provided in the February 24, 2016, revision of APR1400 DCD Tier 2 Section 14.2 (ML16056A002). Additionally the DC applicant's response stated that the verification for radiation and oxygen concentration alarm actuation, including associated monitoring, is conducted with the Process and Effluent Radiological Monitoring System, as described in Subsection 14.2.12.1.106, and the Process and Primary Sampling System, as described in Subsection 14.2.12.1.83, respectively. However, the staff determined that the April 7, 2016, response to RAI 192-8180, Question 14.02-15 (ML16098A297), did not include information regarding the test methodologies, prerequisites and acceptance criteria for the various components that are a part of the GWMS.

In its revised response RAI 192-8180, Question 14.02-15 (ML17167A249), the DC applicant proposed to revise the test method for the GWMS to: (1) verify the operation of the GWMS equipment as described in APR1400 DCD Tier 2 Section 11.3; (2) verify automatic valve operation upon the receipt of a low flow signal from the Gaseous Radwaste System (GRS) discharge line; (3) verify automatic valve operation upon the receipt of low-low ACU (Air Cleaning Unit) exhaust flow signal; and (4) verify automatic drain valve operation upon the receipt of low and high GRS header drain tank level. In addition, the DC applicant proposed to revise the associated acceptance criteria to reflect the aforementioned revisions to the test method.

The staff determined that the proposed revisions provide for verification of manual and automatic response to normal control, alarms, and indications as it relates to monitoring and complying with the effluent concentration limits specified in Appendix I of 10 CFR Part 50. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 192-8180, Question 14.02-15, was resolved and closed.

14.2.12.1.106 Process and Effluent Radiological Monitoring System Test; 14.2.12.1.107 Area Radiation Monitoring System Test

The APR1400 DCD Tier 2 Subsections 14.2.12.1.106 and 14.2.12.1.107 indicate that simulated signals will be used to test control actions and alarms, instead of using a calibration source. In RAI 281-8232, Question 14.02-50 (ML15306A018), the staff requested the DC applicant to:

1. Revise the ITP in order to test the functionality of the radiation monitor computer system in order to ensure that radiation levels, alarms, and control actions are properly being communicated between the radiation monitors, the monitor computer system, the main control room, and any applicable system actuation with a radiation calibration source, or justify why the use of simulated signals is acceptable.
2. Update APR1400 DCD Tier 2 Subsections 14.2.12.1.106 and 14.2.12.1.107, to test the control functions or alarms associated with high radiation levels with a radiation calibration source, or justify why the use of simulated signals is acceptable.

In its response to RAI 281-8232, Question 14.02-50 (ML16167A537), the DC applicant stated, in part that:

1. *The advantage of using a simulated test signal is the ability to adjust the signal level to check various actuation setpoints such as alarm setpoints and interlock setpoints. This adjustability is not readily available with a radioactive check source, which generally provides just a fixed level and for this reason, section 14.2.12.1.106 and 107 describe tests using a simulated test signal. The functionality check of the system using the simulated test signal is more suitable for the intended test. In conjunction with the use of a simulated signal for verification of the setpoint for the alarm and radiation level, the calibration source is used to verify the calibration/drift of the detector sensor during the periodic surveillance functional test period of the radiation monitor.*
2. *In accordance with the discussion provided in (1) above, the use of a simulated test signal is suitable for the intended test.*

The staff's review of the DC applicant's response to RAI 281-8232, Question 14.02-50, concluded that all radiation monitors should be tested with a radiation check source. The staff determined that the above response is not acceptable and the DC applicant should consider revising its response to use a radiation check source to verify that radiation monitors are functional under the ITP to meet the testing guidance in RG 1.68, Appendix A, Section A-1.k.

In its response RAI 281-8232, Question 14.02-50 (ML17212B046) the DC applicant specified that as part of the ITAAC, each channel of the PERMSS and ARMS will be tested with a radiation check source to ensure the radiation detectors adequately respond to radiation. Additionally, the DC applicant stated that the radiation monitors will also be calibrated periodically during operation as part of the radiation protection program.

The staff originally determined that each channel of the PERMSS and ARMS should be tested with a radiation check source under both the ITAAC and the ITP preoperational test; therefore, this test would be performed and counted once under both the ITAAC and the ITP preoperational test. However, after further discussion with the DC applicant, the staff determined that it was acceptable to use a simulated source during preoperational testing as long as each channel of the PERMSS and ARMS are tested with a radiation check source prior to fuel load. The staff determined that since each channel of the PERMSS and ARMS are tested with a radiation check source as part of an ITAAC, the DC applicant's response is acceptable and RAI 281-8232, Question 14.02-50, was resolved and closed.

In RAI 195-8182, Question 14.02-18 (ML152534A346), the staff requested the DC applicant to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.106 to include verification of manual and automatic response to normal control, alarms, and indications for the PERMSS.

In its response to RAI 195-8182, Question 14.02-18, the DC applicant proposed to expand the description in the acceptance criteria for the PERMSS to address the system's monitoring and signal generation when the radiation level detected exceeds the preset levels in accordance with the system design criteria and description in APR1400 DCD Tier 2 Section 11.5. The staff determined that the proposed response provides that verification of radiation monitor and

isolation valves to monitor and control effluent discharge to the environment are addressed as required by 10 CFR Part 50, Appendix I. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 195-8182, Question 14.02-18, was resolved and closed.

In RAI 281-8232, Question 14.02-46 (ML15306A018), the staff requested the DC applicant include preoperational testing of the area radiation monitors or provide justification why it is unnecessary.

In its response to RAI 281-8232, Question 14.02-46 (ML16182A588), the DC applicant indicated that the airborne radiation monitors are part of the process and effluent radiological monitors (airborne monitors) that are tested in APR1400 DCD Tier 2 Subsection 14.2.12.1.106. The DC applicant revised the title of test in APR1400 DCD Tier 2 Subsection 14.2.12.1.107 in Table 14.2-1, to delete the airborne monitors and specify testing of the area radiation monitoring system.

The staff determined that the DC applicant's response to RAI 281-8232, Question 14.02-46 and the proposed revision to Table 14.2-1 clarifies that testing of the area radiation monitors will be performed in accordance with the guidance in RG 1.68, Appendix A, Section A-1.m, to demonstrate operability of these radiation monitoring systems and therefore, is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 281-8232, Question 14.02-46 was resolved and closed.

14.2.12.1.108 4,160 V Class 1E Auxiliary Power System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.108 stated that the preoperational test will verify the 4,160 V and 480 V safety-related systems load shed as designed on undervoltage. In RAI 282-8238, Question 14.02-59 (ML15306A232), the staff requested the DC applicant discuss whether this included degraded voltage conditions and loss-of voltage conditions to meet Appendix A to 10 CFR Part 50, GDC 17 and GDC 18 for the 4.16 kV and 480 V safety-related systems. Specifically, GDC 17 requires onsite and offsite power systems to provide sufficient capacity and capability to permit functioning of SSCs that are important to safety, and GDC 18 requires the testing of electric power systems that are important to safety.

In its response to RAI 282-8238, Question 14.02-59 (ML16230A116), the DC applicant proposed to clarify the test methods and acceptance criteria and to keep consistency with APR1400 DCD, Chapter 8, "Electric Power," as well as the other subsections of Chapter 14. Specifically, APR1400 DCD Tier 2 Subsection 14.2.12.1.108 was revised to incorporate in Test Method 3.4, a clarification that load shedding of the 4.16 kV safety loads occurs on undervoltage conditions (i.e., loss of voltage and degraded voltage condition) of the switchgear. APR1400 DCD Tier 2 Subsections 14.2.12.1.109 (480 V Class 1E) and 14.2.12.1.113 (480 V non-Class 1E) and Tables 14.2-1 and 14.2-7 were also revised to reflect this testing.

The staff reviewed the DC applicant's response and determined that the proposed update to add electrical system test methods and acceptance criteria to APR1400 DCD Tier 2 Subsections 14.2.12.1.108, 14.2.12.1.109 (480 V Class 1E) and 14.2.12.1.113 (480 V non-Class 1E), as well as the proposed update to Tables 14.2-1 and 14.2-7 are acceptable because they clarify that loss of voltage and degraded voltage conditions are included in the tests. Therefore, the staff concludes that the revised description of the electrical system testing meets 10 CFR

Part 50, Appendix A, GDC 17 and GDC 18, and the testing guidance in RG 1.68, Appendix A, Section A-1g. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-59 was resolved and closed.

14.2.12.1.110 Unit Main Power System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.110 discusses the Unit Main Power System Test. Test Method 3.6 states, “verify the operation of interlocks, alarms, and protective relays.” In RAI 282-8238, Question 14.02-57 (ML15306A232), the staff requested the DC applicant discuss how this test verifies that the backup relay protection scheme works for simulated single failures by verifying operation of the primary and backup relay systems in order to meet the regulatory requirements of GDC 17 for onsite and offsite power systems to provide sufficient capacity and capability to permit functioning of SSCs that are important to safety and GDC 18 for the testing of electric power systems that are important to safety.

In its response to RAI 282-8238, Question 14.02-57 (ML16230A116), the DC applicant stated that after a more detailed review of the ITP for the electrical items, the DC applicant developed a general revision of APR1400 DCD Tier 2 Subsections 14.2.12.1.108 through 14.2.12.1.116 to clarify the test methods and acceptance criteria and to keep consistency with APR1400 DCD, Chapter 8 as well as the other subsections of Chapter 14. The DC applicant also stated:

Protection of the major components (e.g., main generator, main transformer, and unit auxiliary transformers) of the unit main power system is provided by three multifunction protective systems (MPSs). When a protective function in one MPS detects a fault, the MPS provides a signal (e.g., trip and/or alarm) for operation of a lockout relay and associated protective equipment. The MPSs of major components are provided with a two-out-of-three (2oo3) coincidence logic in order to preclude spurious operation of protective equipment due to any erroneous operation of any single MPS and to provide reasonable assurance of secure operation of the protective equipment under a fault condition. Upon receipt of at least two individual signals out of three MPSs, the lockout relay is energized and trips the associated protective device(s).

In the preoperational tests phase, operation of the protection scheme is checked and verified by circuit operational tests, which ensure the relay protection scheme works in the event of a single failure.

The proposed revision to APR1400 DCD Tier 2 Subsection 14.2.12.1.110 was included in the February 24, 2016, submittal of the revised APR1400 DCD Tier 2 Section 14.2 (ML16056A002) and was revised a second time to provide further clarification.

The staff reviewed the DC applicant’s response and proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.110 and determined that the more detailed test methods and acceptance criteria for the Unit Main Power System Test meets the regulatory requirements for electrical systems in GDC 17 and GDC 18, and the testing guidance in RG 1.68, Appendix A, Section A-1.g. Specifically, the proposed testing verifies that the backup relay protection scheme works for simulated single failures by verifying operation of the primary and backup relay systems in order to meet the regulatory requirements of GDC 17 for onsite and offsite power systems to provide sufficient capacity and capability to permit functioning of SSCs that are important to

safety and GDC 18 for the testing of electric power systems that are important to safety. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-57 was resolved and closed.

14.2.12.1.111 13,800 V Normal Auxiliary Power System Test

The APR1400 DCD Tier 2 Subsection 14.2.1.12.1.111, "13,800 V Normal Auxiliary Power System Test," discusses the 13,800 V normal auxiliary power system test. In RAI 282-8238, Question 14.02-58 (ML15306A232), the staff requested the DC applicant to discuss how this test verifies the alignment of the 13.8 kV buses to the alternate offsite supply, upon a loss of normal offsite power supply in order to meet the regulatory requirements of GDC 17 for onsite and offsite power systems to provide sufficient capacity and capability to permit functioning of SSCs that are important to safety and GDC 18 for the testing of electric power systems that are important to safety.

In its response to RAI 282-8238, Question 14.02-58 (ML16230A116), the DC applicant stated that a general revision of APR1400 DCD Tier 2 Subsections 14.2.12.1.108 (4.16 kV Class 1E), 14.2.12.1.111 (13.8 kV non-Class 1E), and 14.2.12.1.112 (4.16 kV non-Class 1E) to incorporate changes that will comprise the test methods and acceptance criteria for the automatic bus transfer tests was included in the February 24, 2016 submittal of the revised APR1400 DCD Tier 2 Section 14.2 (ML16056A002). The DC applicant clarified that detailed procedures for the bus transfer tests for the 4.16 kV and 13.8 kV auxiliary power systems will be developed and provided by the COL applicant.

The staff reviewed the DC applicant's response and determined that the response is acceptable because the proposed changes adequately incorporate testing for automatic bus transfers in accordance with the regulatory requirements for electrical systems in Appendix A to 10 CFR Part 50, GDC 17 and GDC 18, and the test guidance in RG 1.68, Appendix A, Subsection A.1.g, "Electrical System," for APR1400 DCD Tier 2 Subsections 14.2.12.1.108, 14.2.12.1.111 and 14.2.12.1.112. The staff confirmed that the COL applicant's responsibility to prepare the site-specific test procedures to be used for the conduct of the startup testing is captured in COL item 14.2(2) in APR1400 DCD Tier 2 Subsection 14.2.13. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-58 was resolved and closed.

14.2.12.1.114 Non-Class 1E DC Power Systems Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.114, discusses the non-Class 1E DC Power Systems Test. Test Methods 3.1, 3.2, and 3.3 for the batteries and battery chargers of the 125 Vdc, 250 Vdc, and alternate AC 125 Vdc power systems, respectively, each state that the battery discharge and charging tests will be performed. In RAI 282-8238, Question 14.02-55 (ML15306A232), the staff requested the DC applicant to discuss the tests for the battery chargers to verify that the battery charger DC output meets design criteria and regulatory requirements in Appendix A to 10 CFR Part 50, GDC 17 for onsite and offsite power.

In its response to RAI 282-8238, Question 14.02-55 (ML16230A116), the DC applicant proposed a revision of APR1400 DCD Tier 2 Subsection 14.2.12.1.114, which included adding test objectives to verify the proper performance of the battery chargers in the float equalization mode, verify proper operation of the battery chargers with its output voltage regulation and

ripple design value, and verify that the standby battery chargers can supply the proper voltage to the non-Class 1E DC control center. Additionally, the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.114 to include an additional test method to verify the battery charger capacity and that the battery charger output meets design requirements. Lastly, the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.114 to include acceptance criteria for the aforementioned added test objectives.

The staff reviewed the DC applicant's response and the proposed revisions to APR1400 DCD Tier 2 Subsection 14.2.12.1.114 and determined that the more descriptive test methods and acceptance criteria adequately verify that the battery charger DC output meets design criteria, and therefore meets the regulatory requirements for electrical systems in Appendix A to 10 CFR Part 50, GDC 17 and the test guidance for electrical systems in RG 1.68 Appendix A, Section A.1.g. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-55 was resolved and closed.

14.2.12.1.115 Class 1E DC Power System Test

In RAI 282-8238, Question 14.02-56 (ML15306A232), the staff requested the DC applicant to provide the following clarifications regarding the APR1400 DCD Tier 2 Subsection 14.2.12.1.115, "Class 1E DC Power Systems Test": (1) clarify whether this test demonstrates that the Class 1E DC power systems are capable of performing as designed in the required operating modes; (2) discuss the test for the battery chargers to verify that the battery charger DC output meets design criteria; (3) discuss how the electrical independence and redundancy of power supplies for safety-related functions are checked for the Class 1E DC power system; and (4) discuss how this test determines that the voltage that would be available at the Class 1E inverters would exceed the design minimum if the batteries were discharged to the minimum voltage limit.

In its response to RAI 282-8238, Question 14.02-56 (ML16230A116), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.115 to reflect that the capacity and capability of Class 1E DC system in the required operating modes is demonstrated by the test. The discharge test stated in Test Method 3.1.1 is for the batteries and the charging test stated in Test Method 3.1.2 is for the battery chargers. Related items to verify that the battery charger DC output meets design criteria are included in the following Parts of the test: Objectives 1.3, 1.8, and 1.9; Test Methods 3.1.2 and 3.5; Data Required 4.2; and Acceptance Criteria 5.2, 5.4, 5.5, and 5.6. The electrical independence and redundancy of power supplies for safety related functions are tested and verified as stated in Test Objective 1.10, Test Method 3.7, and Acceptance Criteria 5.18. The minimum voltages of the battery bank and individual cells are checked and verified in accordance with Test Method 3.2 and Data Required 4.1. The minimum available voltage at the Class 1E inverters is tested and verified as stated in Test Objectives 1.5 and 1.6; Test Methods 3.3 and 3.4; Data Required 4.3; and Acceptance Criteria 5.16.

The staff reviewed the DC applicant's response and determined that the update to the APR1400 DCD Tier 2 Subsection 14.2.12.1.115 objectives, test methods and acceptance criteria meets the regulatory requirements for electrical systems in Appendix A to 10 CFR Part 50, GDC 17 and testing guidance in RG 1.68, Appendix A, Section A-1.g. Specifically, the revised test description addresses the staff's concerns by adequately describing: (1) how the test demonstrates proper functioning of the Class 1E DC system, (2) how the test verifies that the

battery charger DC output meets design criteria, (3) verification of electrical independence and redundancy of power supplies for safety related functions, and (4) verification that the voltage that would be available at the Class 1E inverters would exceed the design minimum if the batteries were discharged to the minimum voltage limit. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-56 was resolved and closed.

14.2.12.1.116 Offsite Power System Test

The APR1400 DCD Tier 2 Subsection 14.2.1.12.1.116, "Offsite Power System," discusses the offsite power system test. In RAI 282-8238, Question 14.02-60 (ML15306A232), the staff requested the DC applicant to confirm that this test includes demonstrating the operation of protective relaying, alarms, and control devices of the main, unit auxiliary and standby auxiliary transformers.

In its response to RAI 282-8238, Question 14.02-60 (ML16200A116), the DC applicant proposed a general revision of APR1400 DCD Tier 2 Subsection 14.2.12.1.116 to clarify the test methods and acceptance criteria and to keep consistency with APR1400 DCD, Chapter 8 as well as the other subsections of Chapter 14. The proposed revision to the offsite power system test includes demonstrating the operation of protective relaying and alarms of the main, unit auxiliary, and standby auxiliary transformers (Main Transformers, Unit Auxiliary Transformers, and Standby Auxiliary Transformers); collectively called power transformers. Additionally, the proposed revision to APR1400 DCD Tier 2 Subsection 14.2.12.1.116 added a new Test Method 3.5 to clearly indicate that the test will demonstrate the operation of protective relaying, alarms, and associated control devices of the power transformers.

The staff reviewed and determined that the DC applicant's response and proposed update to APR1400, DCD Section 14.2.12.1.116 test methods and acceptance criteria are acceptable because they clearly include testing of the SSCs identified in the staff's RAI. Therefore, the staff concludes that the revised test description meets the regulations for electrical systems in Appendix A to 10 CFR Part 50, GDC 17 and electrical system testing requirements in GDC 18, and the testing guidance for electrical systems in RG 1.68 Appendix A, Section A-1.g. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 8238, Question 14.02-60 was resolved and closed.

14.2.12.1.117 Balance-of-Plant Piping Thermal Expansion Measurement Test

In RAI 151-8078, Question 03.09.02-7 (ML15234A407), the staff requested the DC applicant to provide a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and the method regarding how motion will be measured.

In its response to RAI 151-8078, Question 03.09.02-7 (ML16084A989), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 3.9.2.1.3 to state that the thermal motion monitoring program will include verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and how the motion is to be measured. The thermal motion monitoring program would be included as part of the test procedure completed by the COL applicant. The DC applicant also proposed to revise the APR1400 DCD Tier 2 Section 14.2.12.1.117 acceptance criteria to add the correct reference to APR1400 DCD Tier 2

Subsection 3.9.2 for ITP testing commitments related to the ASME OM Code. In addition, the DC applicant proposed to add a COL item to APR1400 DCD Tier 2 Subsection 14.2.13 and Table 1.8.2 to address the thermal motion monitoring program as described in APR1400 DCD Tier 2 Subsection 3.9.2.1.3.

The staff determined that the DC applicant's response meets RG 1.68, Appendix A, Section A-1, "Preoperational Testing," and is acceptable because COL item 14.2(6) in APR1400 DCD Tier 2 Subsection 14.2.13 describes the COL applicant's responsibility to develop the test procedure, including a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and the method regarding how motion will be measured. Additionally, the proposed change provides that the DCD will identify the necessary topics the COL applicant's procedure must address. The staff also agrees with the DC applicant's correction to reference APR1400 DCD Tier 2 Subsection 3.9.2. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 151-8078, Question 13.09.02-7 was resolved and closed.

14.2.12.1.118 Balance-of-Plant Piping Vibration Measurement Test

In RAI 151-8078, Question 03.09.02-6 (ML15234A007), the staff requested the DC applicant to provide appropriate ITP test descriptions for each of the transient vibration conditions in accordance with provisions of RG 1.68 and ASME Operation and Maintenance(OM)-3 such that the APR1400 would meet 10 CFR Part 50, Appendix A, GDC 14 and 15. As pertinent here, GDC 14 and 15 require that the reactor coolant pressure boundary does not fail and can withstand normal operation, including anticipated operational occurrences.

In its response to RAI 151-8078, Question 03.09.02-6 (ML16084A989), the DC applicant provided the following information:

ITP 14.2.12.1.118, "Balance-of-Plant Piping Vibration Measurement Test" includes testing of the systems to withstand flow induced dynamic loadings under the steady state and operational transient conditions and references DCD Section 3.9. The associated test procedures will include the detailed test specifications in accordance with the general requirements of RG 1.68 and the specific vibration testing requirements of ASME OM Part 3. To ensure that the requirements of RG 1.68 and ASME OM are included, DCD Tier 2, Subsection 3.9.2.1 will be updated to specify that these specific provisions are addressed as part of the test program.

The staff determined that the DC applicant's response is acceptable because it describes testing for each of the transient vibration conditions and references the acceptable testing methodologies in RG 1.68 and the ASME OM Code. Given this, the proposed DCD change meets 10 CFR Part 50, Appendix A, GDC 14, GDC 15, and RG 1.68, Appendix A, Section A-1. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 151-8078, Question 03.09.02-6 was resolved and closed.

14.2.12.1.128 Auxiliary Steam System Test

In RAI 281-8232, Question 14.02-48 (ML15306A018), the staff requested the DC applicant to:

1. Update APR1400 DCD Tier 2 Subsection 14.212.1.128, Auxiliary Steam System Test, to include a test to ensure that the radiation monitor performs its function of automatically redirecting the condensate to the LWMS.
2. Specify which radiation monitor performs this function and update APR1400 DCD, Chapters 11 and 12 to ensure it is clear which monitor performs this function.

In its response to RAI 281-8232, Question 14.02-48 (ML16230A490), the DC applicant proposed to revise APR1400 DCD Tier 2 Subsection 14.2.12.1.128 to include testing of radiation monitor PR-RE/RT-103, associated with the Auxiliary Steam System, to verify automatic redirection of the condensate to the LWMS. The DC applicant also proposed to include acceptance criteria 5.3 in APR1400 DCD Tier 2 Subsection 14.2.12.1.128. This acceptance criteria ensures that the monitor functions as described in APR1400 DCD Tier 2 Subsection 10.4.10. APR1400 DCD Tier 2 Subsection 10.4.10, indicates that the monitor actuates an alarm in the MCR and automatically diverts potential radioactive material in the condensate to the LWMS. In addition, the DC applicant addressed which radiation monitors perform the function to automatically redirect the condensate to the liquid radwaste management system. The staff determined the proposed changes ensure that the radiation monitor automatically redirects the auxiliary steam system condensate to the LWMS, and therefore meets the guidance in RG 1.68, Section A-1.k for testing the function of the radiation monitor. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 281-8232, Question 14.02-48 was resolved and closed.

14.2.12.1.134 Leakage Detection System Test

The APR1400 DCD Tier 2 Subsection 14.2.12.1.134, "Leakage Detection System Test," demonstrates the operation of the various leakage detection systems. It will test the sump level switches and flow monitors, airborne radioactivity monitor, and/or atmosphere humidity monitors using simulated signals. Subsection 5.0/5.1, "Acceptance Criteria," of this test states that "the leakage detection system operates as described in APR1400 DCD Tier 2 Subsection 5.2.6.1."

However, the staff could not find the referenced APR1400 DCD Tier 2 Subsection 5.2.6.1. It was not clear that this preoperational test includes the verification of the capability of RCS leakage detection instrumentations.

As part of RAI 80-8040, Question 05.02.05-2 (ML15295A317), the staff requested the DC applicant revise information (supposedly in APR1400 DCD Tier 2 Subsection 5.2.6.1) but incorrectly referenced in APR1400 DCD, Subsection 14.2.2.12.1.134 and demonstrate that the proposed ITP has adequately addressed the tests identified in RG 1.68, Appendix A.

In the February 24, 2016, update to APR1400 DCD, Subsection 14.2.12.1.134, "Leakage Detection System Test," (ML16056A002) the DC applicant changed acceptance criteria 5.1 to:

5.1 The leakage detection system operates as designed and described in Subsection 5.2.5.2.2

This is a cross reference to APR1400 DCD Tier 2 Subsection 5.2.5.2.2, "Primary Indicators of Reactor Coolant Unidentified Leakage." The staff determined that this change to APR1400

DCD, Subsection 14.2.12.1.134 acceptance criteria satisfies requirements to test that leakage detection sensitivity and capability meets TS leakage guidance in RG 1.45 in accordance with guidance in RG 1.68, Appendix A, Section A.1.k Item 5. Therefore, RAI 80-8040, Question 05.02.05-2 was resolved and closed.

14.2.12.1.141 Local of equipment; 14.2.12.1.142 Access to vital equipment; 14.2.12.1.143 Equipment to permit observation of abnormal presence or activity of persons or vehicles; 14.2.12.1.144 Vehicles barrier system to protect against the design basis threat vehicle bombs; 14.2.12.1.145 Vital areas with active intrusion detection systems; 14.2.12.1.146 Security alarm annunciation and video assessment information; 14.2.12.1.147 Location and equipment of the central and secondary alarm stations; 14.2.12.1.148 Secondary security power supply system; 14.2.12.1.149 Intrusion detection and assessment systems; 14.2.12.1.150 Equipment and emergency exits; 14.2.12.1.151 Security communication systems; 14.2.12.1.152 Bullet-resisting barriers; 14.2.12.1.153 Security alarm devices and transmission lines

The DC applicant developed 13 physical security preoperational test abstracts in APR1400 DCD, Subsections 14.2.12.1.141 through 14.2.12.1.153 that are included under the ITP and are associated with ITAAC. Having preoperational tests in the ITP overlap with the ITAAC is acceptable per the guidance in RG 1.68, Revision 4. For the evaluation of the physical security ITAAC and the associated preoperational test abstracts, see FSER Section 14.3.12.

14.2.4.12.2 Post-Core Hot Functional Tests

The following is a list of "Phase II: Fuel Loading and Post-Core Hot Functional Testing" abstracts described in APR1400 DCD, Subsections 14.2.12.2.1 through 14.2.12.2.10:

- 14.2.12.2.1 *Post-core hot functional test controlling document*
- 14.2.12.2.2 *NSSS integrity monitoring system (post-core)*
- 14.2.12.2.3 *Reactor coolant system flow measurements*
- 14.2.12.2.4 *Post-core control element drive mechanism performance*
- 14.2.12.2.5 *Post-core reactor coolant and secondary water chemistry data*
- 14.2.12.2.6 *Post-core pressurizer spray valve and control adjustments*
- 14.2.12.2.7 *Post-core reactor coolant system leak rate measurement*
- 14.2.12.2.8 *Post-core in-core instrumentation test*
- 14.2.12.2.9 *Post-core instrument correlation*
- 14.2.12.2.10 *Post-core acoustic leak monitor system test*

The staff reviewed and evaluated the 10 post core hot functional test objectives, test prerequisites, test methods, test data requirements and test acceptance criteria included in APR1400 DCD, Subsection 14.2.12.2. In comparing the APR1400 hot functional tests to the testing recommended in RG 1.68, Appendix A, Section 2, "Initial Fuel Loading and Precritical Tests," the staff determined that a number of post core hot functions tests reviewed in APR1400 DCD, Subsection 14.2.12.2 did not contain acceptable test objectives, test prerequisites, test methods, test data requirements and test acceptance criteria to demonstrate that these hot functional tests can verify that the tested SSCs can perform their intended safety-related, defense-in-depth and normal operation functions; therefore, parts of APR1400 DCD, Subsection 14.2.12.2 were not acceptable. The staff identified areas where additional information was required to complete its review. Descriptions of the specific issues are as follows:

14.2.12.2.9 Post-Core Instrument Correlation

The APR1400 DCD, Subsection 14.2.12.2.9, provides the post-core instrument correlation test. In RAI 198-8208, Question 14.02-34 (ML15245A546), the staff requested the DC applicant to demonstrate how the test objective of the Post-Core Instrument Correlation (PCIC) Test stated in APR1400 DCD, Subsection 14.2.12.2.9 can be accomplished with the test methods described in this subsection. The test objective is “[t]o demonstrate proper operation of the plant protection system (PPS), core protection calculators (CPCs), information processing system (IPS), and qualified indication and alarm system (QIAS).” However, the test methods only required the PPS, CPCs, IPS and QIAS readouts and the main control room instrument readings to be obtained. It did not appear that these test methods would demonstrate the proper operation of the PPS, CPCs, IPS, and QIAS. In addition, the acceptance criteria for this test stated, “The IPS, QIAS, PPS, and CPCs perform as described in Sections 7.2 and 7.7 of the APR1400 DCD.” APR1400 DCD Tier 2 Sections 7.2 and 7.7 contained a significant amount of design descriptions for these systems. It was unclear what specific design criteria needed to be met for these systems with this test. As part of RAI 198-8208, Question 14.02-34, the staff requested the DC applicant identify the specific acceptance criteria that need to be met with this test.

In its response to RAI 198-8208, Question 14.02-34 (ML16306A436), the DC applicant stated:

The purpose of the Post-Core instrument Correlation is to verify that the as-installed instrumentation is functional for specific I&C systems. Therefore, the objectives in Subsection 14.2.12.2.9 will be modified to align with the purpose of this test.

The staff determined that the DC applicant’s proposed revision to APR1400 DCD, Subsection 14.2.12.2.9 related to PCIC test objectives adequately describes the functional tests to be performed to demonstrate that the PCIC will perform satisfactorily in service, in accordance with the guidance in RG 1.68, Appendix A, Section A-1.j, and, thus, it is acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-34 was resolved and closed.

14.2.12.2.11 Post-Core Ex-Core Neutron Flux Monitoring System Test

The APR1400 DCD, Subsection 14.2.12.2.11, “Post-Core Ex-Core Neutron Monitoring System Test,” described the post-core ENFMS test. The acceptance criteria for this test stated that the “[ENFMS] performs as described in Subsection 7.7.1.1.h.” APR1400 DCD, Subsection 7.7.1.1.h only described the operation of the non-safety channels of the ENFMS. As such, it was not clear to the staff whether this test is only applicable to the non-safety channels or whether it is also supposed to test the safety channels. In RAI 198-8208, Question 14.02-35 (ML15254A546), the staff requested that the DC applicant clarify the scope of this test (i.e. whether it is for both safety and non-safety channels of the ENFMS, or just the non-safety channels). In addition, if this test was only applicable to the non-safety channel of the ENFMS, the staff requested that the DC applicant identify where the safety channels of the ENFMS are tested in the post core ITP.

In its response to RAI 198-8208, Question 14.02-35 (ML16173A245), the DC applicant stated that:

According to the RG 1.68, the proper functional performance tests of the ENFMS and the proper performance tests of the audio and visual indications for both safety and non-safety channels of ENFMS are conducted in the pre-operational testing described in 14.2.12.1.25.

During the initial fuel loading, neutron count rate is continuously monitored by displaying, recording, and audible information by two temporary source-range channels or at least one temporary channel and one permanent channel (startup channel of the ENFMS) as described in 14.2.10.1 so that all changes in the multiplication factor are observed. Before this step, the startup channels of the ENFMS are calibrated. For consistency, Section 14.2.10.1 will be revised to add this calibration.

The proper functional performance tests of the ENFMS and the proper performance tests of the audio and visual indications for both safety and non-safety channels of ENFMS are not required during post-core HFT in RG 1.68. Therefore, Section 14.2.12.2.11 in the APR1400 FSAR Tier 2 will be deleted.

As the Section 14.2.12.2.11 is deleted, the Table 14.2-7 in the APR1400 [DCD] Tier 2 will be revised. For 2.g of RG 1.68, App. A, Subsection # and Individual Test will be revised to "14.2.10.1 Initial Fuel Loading". For 4.c of RG 1.68, App. A, Subsection # and Individual Test will be revised to "14.2.10.2.1 Safe Criticality Criteria" because a minimum of 1 decade of overlap is observed between the startup and log safety channels of the ex-core nuclear instruments as described in g of the Section 14.2.10.2.1. For 4.d of RG 1.68, App. A, Subsection # and Individual Test will be revised to "14.2.12.1.24 Plant Protection System Test" because the operation of associated protective functions and alarms for plant protection is tested as described in the Section 14.2.12.1.24.

The staff determined that this response is not acceptable since deleting APR1400 DCD, Subsection 14.2.12.2.11 would not verify initial fuel loading/initial criticality testing of ENFMS neutron monitors when first loading fuel. The ENFMS preoperational test only covers simulated neutron signals and not actual neutron signals because there is no fuel in the reactor. Therefore, the NRC requested that the DC applicant update or move this test to the applicable portions of the APR1400 DCD, Subsection 14.2.12 where ENFMS neutron monitor testing should be performed, or justify why the test is not needed. Additionally, the staff requested that the DC applicant should consider testing both in-core and ex-core neutron detectors, the CPC and any other digital I&C systems needed to support initial fuel load/initial criticality testing.

In its revised response to RAI 198-8208, Question 14.02-35 (ML17201Q511), the DC applicant stated that, "The startup channels are used during initial fuel loading. The startup channels and safety log power channels are used during initial criticality. Both the safety linear power and control channels are used during power operation. Power distribution is needed from 20 percent power. The safety linear power channels are used to generate core power distribution. The non-safety in-core detectors are also used to generate the core power distribution." The DC applicant provided a table of how operability verification of the ex-core and in-core detector systems with actual neutron sources or by plant startup conditions after the systems' pre-operational tests will be conducted as, described in Subsection 14.2.12.1.25 and Subsection

14.2.12.1.26 of the APR1400 DCD. The DC applicant also referenced the response to RAI 524-8697, Question 14.02-69 in which a new test to incorporate the ex-core tests of safety linear power channel and control channel was proposed. The staff found that the new test proposed in the response to RAI 524-8697, Question 14.02-69 provides for adequate testing of the ex-core neutron monitoring system within the power ascension tests, and conforms to RG 1.68. As such, the staff determined that deleting APR1400 DCD, Subsection 14.2.12.2.11 is acceptable. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 198-8208, Question 14.02-35, was resolved and closed.

14.2.4.12.3 DCD Tier 2 Subsection 14.2.12.3, Low Power Physics Tests

The following is a list of “Phase III: Initial Criticality and Low-Power Physics Testing” abstracts described in APR1400 DCD, Subsections 14.2.12.3.1 through 14.2.12.3.6:

- 14.2.12.3.1 *Low-power biological shield survey test*
- 14.2.12.3.2 *Isothermal temperature coefficient test*
- 14.2.12.3.3 *Shutdown and regulating control element assembly group worth test*
- 14.2.12.3.4 *Differential boron worth test*
- 14.2.12.3.5 *Critical boron concentration test*
- 14.2.12.3.6 *Control element assembly symmetry*

In comparing the APR1400 initial criticality and low power physics tests to the testing recommended in RG 1.68, Appendix A, Section 3 and Section 4, the staff identified areas where additional information was required to complete its review. A description of the specific issue is as follows:

14.2.12.3.1 Low-Power Biological Shield Survey Test

In APR1400 DCD, Subsections 14.2.12.3.1, “Low-power biological shield survey test,” and 14.2.12.4.9, “Biological shield survey test,” the acceptance criteria indicated that the biological shield performs as described in APR1400 DCD, Subsection 12.3.2.2; however, APR1400 DCD, Subsection 12.3.2.2 provided no information on how the biological shield is expected to perform. Therefore, in RAI 281-8232, Question 14.02-51 (ML15306A018), the staff requested the DC applicant clarify what is meant by this statement, update APR1400 DCD, Subsection 12.3.2.2 to provide information on the shielding criteria for the biological shield, or update APR1400 DCD, Subsections 14.2.12.3.1 and 14.2.12.4.9 to reference an accurate section.

In its response to RAI 281-8232, Question 14.02-51 (ML16222A939), the DC applicant stated, in part, that:

As a result of related comments that resulted from review of KHNP’s response to RAI 281-8232 Question 14.02-52, changes to DCD Tier 2 Subsection 14.2.12.3.1, “Low-Power Biological Shield Survey Test” and Subsection 14.2.12.4.9 “Biological Shield Survey Test” are being proposed. Subsection 14.2.12.3.1 is being revised to “Baseline Biological Shield (Primary Shield) Radiation Measurements Test” to describe the radiation survey to be performed around the primary shield structure areas prior to initial power operation to establish radiation baseline levels for comparison of buildup resulting from

normal power operation (Please refer to Attachment 1 of this response). Subsection 14.2.12.4.9 is being revised to “Biological Shield (Primary Shield) Radiation Measurements Test” and addresses radiation measurements at 5% or less, 50%, and 100% power levels to ensure that the radiation dose is acceptable and as designed (Please refer to Attachment 2 of this response). The Biological Shield (Primary Shield) Radiation Measurements Test includes, which may include [sic] areas adjacent to the reactor, steam generators, reactor coolant pumps, and the pressurizer (RCS components), high and very high radiation areas inside the Auxiliary Building and the Compound Building. These designated areas are identified in DCD Tier 2 Subsections 14.2.12.3.1 and 14.2.12.4.9 for clarity. The reference to DCD Tier 2 Subsection 12.3.2.2 has been removed, since the acceptance criteria for “Baseline Radiation Measurements Test” and the “Radiation Measurements Test” are provided in Sub-item 5 “Acceptance Criteria” of Subsections 14.2.12.3.1 and 14.2.12.4.9, respectively in DCD Tier 2 Chapter 14.

The term ‘primary shield’ refers to the heavily reinforced concrete structure that houses the reactor vessel, provides the primary radiation shielding, and provides protection for the reactor vessel from internal missiles (DCD Tier 2 Subsection 3.8.3.1.5). The term, ‘secondary shield’ refers to the reinforced concrete structure surrounding the steam generators, the reactor coolant pumps, and the pressurizer (DCD Tier 2 Subsection 3.8.3.1.6). The term, ‘biological shield’ is a general term used for the provision of shielding against radiation around the primary and the secondary shielding structures. Since the baseline and the regular radiation measurement tests not only include areas of the RCS components, but also include high and very high radiation areas adjacent to these components, DCD Tier 2 Subsections 14.2.12.3.1 and 14.2.12.4.9 are revised accordingly.

The staff reviewed the proposed acceptance criteria for the “Baseline Radiation Measurements Test,” and the “Radiation Measurements Test,” provided in APR1400 DCD, Subsections 14.2.12.3.1 and 14.2.12.4.9 and determined that the acceptance criteria adequately addressed the performance of the biological shield and is consistent with the guidance in RG 1.68, Appendix A, Section A-1.k to demonstrate the proper operation of the components used to monitor or measure radiation levels, provide for personnel protection, or control or limit the release of radioactivity. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 281-8232, Question 14.02- 51 was resolved and closed.

14.2.4.12.4 DCD Tier 2 Subsection 14.2.12.4, Power Ascension Tests

The following is a list of “Phase IV: Power Ascension Testing” abstracts described in APR1400 DCD, Subsections 14.2.12.4.1 through 14.2.12.4-26:

- 14.2.12.4.1 *Variable T_{avg} (isothermal temperature coefficient and power coefficient) test*
- 14.2.12.4.2 *Unit load transient test*
- 14.2.12.4.3 *Control systems checkout test*
- 14.2.12.4.4 *Reactor coolant and secondary chemistry and radiochemistry test*
- 14.2.12.4.5 *Turbine trip test*
- 14.2.12.4.6 *Unit load rejection test*

- 14.2.12.4.7 *Shutdown from outside the main control room test*
- 14.2.12.4.8 *Loss of offsite power test*
- 14.2.12.4.9 *Biological shield survey test*
- 14.2.12.4.10 *Steady-state core performance test*
- 14.2.12.4.11 *Intercomparison of plant protection system, core protection calculator, information processing system, and qualified information and alarm system inputs*
- 14.2.12.4.12 *Verification of core protection calculator power distribution related constants test*
- 14.2.12.4.13 *Feedwater and auxiliary feedwater system test*
- 14.2.12.4.14 *Core protection calculator verification*
- 14.2.12.4.15 *Main steam atmospheric dump and turbine bypass valve capacity test*
- 14.2.12.4.16 *In-core detector test*
- 14.2.12.4.17 *Core operating limit supervisory system verification*
- 14.2.12.4.18 *NSSS integrity monitoring system*
- 14.2.12.4.19 *Loss of one main feedwater pump*
- 14.2.12.4.20 *Penetration temperature survey test*
- 14.2.12.4.21 *HVAC capability test*
- 14.2.12.4.22 *Liquid waste management system test*
- 14.2.12.4.23 *Gaseous waste management system test*
- 14.2.12.4.24 *Pseudo-ejected CEA test*
- 14.2.12.4.25 *Pseudo-dropped CEA test*
- 14.2.12.4.26 *Fatigue monitoring system test*

In comparing the APR1400 power ascension tests to the testing recommended in RG 1.68, Appendix A, Section 5, "Power-Ascension Tests," the staff identified a number of power ascension tests in APR1400 DCD, Subsection 14.2.12.4 that did not contain acceptable test prerequisites, test methods, test data requirements and test acceptance criteria to adequately demonstrate that APR1400 power ascension tests can perform their intended safety-related, defense-in-depth and normal operation functions; therefore, parts of APR1400 DCD, Subsection 14.2.12.4 were not acceptable. The staff identified several areas where additional information was required to complete its review. Descriptions of the specific issues are as follows:

14.2.12.4.7 Shutdown from Outside the Main Control Room Test

In RAI 198-8208, Question 14.02-36 (ML15254A546), the staff requested the DC applicant demonstrate how the test objective for safely cooling down the plant from hot standby to cold shutdown conditions from outside the MCR is met with the test methods described in APR1400 DCD, Subsection 14.2.12.4.7, "Shutdown from Outside the Main Control Room."

In its response to RAI 198-8208, Question 14.02-36, (ML16174A465), the DC applicant stated, in part that:

As described in the attached markup and DCD Tier 2 section 14.2.12.1.48, the capability to cool down the plant to the cold shutdown condition from the remote shutdown room is demonstrated during pre-core hot functional testing. Therefore, during power ascension tests, the objective of the shutdown from outside the main control room test is to demonstrate the plant can be placed in the hot shutdown condition and maintained for at least 30 minutes from outside

the control room. According to NRC Regulatory Guide 1.68.2 Revision 2, licenses do not need to demonstrate cold shutdown capability immediately following the test to achieve and maintain a safe hot shutdown from outside the control room. KHNP submitted a revised DCD Tier 2 section 14.2.12.4.7 as a result of the upgrade effort described in the original response (ref. KHNP submittal MKD/NW-16-0156L dated February 24, 2016; ML16056A003). As a result of subsequent review, the ITP for Shutdown for Outside the Main Control Room Test will be further enhanced as indicated on the attached markup to make additional clarifications to the test objectives, test method and acceptance criteria to meet NRC Regulatory Guide 1.68.2 Revision 2.

The staff determined that the proposed update to APR1400 DCD Tier 2 Subsection 14.2.12.4.7 to clarify test objectives, test methods and acceptance criteria to place the plant in a safe hot shutdown condition for at least 30 minutes from the RSR ensures the design capability for prompt hot shutdown of the reactor in accordance with the requirements of GDC 19 for equipment outside the control room to safely shut down the reactor and bring it to hot shutdown condition and the guidance in RG 1.68.2 to demonstrate this capability and is thus acceptable. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 198-8208, Question 14.02-36 was resolved and closed.

14.2.12.4.8 Loss of Offsite Power Test

The APR1400 DCD, Subsection 14.2.12.4.8 discusses the Loss-of-Offsite-Power Test. In RAI 282-8238, Question 14.02-61 (ML15306A232), the staff requested the DC applicant to discuss how this test demonstrates that upon a loss of offsite power, there is an automatic transfer from offsite power to the onsite emergency diesel generators.

In its response to RAI 282-8238, Question 14.02-61 (ML16230A116), the applicant stated:

The initial test program to demonstrate an automatic transfer from offsite power to the onsite emergency diesel generators (EDGs) upon a loss of offsite power (LOOP) is addressed by the preoperational test described in DCD Tier 2 Subsection 14.2.12.1.87. The preoperational test stated in Part 3.3 of Subsection 14.2.12.1.87, which was provided in the revised response to the RAI 191-8210, Question 14.2-13 (reference KHNP submittal: MKD/NW-16-0684L dated June 28, 2016; ML16180A271), evaluates the ability of EDG start and closing of associated circuit breakers on an undervoltage condition of the 4.16 kV Class 1E bus, which is meant to simulate a LOOP.

The staff reviewed the changes proposed in the DC applicant's June 28, 2016, response to RAI 191-8210, Question 14.02-13 (ML16180A269). The staff determined that the proposed change is acceptable because it satisfies the testing requirements to demonstrate proper operation of transfer schemes for the EDG electrical system in accordance with the regulations in 10 CFR Part 50, Appendix A, GDC 17 and GDC 18, and the testing guidance for electrical systems in RG 1.68, Appendix A, Section A-1.g. The staff also agrees that it is appropriate to perform this testing in the preoperational phase rather than the power ascension phase. The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 282-8238, Question 14.02-61 was resolved and closed.

14.2.12.4.9 Biological Shield Survey Test

In RAI 281-8232, Question 14.02-53 (ML15306A018), the staff requested the DC applicant to update the objective for the biological shield survey test in the APR1400 DCD, as appropriate, to specify that the test will assist in determining allowable occupancy times for areas outside the biological shield.

In its April 19, 2016, response to RAI 281-8232, Question 14.02-53 (ML16110A460), the DC applicant updated APR1400 DCD, Subsection 14.2.12.4.9, Test Objective 1.2, to state:

To assist in determination of allowable occupancy times for these areas outside the biological shield during power operation.

The staff determined that the proposed change to APR1400 DCD, Subsection 14.2.12.4.9 is acceptable because it satisfies the requirements for conducting neutron and gamma radiation surveys to establish the adequacy of the airborne activity monitoring system in accordance with the testing guidance in RG 1.68, Appendix A, Section A.5, "Power Ascension Tests," Test Item bb, for radiation shields which also references RG 1.69, "Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants." The staff verified that the proposed changes have been incorporated into the APR1400 DCD. Therefore, RAI 281-8232, Question 14.02-53 was resolved and closed.

Conclusion

The staff concludes that the DC applicant adequately describes the system testing requirements for the individual preoperational, post-core hot functional, low-power physics, and power accession tests, and is thus acceptable. All issues relating to this section of the ITP have been resolved.

14.2.5 DCD Tier 2 Subsection 14.2.13, Combined License Items

Introduction

In APR1400 DCD, Subsection 14.2.13, "Combined License Information," the DC applicant lists the COL information items relative to the implementation of the ITP, for which responsibility will be deferred to the COL applicant.

Evaluation

The staff reviewed the list of COL responsibilities related to the ITP in APR1400 DCD, Subsection 14.2.13, Combined Licensee Information, for consistency with RG 1.206, Section C.I.14, "Verification Programs," and RG 1.68, Section A, "Introduction." In RAI 91-7867, Question 14.02-4 (ML15201A768) the staff identified corrections below (identified in italics) related to COL applicant responsibilities that the DC applicant should add to APR1400 DCD, Subsection 14.2.13 for consistency with the guidance in RG 1.68 and SRP Section 14.2:

- COL 14.2(1) The COL applicant is to develop the site-specific organization and staffing levels appropriate for its facility *to implement the initial test program. The COL applicant's plant operating and plant technical*

staff should participate, to the extent practical, in developing and conducting the ITP and evaluating the test results.

- COL 14.2(2) The COL applicant is to prepare the site specific *preoperational and startup test specifications and test procedures* that is to be used for the conduct of the plant *Initial Test Program*. *The preoperational and startup test procedures should have controls in place to ensure that test procedures include appropriate prerequisites, objectives, safety precautions, initial test conditions, methods to direct and control test performance and test acceptance criteria by which the test is evaluated. Testing performed at other than design operating conditions for systems is to be reconciled either through the test acceptance criteria or post-test data analysis.* These procedures are to be submitted at least 60 days prior to their intended use to the NRC staff for review as described in Subsection 14.2.11.
- COL 14.2(3) The COL applicant is to prepare a startup administrative manual (SAM) *which contains administrative controls that govern the conduct of each major phase of the ITP. This description should include the administrative controls used to ensure that necessary prerequisites are satisfied for each major phase and for individual tests. The COL applicant should also describe the methods to be followed in initiating plant modifications or maintenance tasks that are deemed to be necessary to conduct the ITP. This description should include methods used to ensure retesting following such modifications or maintenance. In addition, the description should discuss the involvement of design organizations with the COL applicant in reviewing and approving proposed plant modifications. The COL applicant should also describe in the SAM adherence to approved test procedures during the conduct of the ITP as well as the methods for effecting changes to approved test procedures.*
- COL 14.2(4) The COL applicant is to perform a review and evaluation of individual test results *in a test report made available to NRC personnel after preoperational and startup tests are completed. The specific test acceptance criteria for determining success or failure of a test shall be included in the test report approval of the test results. The test report should also include test results associated with any license conditions in the plant specific ITP.*
- COL 14.2(6) The COL applicant is to develop a *sequence and schedule* for the development of the plant operating and emergency procedures should allow sufficient time for trial use of the procedure during the Initial Test Program. The *sequence and schedule* for plant startup is to be developed by the COL applicant to allow sufficient time to systematically perform the required testing in each phase.

COL 14.2(7) *The COL applicant is responsible for establishing hold points at selected milestones throughout the power ascension test phase to ensure that designated personnel or groups evaluate and approve relevant test results before proceeding to the next power-ascension test phase. At a minimum, the COL applicant should establish hold points at approximately 25-percent, 50-percent, and 75-percent power-level test conditions for pressurized-water reactors.*

COL 14.2(13) *The COL applicant is responsible for retaining preoperational and startup test procedures and test results as part of the plant's historical records in accordance with 10 CFR 50.36, "Technical Specification," 10 CFR 50.71, "Maintenance of Records, Making of Reports," 10 CFR 50, Appendix B, Criterion XVII, "Test Records," and RG 1.28, "Quality Assurance Program Criteria (Design and Construction.)"*

The staff also requested the DC applicant to make number sequence changes to COL item 14.2(8) through COL item 14.2(12) but no text changes were needed.

The DC applicant was also asked to revise APR1400 DCD, Subsections 14.2.2, "Organization and Staffing," 14.2.3, "Test Procedures," and 14.2.6, "Test Records," to note these changes in COL applicant responsibilities for implementing the ITP in APR1400 DCD, Subsection 14.2.13, "Combined License Information."

In its submittal of APR1400 DCD Tier 2 Section 14.2, Revision 1 (ML17096A392), the DC applicant substantially revised the list of COL information items to incorporate other areas of COL responsibility that were identified by the applicant and in response to RAIs from the staff. The staff verified that the aforementioned recommended changes were incorporated into the APR1400 DCD. The staff determined that by adopting the proposed text, and making the appropriate modifications to APR1400 DCD, Subsections 14.2 and 14.2.13, the response meets RG 1.206, Section C.I.14, SRP Section 14.2, and RG 1.68 and is acceptable. Therefore, RAI 91-7867, Question 14.02-4 was resolved and closed. The DCD Tier 2 Section 14.2.13 contains 19 COL items pertaining to the ITP. The acceptability of these COL items is evaluated above in this SER section. The staff concluded that no additional COL items were needed.

Table 14.2-1 Combined License Items Identified in the DCD

Item No.	Description	Section
14.2(1)	The COL applicant is to develop the site-specific organization and staffing level appropriate for its facility to implement the initial test program. The COL's plant operating and plant technical staff should participate, to the extent practical, in developing and conducting the Initial Test Program and evaluating the test results.	14.2

Item No.	Description	Section
14.2(2)	The COL applicant is to prepare the site-specific preoperational and startup test specifications and test procedures and/or guidelines that is to be used for the conduct of the plant Initial Test Program. The preoperational and startup test procedures should have controls in place to ensure that test procedures include appropriate prerequisites, objectives, safety precautions, initial test conditions, methods to direct and control test performance and test acceptance criteria by which the test is evaluated. Testing performed at other than design operating conditions for systems is to be reconciled either through the test acceptance criteria or post-test data analysis. These procedures are to be submitted at least 60 days prior to their intended use to the NRC staff for review as described in Subsection 14.2.11.	14.2
14.2(3)	The COL applicant is to prepare a startup administrative manual (SAM) which contains administrative controls that govern the conduct of each major phase of the ITP. This description should include the administrative controls used to ensure that necessary prerequisites are satisfied for each major phase and for individual tests. The COL applicant should also describe the methods to be followed in initiating plant modifications or maintenance tasks that are deemed to be necessary to conduct the ITP. This description should include methods used to ensure retesting following such modifications or maintenance. In addition, the description should discuss the involvement of design organizations with the COL applicant in reviewing and approving proposed plant modifications. The COL applicant should also describe in the SAM adherence to approved test procedures during the conduct of the ITP as well as the methods for effecting changes to approved test procedures.	14.2
14.2(4)	The COL applicant is to develop the test procedure including a listing of the high- and moderate-energy piping systems inside containment that are covered by the vibration, thermal expansion, and dynamic effects testing program.	14.2
14.2(5)	The COL applicant is to develop the test procedure including a listing of the different flow modes to which the systems will be subjected during the vibration, thermal expansion, and dynamic effects testing program to confirm that the piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under the steady-state and operational transient conditions anticipated during service.	14.2
14.2(6)	The COL applicant is to develop the test procedure including a description of the thermal motion monitoring program for verification of snubber movement, adequate clearances and gaps, the acceptance criteria, and the method regarding how motion will be measured.	14.2

Item No.	Description	Section
14.2(7)	The COL applicant is to perform review and evaluation of individual test results in a test report made available to NRC personnel after preoperational and startup tests are completed. The specific test acceptance criteria for determining success or failure of a test shall be included in the test report approval of the test results. The test report should also include test results associated with any license conditions in the plant specific Initial Test Program.	14.2
14.2(8)	The COL applicant is responsible for establishing hold points at selected milestones throughout the power ascension test phase to ensure that designated personnel or groups evaluate and approve relevant test results before proceeding to the next power ascension test phase. At a minimum, the COL applicant should establish hold points at approximately 25- percent, 50- percent, and 75-percent power-level test conditions for pressurized-water reactors.	14.2
14.2(9)	<p>The COL applicant is responsible for retaining preoperational and startup test procedures and test results as part of the plant's historical records in accordance with 10 CFR 50.36, "Technical Specification," 10 CFR 50.71, "Maintenance of Records, Making of Reports," 10 CFR 50, Appendix B, Criterion XVII, "Test Records," and RG 1.28, "Quality Assurance Program Criteria (Design and Construction)."</p> <p>The preoperational and startup testing procedures and test results are to be retained for the life of the plant be the COL applicant.</p>	14.2
14.2(10)	The COL applicant is to describe its program for reviewing available information on reactor operating and testing experiences and discusses how it used this information in developing the initial test program. The description is to include the sources and types of information reviewed, the conclusions or findings, and the effect of the review on the initial test program.	14.2
14.2(11)	The COL applicant is to provide a schedule for the development of plant procedures, as well as a description of how, and to what extent, the plant operating, emergency, and surveillance procedures are use-tested during the initial test program.	14.2
14.2(12)	The COL applicant that references the APR1400 design certification is to identify the specific operator training to be conducted as part of the low-power testing program related to the resolution of TMI Action Plan Item I.G.1, as described in (1) NUREG-0660 – NRC Action Plans Developed as a Result of the TMI-2 Accident, Revision 1, August 1980 and (2) NUREG-0737 – Clarification of TMI Action Plan Requirements.	14.2

Item No.	Description	Section
14.2(13)	The COL applicant is to develop a sequence and schedule for the development of the plant operating and emergency procedures should allow sufficient time for trial use of these procedures during the Initial Test Program. The sequence and schedule for plant startup is to be developed by the COL applicant to allow sufficient time to systematically perform the required testing in each phase.	14.2
14.2(14)	The COL applicant is to perform the appropriate interface testing of the gaseous PERMSS monitors with ERDS.	14.2
14.2(15)	The COL applicant is to prepare the preoperational test of cooling tower and associated auxiliaries, and raw water and service water cooling systems.	14.2
14.2(16)	The COL applicant is to develop the test program of personnel monitors, radiation survey instruments, and laboratory equipment used to analyze or measure radiation levels and radioactivity concentrations.	14.2
14.2(17)	The COL applicant is to prepare the site-specific preoperational and startup test specification and test procedure and/or guideline for plant and offsite communication system.	14.2
14.2(18)	The COL applicant is to prepare the pre-operational test of ultimate heat sink pump house.	14.2
14.2(19)	The COL applicant is to prepare the testing and verification of ultimate heat sink cooling chains.	14.2

Conclusion

The staff finds that list of COL information items adequately describes the actions necessary for the COL applicant or holder to implement the ITP in accordance with the guidance included in RG 1.206, Section C.I.14, SRP Section 14.2, and RG 1.68, and is therefore acceptable. All issues relating to this section of the ITP have been resolved.

14.2.6 Conclusion

As discussed above, the staff completed its review of APR1400 DCD, Chapter 14.1 and 14.2, and concluded that, the DC applicant has fully addressed the information related to the ITP. The staff used the requirements of 10 CFR 30.53(c); 10 CFR 50.34(b)-(6)(iii); 10 CFR 50.43(e); 10 CFR Part 50, Appendix A, GDC 1; Appendix B to 10 CFR Part 50, Criterion XI; Appendix J to 10 CFR Part 50; 10 CFR 52.79(a)(28); 10 CFR Part 52, Subpart A, Subpart B, and Subpart C; and the guidance in SRP Section 14.2 as the bases for evaluating the acceptability of the KHNP's ITP.

14.3 Inspections, Tests, Analyses and Acceptance Criteria

14.3.1 Selection Criteria and Methodology for FSAR Tier 1

14.3.1.1 Introduction

Section 14.3 of this SER describes the NRC staff's evaluation of the DCD Tier 1 for the APR1400 design and the review of the applicant's bases, processes, and selection criteria used to develop the Tier 1 material. This section also addresses the technical adequacy and completeness of the ITAAC given in DCD Tier 1 or references other portions of this SER where those items are evaluated. The staff reviewed DCD Tier 1 for the type of information and the level of detail as discussed in SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," which states in part that the Tier 1 information is based on a graded approach commensurate with the safety significance of the SSCs for the design. Section 14.3 of this SER also describes the staff's evaluation of information contained in DCD Tier 2, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," and DCD Tier 1.

The Tier 1 information includes the following:

- Definitions and general provisions.
- Design descriptions.
- ITAAC.
- Significant site parameters.
- Significant interface requirements.

The applicant intends to have this Tier 1 information certified in a DC rulemaking pursuant to Subpart B of 10 CFR Part 52, "Standard Design Certifications." To be certified, the Tier 1 information must address the complete scope of the design to be certified. The amount of information in the Tier 1 design descriptions is proportional to the safety significance of the structures and systems in the standard plant design. The Tier 1 design descriptions are binding requirements for the life of a facility referencing the certified design.

The Tier 1 design descriptions, interface requirements, and site parameters are derived from Tier 2 information. The staff's review of how the underlying Tier 2 information satisfies the NRC's regulations is documented throughout this SER, and these conclusions also apply to the same information included in Tier 1. Thus, for the Tier 1 design descriptions, interface requirements, and site parameters, the additional staff review is limited to addressing whether Tier 1 includes appropriate information from Tier 2.

The purpose of the ITAAC portion of the Tier 1 information is to verify that a facility referencing the DC has been constructed and will be operated in accordance with the certified design, the Atomic Energy Act of 1954, as amended, and applicable regulations. The principal performance characteristics and safety functions of the SSCs are verified by the appropriate ITAAC.

14.3.1.2 Summary of Application

DCD Tier 1: The Tier 1 information associated with Section 14.3 is summarized below and discussed in the SER 14.3 subsections that evaluate the different aspects of the APR1400 standard design.

Definitions and general provisions: The definitions and general provisions are provided in DCD Tier 1 Sections 1.1 and 1.2.

Design descriptions: Design descriptions are provided in each subsection of the DCD Tier 1 Section 2 (Design Description and ITAAC).

ITAAC: The ITAAC are provided in Section 2 of the DCD Tier 1.

Significant site parameters: The significant site parameters postulated for the certified design are provided in DCD Tier 1 Section 2.1. They are applied for the design of the SSCs important to safety of the Certified Design.

APR1400 Interface Requirements identified in the DCD: The APR1400 Interface Requirements are described in DCD Tier 1 Section 3 and are associated with the following areas of review:

- Electrical System
- Ultimate Heat Sink
- Essential Service Water System

DCD Tier 2: DCD Tier 2 Section 14.3, discusses the criteria and methodology for selecting the SSCs to be included in the ITAAC. This section includes definitions and general provisions, design descriptions, ITAAC, significant site parameters, and significant interface requirements.

It specifically addresses the ITAAC for the SSCs within the scope of the APR1400 DCD. In addition, this section addresses the proposed APR1400 design acceptance criteria (DAC) for specific areas for which a design process has been prescribed to produce predictable and acceptable designs. DCD Tier 2 Section 14.3 also includes a proposed approach for completing the design-related ITAAC (i.e., DAC).

Technical Specifications (TS): There are no TS for this area of review.

Combine License (COL) information or action items: There are four COL Information Items associated with the APR1400 ITAAC.

Technical Report(s): There are no technical reports associated with this area of review.

Topical Report(s): There are no topical reports associated with this area of review.

14.3.1.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Section 14.3 of NUREG-0800. Review interfaces

with other SRP sections can be found in Section 14.3 of NUREG-0800. The applicable regulatory requirements are as follows:

- Title 10 CFR 52.47(b)(1), which requires that a DC application include the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the NRC's rules and regulations.
- Title 10 CFR 52.47(a)(26), which requires that a DC application provide justification that compliance with the interface requirements of 10 CFR 52.47(a)(25) is verifiable through inspections, tests, or analyses. The method to be used for verification of interface requirements must be included as part of the proposed ITAAC required by 10 CFR 52.47(b)(1).

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above can be found in Part II of Section 14.3 of NUREG-0800.

NUREG-0800, Section 14.3, describes the regulatory basis for acceptance of the ITAAC associated with a DC application. In reviewing the ITAAC, the staff also considered the guidance in NRC Regulatory Issue Summary (RIS) 2008-05, Revision 1, "Lessons Learned to Improve Inspections, Tests, Analyses, and Acceptance Criteria Submittal." Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants – Light Water Reactor Edition," provides COL applicants referencing a certified design, guidance on the development of site specific ITAAC and the use of ITAAC contained in a certified design. In DCD Tier 2, Section 14.3, the applicant provided the selection criteria and processes used to develop DCD Tier 1 ITAAC. The DCD Tier 1 information provides the principal design bases and design characteristics that are proposed for certification by the 10 CFR Part 52 rulemaking process and that would be included in the APR1400 rule.

14.3.1.4 Technical Evaluation

DCD Tier 2

The staff reviewed the information provided by the applicant in DCD Tier 2, Sections 14.3.1 and 14.3.2 in accordance with SRP Section 14.3. The staff finds it consistent with the staff review guidance and concludes that it is acceptable. As a result, the staff concludes that the applicant's implementation of the described selection criteria and methodology results in acceptable Tier 1 design descriptions and the ITAAC necessary to demonstrate that the facility has been constructed and will be operated in accordance with the certified design.

DCD Tier 1

The staff reviewed the following Tier 1 information which is derived from the DCD Tier 2 information: definitions and general provisions, design descriptions, ITAAC, significant site parameters and significant interface requirements.

The staff reviewed the DCD Tier 1 information in accordance with the guidance provided in SRP Section 14.3 and RIS 2008-05, the requirements in 10 CFR 52.47, and the AEA. The applicant organized its DCD Tier 1 information, as described in SRP Section 14.3.

Definitions and general provisions

The staff reviewed the definitions and general provisions in DCD Tier 1 Sections 1.1 and 1.2. The staff issued RAI 558-9456, Question 14.03.01-1 (ML18074A402) requesting the applicant add or modify the definitions of some of the terms in Tier 1 Section 1.1 and make wording changes to portions of the general provisions in Section 1.2 to clarify the technical content of the ITAAC. In its response to RAI 558-9456, Question 14.03.01-1 (ML18137A480), the applicant stated that the changes were reasonable and provided markups of DCD Tier 1 Sections 1.1 and 1.2. Since the proposed markups are consistent with the changes requested in the RAI, the staff finds the response acceptable. With the proposed changes, the staff finds that the definitions and general provisions are consistent with NRC guidance and reflect lessons learned from experience with Part 52 plants that commenced construction. Based on a review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 558-9456, Question 14.03.01-1 was resolved and closed.

Design descriptions and ITAAC

The staff reviewed the Design Descriptions provided in each subsection of the DCD Tier 1 Section 2, together with the associated ITAAC.

In accordance with SRP Section 14.3, DCD Tier 1 information should identify the principal performance characteristics and safety functions of the standard design. The design information includes design commitments that identify those features and capabilities that are necessary for compliance with the AEA and NRC rules and regulations, and that are to be verified by ITAAC. As required by 10 CFR 52.47(b)(1), the proposed ITAAC must be necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance with the DC, the provisions of the AEA, and the NRC's rules and regulations.

For the ITAAC to be "sufficient" as required by 10 CFR 52.47: (1) the inspections, tests, and analyses (ITA) must clearly identify those activities necessary to demonstrate that the acceptance criteria (AC) are met; (2) the AC must state clear design or performance objectives demonstrating that the Tier 1 design commitments (DCs) are satisfied; (3) the ITA and AC must be consistent with each other and the Tier 1 DC; (4) the ITAAC must be capable of being performed and satisfied prior to fuel load; and (5) the ITAAC, as a whole, must provide reasonable assurance that, if the ITAAC are satisfied, the facility has been constructed and will be operated in accordance with the DC, the AEA, and the NRC's rules and regulations.

Subsections 14.3.2 through 14.3.13 of this SER discuss the ITAAC listed in DCD Tier 1 Sections 2.2 through 2.13, respectively. These SER subsections either document the staff's review of the ITAAC in the associated Tier 1 Sections or identify other sections of the SER where the staff's review is being documented. In addition to the ITAAC review addressed in SER Subsections 14.3.2 to 14.3.13, the staff conducted a comprehensive review of all DCD Revision 1 Tier 1 ITAAC tables against the objectives identified in the previous paragraph and issued RAI 558-9456, Question 14.03.01-1 (ML18074A402), requesting the applicant:

- to make suggested ITAAC wording changes based on NRC guidance, and lessons learned from plants that are currently under construction that are in the process of implementing ITAAC, to ensure that the DC, ITA, and AC are consistent with each other and are clearly and unambiguously stated
- to make suggested ITAAC wording changes so that environmental qualification of Class 1E equipment does not rely solely on an analysis, consistent with 10 CFR 50.49(f).
- to clarify the technical content of some ITAAC
- to rectify some discrepancies
- to delete an ITAAC that could not be completed until after fuel load and to delete a programmatic ITAAC, which the Commission generally does not find necessary as discussed in SECY-05-0197, on a topic that would be the responsibility of a COL applicant
- to explain why ITAAC were not included to test the leak detection capacity of the containment atmosphere humidity monitor
- to explain why ITAAC were not included to require type testing, analysis, or a combination of type testing and analysis of the seismic category I components in the Containment Hydrogen Control System, and to require an inspection of the as-built components to verify that the as-built components were bounded by the tested or analyzed conditions.

In its response to RAI 558-9456, Question 14.03.01-1 (ML18137A480), the applicant:

- made the requested ITAAC wording changes, with a few exceptions where the applicant proposed acceptable alternative language to clarify the ITAAC.
- made additional ITAAC wording changes not requested in the RAI but which appropriately corrected references to Tier 1 table numbers and grammatical and spelling errors
- provided sufficient technical clarification when requested by the staff and revised the associated wording when needed
- corrected the discrepancies identified by the staff to ensure overall consistency
- agreed to delete the ITAAC when requested
- provided technical justification for why ITAAC are not included to test the leak detection capacity of the containment atmosphere humidity monitor consistent with responses to RAI 80-8040 Question 05.02.05-1 and RAI 369 8486 Question 05.02.05-3 which are discussed in Section 5.2.5 of this SER

- provided ITAAC to require type testing, analysis, or a combination of type testing and analysis of seismic category I components in the Containment Hydrogen Control System, and to require inspection of the as-built components to verify that the as-built components were bounded by tested or analyzed conditions

In addition, the applicant provided ITAAC wording changes incorporating comments provided in other RAIs submitting proposed or revised ITAAC or during public meetings held on March 7, 2018 (ML18068A129) and April 5, 2018 (ML18086B573). The staff finds these changes acceptable because they ensure the DC, ITA, and AC are consistent and clear as well as ensuring that the ITAAC are consistent with other Tier 1 information. Finally, the applicant made conforming changes to the Tier 1 design descriptions to reflect changes to the Tier 1 design commitments.

Therefore, the staff finds the applicant's response to be acceptable. The staff's review of this RAI response supports the staff's ITAAC review documented or referenced in Subsections 14.3.2 to 14.3.13 of this SER. Based on a review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 558-9456, Question 14.03.01-1 was resolved and closed.

The staff also finds that the Tier 1 design descriptions, as modified by the response to RAI 558-9456 Question 14.03.01-1, identify the principal performance characteristics and safety functions of the standard design. The staff's review of the Tier 1 design descriptions is based largely on the review of the ITAAC. Each ITAAC verifies a Tier 1 design commitment and corresponding design description describing a performance characteristic or safety function of the standard design. Given this, the staff's conclusion that the ITAAC are sufficient to verify that the as-built plant complies with the AEA and NRC rules and regulations, also reflects a conclusion that the corresponding Tier 1 design commitments and design descriptions include the principal performance characteristics and safety functions of the standard design. Based on a review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 558-9456, Question 14.03.01-1 was resolved and closed.

Site parameters

The staff's evaluation of site parameters is provided in Section 2 of this SER.

Interface requirements

Based on engineering judgement, the staff agrees that the applicant has included the significant interface requirements in Tier 1 Section 3.1 of the DCD.

The applicant provided 10 interface requirements for the electrical system in Tier 1 Section 3.1 of the DCD. The staff's evaluation of the interface requirements and the basis for the staff's finding that they meet 10 CFR 52.47(a)(25) can be found in Section 8.2 of this SER. The applicant did not propose specific ITAAC to verify these interface requirements. Therefore, COL applicants referencing the APR1400 have the responsibility for developing ITAAC to verify these interface requirements, as appropriate. Based on engineering judgement and experience in the review of previous site-specific ITAAC, the staff finds that ITAAC could be developed by a COL applicant to verify each of these interface requirements. Therefore, the provisions of 10 CFR 52.47(a)(26) have been met.

The applicant provided 16 interface requirements for the UHS in Tier 1 Section 3.2 of the DCD. The staff's evaluation of the interface requirements and the basis for the staff's finding that they meet 10 CFR 52.47(a)(25) can be found in Section 9.2 of this SER. The applicant did not propose specific ITAAC to verify these interface requirements. Therefore, COL applicants referencing the APR1400 have the responsibility for developing ITAAC to verify these interface requirements, as appropriate. Based on engineering judgement and experience in the review of previous site-specific ITAAC, the staff finds that ITAAC could be developed by a COL applicant to verify each of these interface requirements. Therefore, the provisions of 10 CFR 52.47(a)(26) have been met.

The applicant provided two interface requirements for the essential service water system in Tier 1 Section 3.3 of the DCD. The staff's evaluation of the interface requirements and the basis for the staff's finding that they meet 10 CFR 52.47(a)(25) can be found in Section 9.2 of this SER. The applicant did not propose specific ITAAC to verify these interface requirements. Therefore, COL applicants referencing the APR1400 have the responsibility for developing ITAAC to verify these interface requirements, as appropriate. Based on engineering judgement and experience in the review of previous site-specific ITAAC, the staff finds that ITAAC could be developed by a COL applicant to verify each of these interface requirements. Therefore, the provisions of 10 CFR 52.47(a)(26) have been met.

14.3.1.5 Combined License Information Items

The DCD Tier 2 Table 1.8-2 lists four COL items pertaining to ITAAC. These COL items are evaluated in SER Sections 13.3, 14.3.7, 14.3.9, and 14.3.12.

Table 14.3-1 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 14.3(1)	The COL applicant is to provide the ITAAC for the site-specific portion of the plant systems specified in DCD Tier 2, Subsection 14.3.3.	14.3
COL 14.3(2)	The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC as addressed in DCD Tier 2, Subsection 14.3.2.9.	14.3
COL 14.3(3)	The COL applicant is to provide the proposed ITAAC for the facility's emergency planning not addressed in the DCD in accordance with RG 1.206.	14.3
COL 14.3(4)	The COL applicant is to provide the proposed ITAAC for the site specific facility's physical security hardware not addressed in the DCD in accordance with RG 1.206.	14.3

14.3.1.6 Conclusion

The staff has reviewed the description in DCD Tier 2, Section 14.3 of the applicant's criteria and methodology for selecting the SSCs to be included and described in DCD Tier 1, as well as the associated ITAAC, in accordance with SRP Section 14.3. The staff also reviewed the Tier 1

definitions, general provisions, and design descriptions. Finally, the staff reviewed whether ITAAC can be developed for the Tier 1 interface requirements.

The staff concludes that information provided in DCD Tier 2, Section 14.3 describes acceptable criteria and methodology for selecting the SSCs to be included in DCD Tier 1. The staff also concludes that the requirements in 10 CFR 52.47(a)(26) are met because ITAAC can be developed for the Tier 1 interface requirements.

Furthermore, the staff concludes that the Tier 1 definitions, general provisions, and design descriptions are acceptable. Finally, based on the ITAAC review documented or referenced in SER Subsections 14.3.2 to 14.3.13, the staff finds that the requirements of 10 CFR 52.47(b)(1) are satisfied, because the APR1400 ITAAC are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will operate in accordance with the DC, the AEA, and the NRC's rules and regulations.

14.3.2 Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.2.1 Introduction

In DCD Tier 2, Section 14.3, the applicant discussed the selection criteria and methods used to develop the DCD Tier 1 information, including the ITAAC. In DCD Tier 1, the applicant includes the portion of the design-related information that, if acceptable, would be approved, certified, and incorporated by reference into a new DC rule for the APR1400 design. The design descriptions, interface requirements, and site parameters are derived from DCD Tier 2 information.

In DCD Tier 2, Section 14.3.2.2, the applicant addressed ITAAC related to structural and systems engineering. The scope of the structural and systems engineering ITAAC covers the major structural systems in the APR1400 standard design facility, including the reactor pressure vessel (RPV); Class 1, 2, and 3 piping systems defined by the ASME Code; and major building structures of the APR1400 standard design.

As part of the review of each system in the APR1400 structural and systems engineering design, the staff reviewed the ITAAC with respect to the systems described in the DCD and in accordance with the SRP (NUREG-0800) Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," and Section 14.3.2, "Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria." The staff reviewed the ITAAC to determine whether these are necessary and sufficient to provide reasonable assurance that, if the ITAAC are successfully completed, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations. In addition, the staff reviewed interface requirements for structural and systems engineering systems.

14.3.2.2 Summary of Application

DCD Tier 1: The applicant provided design descriptions and ITAAC for structural and systems engineering in DCD Tier 1, Chapter 2.0, "Design Description and ITAAC." The applicant provided the design descriptions and ITAAC for building structures in DCD Tier 1, Section 2.2, "Structural and Systems Engineering."

DCD Tier 2: In DCD Tier 2, Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria,” the applicant provided a general description of the APR1400 ITAAC, the ITAAC selection criteria, and ITAAC content. In DCD Tier 2, Section 14.3.2, “Tier 1, Chapter 2: Design Descriptions and ITAAC,” the applicant provided a general description of the approach used to develop DCD Tier 1, Chapter 2.0. The applicant provided ITAAC descriptions for structural and systems engineering in DCD Tier 2, Section 14.3.2.2.

ITAAC: The applicant provided ITAAC for structural and systems engineering in DCD Tier 1, Section 2.2 as follows:

- Section 2.2.1, “Nuclear Island Structures”
- Section 2.2.2, “Emergency Diesel Generator Building”
- Section 2.2.3, “Turbine Generator Building”
- Section 2.2.4, “Compound Building”
- Section 2.2.5, “Protection against Hazards”
- Section 2.2.6, “Reactor Vessel Internals”
- Section 2.2.7, “In-core Instrument Guide Tube System”
- Section 2.2.8, “Essential Service Water Building ITAAC”
- Section 2.2.9, “Component Cooling Water Heat Exchanger Building ITAAC”

TS: There are no TS provided for this area of review.

14.3.2.3 Regulatory Basis

The relevant requirements for the Commission regulations for this area of review, and the associated acceptance criteria, are given in Sections 14.3 and 14.3.2 of NUREG-0800. Review interfaces with other SRP sections are also identified in these SRP sections.

The applicable regulatory requirements are as follows:

- Title 10 CFR 52.47(b)(1), “Contents of applications; technical information,” as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

Specific acceptance criteria found in SRP Section 14.3.2 are listed below:

- Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, General Design Criteria (GDC) 1, “Quality Standards and Records,” as it relates to codes and standards.
- GDC 2, “Design Bases for Protection Against Natural Phenomena,” as it relates to normal loads; seismic loads; flood, wind, and tornado loads; and rain and snow loads.
- GDC 4, “Environmental and Dynamic Effects Design Bases,” as it relates to suppression pool hydrodynamic loads and pipe rupture loads.

- GDC 14, “Reactor Coolant Pressure Boundary”; GDC 16, “Containment Design”; and GDC 50, “Containment Design Basis”; as they relate to pressure boundary integrity.
- Appendix J, “Primary Reactor Containment Leakage Testing for Water Cooled Power Reactors,” to 10 CFR Part 50, as it relates to containment leak rate testing.

14.3.2.4 Technical Evaluation

The staff performed its review of the ITAAC in accordance with SRP Section 14.3 and SRP Section 14.3.2, particularly the applicable review procedures identified in Section III of each SRP section, as well as the guidance provided by RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria.” The staff examined the ITAAC to ensure that the ITAAC can be inspected by the organization holding the combined license and closed out by the NRC. The staff also reviewed the phrasing and format of the ITAAC to determine that the Design Commitment wording; the Inspection, Test, or Analysis; and the Acceptance Criteria are parallel and in agreement. In addition, the staff determined that the DCD Tier 1 ITAAC items were derived from the DCD Tier 2 information.

In DCD Tier 1, Section 2.2, the applicant discussed the nuclear island (NI) structures, emergency diesel generator building (EDGB), turbine generator building (TGB), compound building (CPB), protection against hazards, structural aspects of the reactor pressure vessel and in-core instrument guide tube system, the essential service water building (ESWB), and the component cooling water heat exchanger building (CCWHXB). This section also provides the ITAAC tables that define the activities to be performed to verify that the as-built structures and systems conform to the design features and performance characteristics contained within the design description, as well as the acceptance criteria for these activities.

The staff’s detailed evaluation of the ITAAC is documented in the respective sections listed in the table below.

Table 14.3-2 Cross References for the Staff’s Evaluation of Structural and Systems Engineering ITAAC

DCD Tier 1 Section	Title	ITAAC Table	SER Section(s)	SER Section for 52.47(b)(1) Finding
2.2.1	Nuclear Island Structures	2.2.1-2	14.3.2	14.3.2
2.2.2	Emergency Diesel Generator Building	2.2.2-2	14.3.2	14.3.2
2.2.3	Turbine Generator Building	2.2.3-1	14.3.2	14.3.2

DCD Tier 1 Section	Title	ITAAC Table	SER Section(s)	SER Section for 52.47(b)(1) Finding
2.2.4	Compound Building	2.2.4-1	14.3.2	14.3.2
2.2.5	Protection against Hazards	2.2.5-1	3.4.1 3.5.1 9.5.1 14.3.2	14.3.2
2.2.6	Reactor Vessel Internals	2.2.6-2	3.9.5 14.3.3	3.9.5
2.2.7	In-core Instrument Guide Tube System	2.2.7-2	3.9.5 14.3.3	3.9.5
2.2.8	Essential Service Water Building	2.2.8-1	14.3.2	14.3.2
2.2.9	Component Cooling Water Heat Exchanger Building	2.2.9-1	14.3.2	14.3.2

14.3.2.4.1 Design Description and Key Building Dimensions for Structures

The staff reviewed the information in DCD Tier 1, Section 2.2, which includes the design descriptions, key dimensions, and the ITAAC for the key buildings (i.e., NI, EDGB, TGB, CPB, ESWB, and CCWHXB). The design commitment in item 1 of DCD Tier 1, Table 2.2.1-2, "Nuclear Island Structures ITAAC," states that Figures 2.2.1-1 through 2.2.1-13, show the basic configuration of the NI structures. Similarly, design commitment 1 of Tier 1 Table 2.2.2-2, "Emergency Diesel Generator Building ITAAC," states that Figures 2.2.2-1 and 2.2.2-2 show the basic configuration of the EDGB. The design commitment in item 4 states that Table 2.2.1-1, "Definition of Wall and Floor Thicknesses for Nuclear Island Structure," and Figures 2.2.1-1 through 2.2.1-13, describe the dimensions and elevations of the NI structures. Similarly, for the EDGB building, DCD Tier 1, Table 2.2.2-1, "Definition of Wall and Floor Thicknesses for Emergency Diesel Generator Building," and Figures 2.2.2-1 and 2.2.2-2, describe the dimensions and elevations of the EDG building. There are ITAAC to verify these design commitments for the NI and EDGB. DCD Tier 1 Sections 2.2.1 and 2.2.2 provide design descriptions and ITAAC to address the ability of the NI structures and the EDGB to withstand

design basis loads and the design and construction of these structures in accordance with applicable codes and standards, as discussed below.

When evaluating the acceptability of design information for seismic Category I structures, the staff's review focuses on a subset of structural information that includes seismic analysis methods, key dimensions of seismic Category I structures, and design of "critical sections." However, even minor changes to these critical sections could, when applied to the entire safety-related structure, result in significant changes to the overall performance of the structure. Therefore the staff requested in RAI 557-9199 Question 03.08.05-20 (ML17335A776) to add the critical sections to Tier 1. In its response to RAI 557-9199 Question 03.08.05-20 (ML18150A582), the applicant added Table 2.2.1-4, "Critical Sections and Design Attributes," for the NI and the EDGB. The applicant also provided ITAAC to verify: (1) the critical sections and design attributes of the NI and EDGB; and (2) the design and construction of the NI and EDGB and the site-specific structures, the ESW and the CCWHX buildings, are in accordance with the applicable codes and standards listed in Table 2.2.1-5 of DCD Tier 1. The staff reviewed Table 2.2.1-4 and the ITAAC in Table 2.2.1-2, Items 5 and 6; ITAAC Table 2.2.2-2, Items 4 and 5; ITAAC Table 2.2.8-1, Item 2; and ITAAC Table 2.2.9-1, Item 2, and considers the ITAAC proposed by the applicant to be acceptable because the ITAAC provide necessary information to verify the structural integrity of these buildings so that they can withstand seismic design bases loads without loss of their safety functions. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 557-9199, Question 03.08.05-20 was resolved and closed.

In DCD Tier 1, Section 2.2.2, the applicant stated that the EDGB block comprises two extra buildings: one that houses an additional two generators, and one that houses the diesel fuel oil tank (DFOT). The staff issued RAI 255-8285, Question 03.08.05-06 (ML15293A569), requesting the applicant to provide the ITAAC items for the DFOT building. In its response to RAI 255-8285, Question 03.08.05-06 (ML16036A129), the applicant clarified that the DFOT building is part of the EDGB block and, thus, the ITAAC items listed in Table 2.2.2-2 of DCD Tier 1, Section 2.2.2.1, also apply to the DFOT. The applicant also provided marked-up changes of the ITAAC. The staff reviewed the response and finds the proposed changes acceptable in clarifying the applicability of the ITAAC to the DFOT building, a major structural system in the APR1400 design. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 255-8285, Question 03.08.05-06. Therefore, the staff considers RAI 255-8285, Question 03.08.05-06, resolved and closed.

As indicated in Tier 2, Section 1.2.14, Rev. 2, the seismic and structural design of the TGB, CPB, ESWB, and CCWHXB are not within the scope of the certified design, but will be performed by the COL applicant. Nonetheless, Tier 1 Sections 2.2.3, 2.2.4, 2.2.8, and 2.2.9 provide design descriptions and ITAAC for these structures. For the TGB and CPB, the design descriptions and ITAAC relate to ensuring that failure of these Seismic Category II structures do not impair the ability of the safety-related SSCs to perform their safety-related functions. For the ESWB and CCWHXB, the design descriptions and ITAAC relate to ensuring that these structures can withstand the structural design basis loads.

The staff reviewed these tables and figures and finds the ITAAC for the NI, EDGB, TGB, CPB, ESWB, and CCWHXB includes the major structural systems in the APR1400 design to verify the structural capability of the buildings consistent with SRP acceptance criterion 14.3.2.II.2. The detailed review of the following items are in the next subsections:

- Standard design structural integrity
- Pressure boundary integrity
- Normal and seismic loads
- External loads
- Pipe break
- Codes and standards
- As-built reconciliation

14.3.2.4.2 Standard Design Structural Integrity

The staff reviewed DCD Tier 1, Section 2.2, in which the applicant addressed the building structures and structural aspects of the major components. Specifically, the following ITAAC verification criteria for the major structural systems are found in DCD Tier 1:

- Table 2.2.1-2 for the NI
- Table 2.2.2-2 for the EDGB
- Table 2.2.5-1 for protection against hazards (external flood, internal flood, fire barrier, and internally generated missiles) inside and outside containment
- Table 2.2.8-1 for the ESWB
- Table 2.2.9-1 for the CCWHXB

The staff reviewed the information in the tables and determined that the ITAAC verifies the following:

- The NI and EDGB structures are classified, designed, and constructed to withstand design-basis loads associated with normal plant operation loads and loads generated by external and internal events.
- The containment and containment penetrations are designed and constructed to meet the criteria in ASME B&PV Code, Section III, Division 2, and ASME B&PV Code, Section III, respectively.
- The containment and its penetrations are designed to maintain the containment allowable leak rate associated with peak containment pressure for the design-basis accident.

In addition, the staff determined that the ITAAC for the site-specific seismic Category I structures (ESWB and CCWHXB) identified in the DCD Tier 1, Tables 2.2.8-1 and 2.2.9-1, are acceptable because the ITAAC provide the necessary information to verify that the structural integrity of these buildings can withstand seismic design bases loads without loss of its safety functions.

The staff finds that the ITAAC in the aforementioned tables have sufficient information to verify the design and construction of structures to maintain structural integrity consistent with SRP criterion 14.3.2.II.3.

14.3.2.4.3 Pressure Boundary Integrity

The staff reviewed DCD Tier 1, Table 2.2.1-2, which lists the design commitment for the NI structures in item 2.c, and states that the containment and its penetrations retain their pressure boundary integrity associated with design pressure, and the acceptance criteria requires the

results of the structural integrity test on the containment and its penetrations conform with the pressure testing acceptance criteria in ASME B&PV Code, Section III, Division 2. In addition, item 2.d states the containment and its penetrations maintain the containment leakage rate less than or equal to the maximum allowable leakage rate associated with the peak containment pressure for the design basis accident, and the acceptance criteria uses the allowable limits specified in 10 CFR Part 50, Appendix J. Together, these ITAAC verify the pressure boundary integrity of the primary containment consistent with the SRP acceptance criterion 14.3.2.II.4; therefore, the staff finds the ITAAC acceptable.

In DCD Tier 1, Tables 2.2.6-2 and 2.2.7-2, the applicant proposed ITAAC for the reactor vessel internals and the in-core instrument guide tube system. The staff evaluated the structural and systems engineering related ITAAC in SER Section 3.9.5. In SER Section 14.3.3, the staff evaluated the piping and component related ITAAC. The staff conclusion on ITAAC Tables 2.2.6-2 and 2.2.7-2, is found in SER Section 3.9.5.

14.3.2.4.4 Normal and Seismic Loads

In DCD Tier 1, Section 2.2.1, 2.2.2, 2.2.8, and 2.2.9, the applicant states that the NI structures, EDGB, ESWB, and CCWHXB are designed and constructed to withstand the design-basis loads associated with normal plant operations (including dead live loads, lateral earth pressure loads, hydrodynamic loads and equipment loads, the effect of temperature and equipment vibration), external events (including earthquake), and internal events (including pipe rupture). In DCD Tier 1 the design commitment in Table 2.2.1-2, item 3, Table 2.2.2-2, item 2, Table 2.2.8-1, item 1, and Table 2.2.9-1, item 1, respectively states that the NI structures, EDGB, ESWB, and CCWHXB are designed and constructed to withstand the design-basis loads, which will be verified and documented in a structural analysis report created to satisfy the corresponding ITAAC for this design commitment.

Therefore, the staff finds these ITAAC acceptable because they meet the SRP acceptance criterion 14.3.2.II.5, for an analysis to reconcile the as-built plant with the structural design-basis loads (which include the combination of normal and accident loads with the effects of natural phenomena), and SRP acceptance criterion 14.3.2.II.6, related to the verification that the safety-related systems and structures have been designed to seismic loads.

The staff reviewed the nonseismic Category I structures discussed in DCD Tier 1, Section 2.2.3 and Table 2.2.3-1, item 1 (the TGB), and DCD Tier 1, Section 2.2.4 and Table 2.2.4-1, item 1 (the CPB). Each ITAAC states that seismic Category II buildings do not impair the ability of safety-related SSCs to perform their safety-related function as verified through analyses and inspections, and documented in a report. However, in DCD Revision 0, Tier 1, the applicant did not mention the AAC gas turbine generator building, which is characterized as a seismic Category II structure in DCD Tier 2, Table 3.2-1, "Classification of Structures, Systems, and Components." Therefore, the staff issued RAI 252-8299, Question 03.07.02-15, item (b) (ML15293A566), requesting the applicant to clarify the interaction of the AAC gas turbine generator building with the seismic Category I structures. In its response to RAI 252-8299, Question 03.07.02-15 (ML16089A155), the applicant stated that the AAC gas turbine generator building is located at a considerable distance from the seismic Category I structures and that the interaction criterion for the building is maintenance of sufficient separation between nonseismic Category I structures and seismic Category I structures.

The staff reviewed DCD Tier 2, Figure 1.2-1, and concluded that the AAC gas turbine generator building is at a sufficient distance from seismic Category I structures and does not impair the integrity of an adjacent seismic Category I structure or affect the ability of safety-related SSCs to perform their safety-related function under the effect of a seismic event. The staff confirmed that the DCD was revised as committed to in the response to RAI 252-8299, Question 03.07.02-15. Therefore, the staff considers RAI 252-8299, Question 03.07.02-15, resolved and closed. Based on the discussion above, the staff finds the ITAAC for the nonseismic Category I structures acceptable because the ITAAC conforms to SRP acceptance criterion 14.3.2.II.6, which states that the failure of these structures will not impair the ability of nearby safety-related SSCs to perform their safety-related functions.

For piping, SRP acceptance criterion 14.3.3.II.1, states that DCD Tier 1 should require an ASME B&PV Code-certified stress report to ensure that the ASME B&PV Code Class 1, 2, or 3 piping systems and components are designed to retain their pressure integrity and functional capability under internal design and operating pressures and design-basis loads. In addition, SRP Section 14.3.3, states that DCD Tier 1 should ensure that the piping systems will be designed to perform their safety-related functions under all postulated combinations of normal operating conditions, system operating transients, postulated pipe breaks, and seismic events. The staff addresses the pressure integrity and functional capability of the piping systems in SER Section 14.3.3.

14.3.2.4.5 Flood, Wind, Tornado, Hurricane, Rain, and Snow

In DCD Tier 1, Section 2.2.1, the applicant stated that the NI structures are designed and constructed to withstand the design loads associated with external events including rain, snow, wind, flood, hurricane, hurricane-generated missiles, and earthquake. The applicant did not include tornado in the list. The staff issued RAI 247-8314, Question 14.03.02-1 (ML15296A015), requesting that the applicant add the tornado effect to the list. In its response to RAI 247-8314, Question 14.03.02-1 (ML15327A441), the applicant added tornadoes and tornado-generated missiles to the list of external events that the NI structures are designed and constructed to withstand. The staff confirmed that DCD Tier 1 was revised as committed to in the response to RAI 8314, Question 14.03.02-1. Therefore, the staff considers RAI 247-8314, Question 14.03.02-1, resolved and closed. The EDGB, ESWB, and CCWHXB also have design description and ITAAC requiring these structures to withstand design basis loads associated with external events. However, the Tier 1 list of external events did not include tornadoes, tornado generated missiles, and hurricanes. The staff informed KHNP of this discrepancy in a meeting on May 3, 2018. In its response to RAI 557-9199 Question 03.08.05-20, (ML18150A582) the applicant added this missing information. Therefore, the staff concludes that Tier 1 design descriptions and ITAAC for the NI structures, the EDGB, the ESWB, and CCWHXB address the applicable requirements of GDC 2 and verify that the structures have been designed to withstand the effects of the natural phenomena identified in SRP acceptance criterion 14.3.2.II.8

In DCD Tier 1, Section 2.2.5.1.2, "Internal Flooding," the applicant states, in part, that key characteristics of the protective provisions against internal flooding hazards are divisional flood barriers provided in the NI against the internal flooding, and that safety-related electrical, instrumentation, and control equipment are located above the internal design flood level. However, the applicant did not provide any specific measurements. The staff issued RAI 247-8314, Question 14.03.02-3 (ML15296A015), requesting the applicant to provide the measurements from the floor of the division walls and the distance between the floor and the

safety-related electrical, instrumentation, and control equipment. In its response to RAI 247-8314, Question 14.03.02-3 (ML15327A441), the applicant stated that the penetrations in the divisional walls are at least 2.5 m (8.2 feet) above the floor, and the minimum installation height above the floor for safety-related electrical, instrumentation, and control equipment is 20 cm (7.9 inches). The staff finds that the response is consistent with the SRP acceptance criterion 14.3.2.II.8; therefore, ITAAC 2 in Table 2.2.5-1, is acceptable. The staff confirmed that DCD Tier 1 was revised as committed in the response to RAI 247-8314, Question 14.03.02-3. Therefore, RAI 247-8314, Question 14.03.02-3 was resolved and closed.

In DCD Tier 1, Section 2.2.5, and Table 2.2.5-1, item 1, the applicant provides ITAAC that can verify flood protection features consistent with SRP 14.3.2.II.8; i.e., external walls below flood level are equal to or greater than 0.6 meter (2 feet) to protect against water seepage. Therefore, the staff finds this acceptance criterion acceptable. DCD Tier 1, Section 2.2.5.1.2, addresses the internal flooding sources from high-energy or moderate-energy piping failure, and non-seismically designed component or tank failure, including the operation of the fire protection system. In DCD Tier 1, Table 2.2.5-1, item 2, the applicant provides the characteristics of the protective provisions against internal flooding. The staff evaluated this ITAAC in SER Section 3.4.1.4.10, "ITAAC for Internal Flood Protection for Onsite Equipment Failures."

In DCD Tier 1, Section 2.2.5.1.3, and Table 2.2.5-1, item 3, the applicant discusses the key characteristics of the protective provisions against fire hazards and the ITAAC to verify the as-built design. The staff discusses the protection against fire hazards in SER Section 9.5.1, and the staff's evaluation of the fire protection ITAAC. Similarly, DCD Tier 1, Section 2.2.5.1.4 and Table 2.2.5-1, item 4, discuss the protective provisions against internally generated missiles. The staff discusses protection against this hazard and this ITAAC in SER Section 3.5.1.

14.3.2.4.6 Pipe Break

DCD Tier 1, Section 2.3, "Piping Systems and Components," addresses the analysis of protection against the dynamic effects of piping rupture. The staff evaluates the piping ITAAC in SER Section 14.3.3.

14.3.2.4.7 Codes and Standards

The NRC endorses the ASME B&PV codes under 10 CFR 50.55a, "Codes and Standards," and referenced in the ITAAC tables found in DCD Tier 1, Section 2.2, for the design and construction of safety-related systems and components. Therefore, the staff finds the applicant's use of these codes and standards acceptable and consistent with the SRP acceptance criterion 14.3.2.II.10, to ensure the applicable requirements of GDC 1 have been adequately addressed.

However, the staff noticed that some of the ITAAC were missing the code, section, division and/or class information. The staff issued RAI 247-8314, Question 14.03.02-1 (ML15296A015), requesting the applicant to specify the code, section, division, and class information in Table 2.2.1-2, items 2.a, 2.b, and 2.c, as applicable. In its response to RAI 247-8314, Question 14.03.02-1 (ML15327A441), the applicant added the applicable code, sections, divisions, and class information. The staff confirmed that DCD Tier 1 was revised as committed to in the response to RAI 247-8314, Question 14.03.02-1. Therefore, RAI 247-8314, Question 14.03.02-1 was resolved and closed.

As Part of the Tier 1 review, the staff issued RAI 557-9199, Question 03.08.05-20 requesting the applicant to identify the applicable codes and standards used for the design of the APR1400. In its response to RAI 557-9199 Question 03.08.05-20 (ML18150A582) the applicant added Table 2.2.1-5, "Principal Codes and Standards," listing the codes and standards used for the design of the NI, EDGB, ESWB, and CCWHXB. The applicant further stated that the tolerances for the dimensions in Table 2.2.1-1 and Figures 2.2.1-1 through 2.2.1-13 for the NI and in Table 2.2.2-1 and Figures 2.2.2-1 through 2.2.2-2 for the EDG building shall be in accordance with ACI 117 for concrete structures, ANSI/AISC 303 for structural steel members, and ASME Section III, Division 2, Subsection CC and applicable appendices related to tolerances for containment. The applicant also included a new COL Item (COL 3.8(22) stating that the COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, and/or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303 may be exceeded, for structural concrete and steel, respectively. The applicant provided the corresponding ITAAC to verify that these structures are designed and constructed in accordance with the applicable codes and standards for these structures. Therefore, the staff considers Tier 1 Table 2.2.1-1, Table 2.2.2-1, Table 2.2.1-2 item 5, Table 2.2.2-2 item 4, Table 2.2.8-1 item 2 and Table 2.2.9-1 item 2, Figures 2.2.1-1 through 2.2.1-13 and Figures 2.2.2-1 through 2.2.2-2 to be acceptable. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 557-9199, Question 03.08.05-20 was resolved and closed.

14.3.2.4.8 As-Built Reconciliation

As discussed in the previous subsections, the staff reviewed the ITAAC tables and confirmed that the inspections, test, analyses and acceptance criteria are consistent with SRP acceptance criterion 14.3.2.II.11, in ensuring that the final as-built plant structures are built in accordance with the certified design, including reference to structural analysis reports using the as-designed and as-built information. Therefore, the staff finds the ITAAC tables acceptable as regards as-built reconciliation.

14.3.2.5 Combined License Information Items

The DCD Tier 2 Section 3.8.6 contains the following COL information item. Based on the discussion above, the staff concludes that the COL information item is acceptable.

Table 14.3-3 Combined License Item Identified in the DCD

Item No.	Description	Section
COL 3.8(22)	The COL applicant may provide construction tolerance acceptance criteria and the basis for the criteria (e.g., through the use of analysis, industry research, and/or testing) for cases where the tolerances in ACI 117 and ANSI/AISC 303 may be exceeded, for structural concrete and steel, respectively.	3.8

The staff found the COL information item list to be complete because it adequately describes actions necessary for the COL applicant to perform. Therefore, no additional COL information items are needed for the construction tolerance acceptance criteria for concrete and steel structures.

14.3.2.6 Conclusion

Based on the discussion above and the additional information referenced in Table 14.3-2, the staff finds that the ITAAC proposed by the applicant in DCD Tier 1 Tables 2.2.1-2, 2.2.2-2, 2.2.3-1, 2.2.4-1, 2.2.5-1, 2.2.8-1, and 2.2.9-1 acceptable for structural and system engineering and are in accordance with the requirements in 10 CFR 52.47(b)(1). Specifically, the staff finds that these ITAAC will provide reasonable assurance that the final as-built condition of the plant will conform to the basis for the structural design and associated design documents, and provide reasonable assurance that the building structures of the APR1400 standard design will meet the requirements of GDC 1, 2, 4, 14, 16, and 50, and 10 CFR Part 50, Appendix J.

Therefore, the staff concludes that the proposed ITAAC provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will operate in accordance with the applicable portions of the DC, the Atomic Energy Act of 1954, as amended, and the NRC rules and regulations.

14.3.3 Piping Systems and Components – Inspections, Test, Analyses, and Acceptance Criteria

14.3.3.1 Introduction

ITAAC are identified in Tier 1 of the DCD, and this section of the SER documents staff's review of information provided by the applicant in DCD Tier 2, Section 14.3.2.3, "ITAAC for Piping Systems and Components," which covers DCD Tier 1 information and ITAAC applicable to piping systems and components.

14.3.3.2 Summary of Application

DCD Tier 2, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," discusses the bases, processes, and selection criteria used to develop Tier 1 information. It specifies a graded approach commensurate with the safety significance of the SSCs. The section discusses the organization of the Tier 1 information, and specifies that Tier 1, Section 2.3, "Piping Systems and Components," covers the material reviewed in accordance with SRP Section 14.3.3, "Piping Systems and Components – Inspections, Tests, Analyses, and Acceptance Criteria." Further discussion on the general approach to Tier 1 material is contained in Section 14.3 of this SER.

DCD Tier 2, Section 14.3.2.3, "ITAAC for Piping Systems and Components," specifically discusses the approach to Tier 1 information regarding piping systems and components. The DC analysis of ASME Code Class 1 piping includes the reactor coolant system (RCS) main loop, pressurizer surge line, direct vessel injection line, and shutdown cooling line. Main steam and main feedwater piping is analyzed as representative piping for Class 2 and 3. The graded approach is also applied to pipe rupture hazards and leak-before-break (LBB) analyses. This graded approach provides a level of piping design detail sufficient to remove the need for piping design acceptance criteria (DAC), as described in Section 14.3.3.3, "Regulatory Basis," below.

The applicant provided ITAAC for Piping Systems and Components in DCD Tier 1, Tables 2.2.6-2, 2.2.7-2, 2.3-3, 2.4.1-4, 2.4.2-4, 2.4.3-4, 2.4.4-4, 2.4.5-4, 2.4.6-4, 2.6.2-3, 2.7.1.2-4, 2.7.1.4-4, 2.7.1.5-4, 2.7.1.8-3, 2.7.2.1-4, 2.7.2.2-4, 2.7.2.3-4, 2.7.2.5-4, 2.7.2.6-4, 2.7.4.3-4,

2.7.4.4-2, 2.11.2-4, and 2.11.3-2, as discussed in SER Sections 3.6.2, 3.6.3, 3.9.5, 3.9.6, 3.10, 3.11, 3.12, and 5.2.1.1.

14.3.3.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Section 14.3 and 14.3.3 of NUREG-0800. Review interfaces with other SRP sections are also identified in this SRP section.

The applicable regulatory requirements are as follows:

- 10 CFR 52.47(b)(1), "Contents of applications; technical information," as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will be operated in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

SECY-90-377, "Requirements for Design Certification under 10 CFR Part 52," dated November 8, 1990, and its associated staff requirements memorandum (SRM) dated February 15, 1991, provide Commission guidance on the level of detail that a DC application should reflect. Additional Commission guidance on the development and use of ITAAC included in the licensing process described in 10 CFR Part 52 includes the following:

1. SECY-90-241, "Level of Detail Required for Design Certification under Part 52," and its associated SRM
2. SECY-91-178, "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) for Design Certifications and Combined Licenses"
3. SECY-91-210, "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) Requirements for Design Review and Issuance of a Final Design Approval (FDA)," dated July 16, 1991
4. SECY-92-214, "Development of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) for Design Certifications," dated June 11, 1992

In SECY-92-053, "Use of Design Acceptance Criteria during 10 CFR Part 52 Design Certification Process," dated February 19, 1992, the staff discussed a method for using DAC, together with detailed design information, during the 10 CFR Part 52 process for reviewing and approving designs. The NRC intended DAC to be used for applications that do not provide design and engineering information at a level of detail customarily considered by the staff in reaching a final safety decision, and primarily for areas of design that are subject to rapidly changing technologies or depend on as-built or as-procured information to reach the final safety decision.

SRP Section 14.3, in addition to the other documents listed above, provides the regulatory guidance for staff's acceptance of the ITAAC associated with those presented in the APR1400

DCD. Furthermore, SRP Section 14.3.3 establishes the regulatory guidance for acceptance of the ITAAC specifically related to piping systems and components.

The APR1400 DC avoided the use of DAC by implementing a graded approach consistent with Commission direction and the more detailed information contained in SECY-90-377. This graded approach consists of four main concepts:

1. The DC would continue to present essentially complete designs for the overall systems, consistent with past DCs regardless of the use of DAC.
2. The proposed ITAAC for the DC would continue to include verification of design (including reconciliation), fabrication, installation, inspection, and testing for all American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code Class 1, 2, and 3 components and piping.
3. The DC application would document the overall methodology to be employed in completing the detailed piping design for all systems.
4. The NRC review of the piping design in the DC application would employ a graded approach, with the highest level of detail being expected for Class 1 reactor coolant pressure boundary (RCPB) piping, as these piping systems have the most significant effect on plant safety. A similar level of detail would also be expected for the Class 2 steam and feedwater lines from the reactor vessel to the first anchor beyond the containment isolation valves. Less detail would be needed for other portions of Class 2 and 3 piping, for which breaks have lower safety significance, as well as for small-bore piping (nominal pipe size of 2 inches (5.1 cm) or less), for which the final design relies heavily on as-built information and for which breaks also have lower safety significance.

In DCD Tier 2, Section 14.3, the applicant provided the selection criteria and processes used to develop the DCD Tier 1 ITAAC, including those related to piping systems and components. The DCD Tier 1 information provides the principal design bases and design characteristics that are certified by the 10 CFR Part 52 rulemaking process and that would be included in the APR1400 DC rule.

14.3.3.4 Technical Evaluation

14.3.3.4.1 Tier 1 Discussion

DCD Tier 1, Section 2.3.1, "Design Description," discusses four specific areas related to piping systems and components as addressed in the Tier 1 material. They are: piping stress analysis, analysis of protection against the dynamic effects of piping rupture, evaluation of LBB, and analysis of component stress. The staff's evaluation of the piping and component stress analysis, pipe break hazards analysis, and LBB analysis is discussed in Sections 3.12, "ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports"; 3.6.2, "Determination of Pipe Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping"; and 3.6.3, "Leak-Before-Break Evaluation Procedures," respectively.

DCD Tier 2, Section 14.3.2.3, discusses the development of several as-built ITAAC. These include:

- As-built reconciliation with ASME Section III requirements
- Welding quality of pressure boundary welds for ASME Class 1, 2, and 3 SSCs
- Hydrostatic testing for ASME Class 1, 2, and 3 SSCs
- Dynamic qualification records of seismic Category I mechanical and electrical equipment including anchorage
- Vendor test records for pumps, valves, and dynamic restraint functionality under design conditions
- In-situ testing and functional design and qualification records demonstrating that installed pumps, valves, and dynamic restraints have the capability to perform their intended functions under a range of conditions up to and including design basis conditions
- LBB evaluation report demonstrates as-built piping and materials comply with LBB acceptance criteria

The staff identified a typographical error in the acceptance criteria of many of the ITAAC originally proposed in the DCD, specifically that the phrase “exists and concludes” was replaced by “exits and concludes.” In a public meeting held on July 1, 2015 (ML15183A392), the staff discussed this error with the applicant, and the applicant’s meeting presentation included DCD markups to address the error. The applicant incorporated these modifications in Revision 1 of the DCD, dated March 10, 2017, closing this issue.

The discussion in DCD Tier 2, Section 14.3.2.3, stated that Section 2.3 of the Tier 1 material includes piping systems and components, including the treatment of motor-operated valves (MOV), power-operated valves (POV), and check valves, as well as dynamic qualification, welding, fasteners, and safety classification of SSCs. Upon the staff’s review of Tier 1, Revision 0, Section 2.3, Staff noted that portions of this list referenced in DCD Section 14.3.2.3 were not discussed in Tier 1. The staff requested, in a public meeting held on July 1, 2015 (ML15183A392), that the applicant update the list for consistency with the Tier 1 material. The applicant stated that this change (as well as several others) would be made once the standardized ITAAC guidance has been issued. The use of standardized ITAAC was ultimately not pursued by the applicant, and is further discussed below in Section 14.3.3.4.3, “Incorporation of Standardized ITAAC Guidance.” The applicant subsequently updated the list as part of its response to RAI 546-8782, which is discussed later in this SER, thus resolving this inconsistency.

A consistency issue was identified between DCD Tier 1, Table 2.3-3, “High and Moderate Energy Piping Systems,” and the rest of Tier 1, specifically that the named systems in the table did not appear as named in later sections. Some were incorrectly named, others were not present in Tier 1, and others were grouped with other systems such that making findings for each system became complicated. This was identified to the applicant at a July 1, 2015, public meeting (ML15183A392). The staff issued RAI 78-8021, Question 14.03.03-2 (ML15196A608), requesting the applicant to address this issue. In its response to RAI 78-8021, Question 14.03.03-2 (ML15238B430) the applicant provided revisions that resolved all

significant consistency issues identified in the RAI. The staff confirmed that the DCD was revised as committed in the response to RAI 78-8021, Question 14.03.03-2. Therefore, RAI 78-8021, Question 14.03.03-2, was resolved and closed.

An additional consistency issue was identified after comparing the DCD Tier 1 and Tier 2 material, namely that the steam generators were identified as ASME Class 1 SSCs, rather than a Class 1/Class 2 SSC. This was identified to the applicant at the July 1, 2015, public meeting and subsequently corrected. In the public meeting held on July 1, 2015, the applicant committed to revise the Tier 1 code applicability to be consistent with Table 3.2-1, "Classification of Structures, Systems, and Components." The applicant included this modification in Revision 1 of the DCD, dated March 10, 2017, and the staff confirmed that this modification was incorporated.

14.3.3.4.2 Item Numbers

Tables in Tier 1 contain a column for Item Number. In Revision 0 of the DCD, the applicant noted that this column was considered information only and was not part of the certified design. This language could create confusion about the process for changing Tier 1 information described in 10 CFR 52.63, "Finality of standard design certifications." In particular, the idea of "information only" material differs from the definitions of Tier 1 information that have appeared in previous DC rule appendices to 10 CFR Part 52. Item numbers are used to identify specific valves and components that serve as boundaries in systems or portions of systems with specific attributes. It is necessary to establish a way of identifying and tracking SSCs of importance within the certified design material. The staff issued RAI 78-8021, Question 14.03.03-1 (ML15196A608), requesting the applicant provide clarification. In its response to RAI 78-8021, Question 14.03.03-1 (ML16175A656), the applicant proposed to remove the "information only" language and still maintain traceability of SSCs throughout Tier 1 through the use of item numbers, which are defined as not being representative of the actual equipment or tag numbers. The staff finds this approach acceptable, as traceability is maintained throughout Tier 1 through the use of item numbers, and it will be possible to map these item numbers to the actual equipment or tag numbers of SSCs, when needed. The staff confirmed that the DCD was revised as committed in the response to RAI 78-8021, Question 14.03.03-1. Therefore, RAI 78-8021, Question 14.03.03-1, was resolved and closed.

14.3.3.4.3 Incorporation of Standardized ITAAC Guidance

The staff identified several issues regarding the applicant's use of ITAAC. For instance, the applicant's proposed ITAAC for pipe break hazards analysis failed to consider the environmental effects of pipe breaks in high energy systems. Additionally, the applicant's proposed ITAAC did not adequately address safety-related mechanical equipment harsh environment qualification. A set of standardized ITAAC was provided to the applicant for its review in a letter dated August 3, 2016 (ML16208A548). The applicant had initially indicated plans to adopt the standardized ITAAC, but ultimately decided to not incorporate the standardized ITAAC. The staff issued RAI 546-8782, Question 14.03.03-6 (ML17123A458), requesting the applicant to resolve deficiencies in the proposed ITAAC contained in the DCD. In its response to RAI 546-8782, Question 14.03.03-6 (ML17227A608), the applicant proposed incorporating the standardized ITAAC wording for the topic of equipment qualification for nonmetallic parts of mechanical equipment and application of it to the applicable systems. As further discussed in Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment," of this SER, the applicant's response is acceptable because it addresses the

inadequacy regarding ITAAC for safety-related mechanical equipment harsh environment qualification. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-6 was resolved and closed.

In its response to RAI 546-8782, Question 14.03.03-4 (ML17229B591), the applicant revised an ITAAC for reactor vessel internals to be consistent with other ITAAC within the DCD and to more closely align this reactor vessel internals ITAAC with the standardized ITAAC guidance by using the phrase “as-built” instead of fabricated when referring to components to be inspected. The staff finds this to be acceptable as it maintains consistency throughout the DCD. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-4 was resolved and closed. Further discussion of reactor vessel internals may be found in Section 3.9.5, “Reactor Pressure Vessel Internals,” of this SER.

In its response to RAI 546-8782, Question 14.03.03-3 (ML17244A012), the applicant resolved the earlier discussed inconsistency between the discussion in DCD Tier 2 and the contents of Tier 1, Section 2.3. Furthermore, this response clarified that ASME Section III Data Reports are used to verify that as-built systems and components are compliant with ASME Section III requirements as opposed to design reports. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-3 was resolved and closed.

14.3.3.4.4 Piping Stress Analysis

In DCD Tier 2, Section 14.3.2.3, the applicant described its approach to the piping system design. The applicant has elected to follow a graded approach, as described above, with more emphasis placed on the design of the ASME Class 1 piping systems than Class 2 and 3, due to the higher safety significance of Class 1. The RCS main loop, pressurizer surge line, and two RCS branch lines (the 12 in. (30.5 cm) direct vessel injection line and 16 in. (40.6 cm) shutdown cooling line) comprise the scope of the designed ASME Class 1 piping systems. Only one direct vessel injection line and one shutdown cooling line are analyzed, as subsequent lines are in a symmetric arrangement. The acceptability of this Class 1 piping scope is discussed in Section 3.12 of this SER. The scope of ASME Class 2 and 3 piping systems designed at the DC stage includes the main steam and main feedwater piping located in the containment building. The main steam and main feedwater piping are the largest ASME Class 2 piping lines connected to the steam generators and carry the largest structural load. The scope of design for main steam and main feedwater piping located outside the containment building is from the containment penetration anchors to the main steam valve house (MSVH) penetration anchors beyond the isolation valves, which are located in the break exclusion area in the auxiliary building.

This scope of design for Class 2 and 3 piping systems is intended to be consistent with the graded approach discussed in Section 14.3.3.3. Use of the graded approach, as discussed in Section 14.3.3.3, avoids the need for DAC within the DCD. The inclusion of ITAAC for each piping system listed in the tables identified in subsection 14.3.3.2 of this SER section, which will verify that Seismic Category I and ASME Code SSCs are designed and constructed in accordance with ASME Code Section III requirements, is sufficient to demonstrate that if the acceptance criteria are met, the piping systems within the scope of review for Section 3.12 have been constructed in compliance with 10 CFR 50.55a; 10 CFR 52.47(b)(1); 10 CFR Part 50,

Appendix S; and GDC 1, 2, 4, 14, and 15. Further discussion of the staff's review of piping stress analysis is found in Section 3.12 of this SER.

Review of DCD Tier 1, Table 2.3-1, "Systems with ASME Section III Class 1, 2, and 3 Piping Systems and Components," identified that the Containment Isolation System was missing from the listing of systems designed to retain their pressure integrity and functional capability under internal design and operating pressures and design basis loads. The staff issued RAI 546-8782, Question 14.03.03-7 (ML17123A458), requesting the applicant add this system to the table or provide justification to preclude its presence. In its response to RAI 546-8782, Question 14.03.03-7 (ML17223b344), the applicant added the Containment Isolation System to Table 2.3-1 in a proposed markup. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-7 was resolved and closed.

14.3.3.4.5 Pipe Break Hazards Analysis

In Tier 1, Section 2.3.1, the applicant stated that SSCs required for safe shutdown are protected from the dynamic and environmental effects of postulated piping failures when the dynamic effects are not eliminated from consideration by LBB analysis. Each postulated piping failure will be documented in an as-built pipe break analysis report prepared by the COL holder and will consider, as applicable, pipe whip, jet impingement, flooding, compartment pressurization, and environmental conditions associated with the postulated piping failure. Analysis of pipe break hazards also follows the graded approach discussed in the Regulatory Basis section above. The applicant has included the main steam and main feedwater piping in this analysis because it is considered the most safety-significant in terms of pipe break hazards and RCS structural analysis. The staff's evaluation of this approach is detailed in Section 3.6.2 of this SER.

Tier 1, Section 2.3 contains two tables that identify piping systems. Table 2.3-1 identifies ASME BPV Code Section III piping systems and references the corresponding Tier 1 section. Table 2.3-2, "High and Moderate Energy Piping Systems," identifies the high and moderate energy piping systems which are evaluated for pipe break hazards analysis. Many of the named systems in Table 2.3-3 did not initially appear as named and classified in the remainder of Tier 1. For instance, the Emergency Diesel Generator System (EDGS) was identified as a high-energy piping system (with a footnote clarifying that there were also moderate-energy portions), but there was only an ITAAC for a moderate-energy piping system. Additionally, some systems were missing, such as the auxiliary steam system, which was identified as a high-energy system in the table. Finally, some systems were grouped together instead of receiving separate entries, such as Safety Injection and Shutdown Cooling Systems. In a public meeting on July 1, 2015 (ML15183A392), the staff discussed these areas for alignment and clarification, and the applicant's meeting presentation included DCD markups to address the error. The applicant's proposed markups were reviewed and found to appropriately address the error. The applicant included these modifications in Revision 1 of the DCD, dated March 10, 2017, closing this issue.

Upon review of the originally proposed pipe break hazards analysis ITAAC located in various systems, the staff noted that although moderate-energy piping systems were analyzed for environmental effects of pipe break, the high-energy piping systems were not. Rather, they were only analyzed for dynamic effects. The ITAAC also did not verify that the installation of protective features were in accordance with the as-built pipe break hazards analysis report. Additionally, the system-by-system approach used by the applicant failed to account for

interactions across systems. Specifically, the system-by-system approach does not include all systems for which pipe ruptures are to be postulated in accordance with the methodology and criteria described in DCD Tier 2, Section 3.6.2. In order to include all applicable systems within the scope of SRP 3.6.2, a non-system-based (i.e., include both safety-related and nonsafety-related sources) pipe break hazards analysis ITAAC approach should be used. The staff issued RAI 546-8782, Question 14.03.03-5 (ML17123A458), requesting the applicant to address these issues. In its response to RAI 546-8782, Question 14.03.03-5 (ML17235B275), the applicant proposed a non-system-based approach, informed by the guidance of the standardized ITAAC, and the applicant subsequently proposed a non-system-based ITAAC to DCD Tier 1, Table 2.3-3. This proposed non-system-based ITAAC, as well as the other proposed revisions included in the RAI response, adequately addresses the issues raised regarding pipe break hazards analysis ITAAC, and is acceptable to the staff because the full scope of safety-related SSCs is addressed in the proposed non-system-based ITAAC and the wording utilized is consistent with the standardized ITAAC guidance. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-5 was resolved and closed.

14.3.3.4.6 Leak Before Break Analysis

In Tier 1, Section 2.3.1, the applicant stated that LBB analysis is applied to the following piping systems:

- Reactor coolant piping (hot and cold legs)
- Pressurizer surge line
- Shutdown cooling line from the reactor coolant system to the second isolation valve
- Direct vessel injection line from the reactor vessel to the safety injection tank and the second isolation valve

This analysis considers normal and abnormal loads and combinations to demonstrate compliance with the LBB design criteria. The applicant further stated that the as-built piping and materials are reconciled with the bases for the LBB acceptance criteria. The LBB analysis follows the graded approach discussed in Section 14.3.3.3, above. The pressurizer surge line is modeled as a representative case of thermal stratification. The staff's review of this analysis and the acceptability of the proposed ITAAC for this topic is discussed in Section 3.6.3 of this SER.

14.3.3.4.7 Equipment Analysis and Qualification

Discussion of the applicant's treatment of equipment analysis and qualification is included in various sections. The applicant provided system-based ITAAC in DCD Tier 1, Section 2 to address the seismic qualification of equipment. The staff finds that the system-based ITAAC provide reasonable assurance that the mechanical and electrical equipment will be adequately qualified to withstand the effect of a safe-shutdown earthquake (SSE). Additional discussion of this evaluation may be found in Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," of this SER.

Section 3.9.6, “Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints,” of this SER discusses the applicant’s treatment of the functional design, qualification, and inservice testing programs for pumps, valves, and dynamic restraints. The staff identified multiple ITAAC in the APR1400 DCD that required revision to provide assurance of the verification of the design, qualification, and testing of as-built pumps, valves, and dynamic restraints consistent with the design when certified. The staff issued RAI 546-8782, Question 14.03.03-8 (ML17123A458), to address these issues. In its response to RAI 546-8782, Question 14.03.03-8 (ML17248A364), the applicant proposed ITAAC the staff finds acceptable for meeting the requirements for the functional design, qualification, and inservice testing programs for pumps, valves, and dynamic restraints. Further discussion on the acceptability of these ITAAC may be found in Section 3.9.6 of this SER. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 546-8782, Question 14.03.03-8 was resolved and closed.

14.3.3.5 Combined License Information Items

DCD Tier 2, Section 14.3.6, “Combined License Information,” Revision 0 included a COL item for DAC closure. Based on the discussion above about the implementation of the graded approach (and additional evaluations documented in Section 3.6.2 and Section 3.12 of this SER), the applicant removed this DAC and associated COL item, which the staff confirmed in Revision 1 of the DCD, dated March 10, 2017. There are no COL items associated with Section 14.3.2.3 of the APR1400 DCD.

14.3.3.6 Conclusion

The staff reviewed the Tier 1 information in the APR1400 DCD in accordance with the guidance in SRP Section 14.3.3. Based on this review and a review of the selection methodology and criteria for the development of the Tier 1 information in Tier 2, Section 14.3.2.3 of the DCD, the staff finds that, the top-level design features and performance characteristics of the SSCs are appropriately described in Tier 1 and the Tier 1 information is acceptable to meet the requirements of 10 CFR 52.47(b)(1).

Further, the Tier 1 design descriptions can be verified adequately by ITAAC. The staff’s review in SER Sections 3.6.2, 3.6.3, 3.9.5, 3.9.6, 3.10, 3.11, 3.12, and 5.2.1.1 support the staff’s finding that the ITAAC are necessary and sufficient for reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, then a facility referencing the certified design can be constructed and operated in compliance with the DC and applicable regulations.

These findings are based on:

- The applicant’s treatment of piping design information in Tier 1 of the DCD, as supplemented by discussion in Tier 2 of the DCD. This is discussed in Section 14.3.3.4.4 above.
- The ITAAC tables in Tier 1 of the DCD, listed in subsection 14.3.3.2, which address, in part, conformance with the ASME B&PV Code, seismic and dynamic qualification of equipment, and integrity of the RCPB, consistent with the regulatory guidance, ensuring the proper piping design and the verification of

pipings and component classification, fabrication, dynamic and seismic testing, and performance requirements.

14.3.4 Reactor Systems – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.4.1 Introduction

The DCD Tier 2, Section 14.3, discusses the selection criteria and methods used to develop the DCD Tier 1 information, including the ITAAC. DCD Tier 1 includes the portion of the design-related information that, if acceptable, would be approved, certified, and incorporated by reference into a new DC rule for the APR1400 design. The design descriptions, interface requirements, and site parameters are derived from DCD Tier 2 information.

The DCD Tier 2, Section 14.3.2.4 addresses ITAAC related to reactor systems. The scope of “reactor systems” encompasses the reactor coolant system, in-containment water storage system, safety injection system, shutdown cooling system, reactor coolant gas vent system, chemical and volume control system, and leakage detection system, which are all significantly related to normal operation, transients, and accidents.

As part of the review of each of the APR1400’s reactor systems, the staff reviewed the ITAAC with respect to reactor systems described in the DCD in accordance with SRP, NUREG-0800, Sections 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria,” and 14.3.4, “Reactor Systems – Inspections, Tests, Analyses, and Acceptance Criteria.” The staff reviewed the proposed ITAAC to determine whether they are necessary and sufficient to provide reasonable assurance that, if the ITAAC are successfully completed, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission’s rules and regulations. In addition, the staff reviewed interface requirements for reactor systems.

The scope of the review of the reactor systems ITAAC included the DCD Tier 1 sections given in Table 14.3-4, “Cross References for the Staff’s Evaluation of Reactor Systems ITAAC,” of this report, that are significantly related to normal operation, transients, and accidents. The staff’s detailed evaluation of each reactor system’s Tier 1 material is documented in the system’s respective section of this SER (see Table 14.3-4 below).

14.3.4.2 Summary of Application

DCD Tier 1: The applicant provided design descriptions for reactor systems in DCD Tier 1 Section 2.4, “Reactor Systems.” DCD Tier 1, Chapter 1, “Introduction,” provides definitions, general provisions, and a legend for figures, acronyms, and abbreviations.

Table 14.3-4 Cross References for the Staff's Evaluation of Reactor Systems ITAAC

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
2.4.1	Reactor Coolant System (RCS)	2.4.1-4	5.4	5.4
2.4.2	In-containment Water Storage System (IWSS)	2.4.2-4	6.8	6.8
2.4.3	Safety Injection System (SIS)	2.4.3-4	6.3	6.3
2.4.4	Shutdown Cooling System (SCS)	2.4.4-4	5.4.7	5.4.7
2.4.5	Reactor Coolant Gas Vent System (RCGVS)	2.4.5-4	5.4.12	5.4.12
2.4.6	Chemical and Volume Control System (CVCS)	2.4.6-4	9.3.4	9.3.4
2.4.7	Leakage Detection System	2.4.7-1	5.2.5	5.2.5

System design descriptions include relevant information for the ITAAC such as key design features; seismic and ASME code classifications used in design and construction; system operation; alarms, displays, and controls; logic for system actuation; interlocks; class 1E power sources and divisions; equipment to be qualified for harsh environment; interface requirements; and numeric performance values. The design descriptions contain tables and figures that are referenced in the Design Commitment column of the ITAAC tables listed above.

The applicant organized its Tier 1 information in a manner similar to that used for the evolutionary designs as described in SRP Section 14.3 and RG 1.206 Section C.II.1-1. The ITAAC tabular format and content for the reactor systems follows the NRC recommended format described and presented in RG 1.206, Table C.II.1-1, "Sample ITAAC Format." The ITAAC are presented in a three-column table that includes the proposed design commitment to be verified (column 1), the method by which the licensee will verify (column 2), and specific acceptance criteria for the inspections, tests, or analyses (column 3) that, if met, demonstrate the licensee has met the design commitment in column 1.

DCD Tier 2: DCD Tier 2, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," provides a general description of the APR1400 ITAAC including its relationship to other DCD Tier 1 information, and the bases, processes, and selection criteria used to develop Tier 1 information.

The applicant specified that the ITAAC for reactor systems were prepared in accordance with the guidance in RG 1.206, Section C.II.1, "Inspections, Tests, Analyses, and Acceptance

Criteria”; NUREG-0800 SRP Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria”; and NUREG-0800 SRP Section 14.3.4, “Reactor Systems – Inspections, Tests Analyses, and Acceptance Criteria.”

ITAAC: The applicant provided ITAAC for reactor systems in DCD Tier 1 sections as listed above in Table 14.3-4.

Technical Specifications (TS): There are no TS for this area of review.

14.3.4.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Sections 14.3 and 14.3.4 of NUREG-0800. Review interfaces with other SRP sections are also identified in these SRP sections.

The applicable regulatory requirements are as follows:

- Title 10 CFR 52.47(b)(1), “Contents of applications; technical information,” as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

14.3.4.4 Technical Evaluation

The staff performed its review of the system and non-system based ITAAC in accordance with SRP Section 14.3 and SRP Section 14.3.4, particularly the applicable review procedures identified in each SRP Section III, as well as the guidance provided by RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria.” The staff examined the ITAAC to ensure that they can be inspected by the organization holding the combined license and closed out by the staff. The staff also reviewed the phrasing and format of the ITAAC to determine if the Design Commitment wording; the Inspection, Test, or Analysis; and the Acceptance Criteria are parallel and in agreement. In addition, the staff determined that the DCD Tier 1 ITAAC items were derived from the DCD Tier 2 information.

14.3.4.4.1 ITAAC Development Criteria

The RG 1.206 Section C.II.1.2.4, “ITAAC for Reactor Systems,” describes the ITAAC development for reactor systems and identifies the aspects to be verified through ITAAC. These are related to the reactor design, such as core components, fuel, control rods, reactor coolant system, emergency core cooling system, residual heat removal system, chemical and volume control system, and loose parts monitoring system.

During the review, the staff noted that in DCD Tier 2, Section 14.3.2.4, the applicant stated that DCD Tier 1, Section 2.4 includes fuel, control rods, and loose parts monitoring systems. However, the staff also noted that in DCD Tier 1, Section 2.4, the applicant did not provide any information regarding fuel or loose parts monitoring systems, and very little information regarding control rods. Therefore, the staff issued RAI 83-7962, Question 14.03.04-1 (ML15197A267), to address this issue. In its response to RAI 83-7962, Question 14.03.04-1

(ML16035A514), the applicant clarified that the APR1400 ITAAC for reactor systems includes the RCS, IWSS, SIS, SCS, RCGVS, CVCS, and leakage detection system.

The staff reviewed the fuel system design, control rod design, and core design to determine if it was necessary to develop ITAAC for these areas. For these three areas of review, the staff notes that ITAAC are not typically developed and implemented, as discussed in SRP 14.3.4. ITAAC are not typically developed for the core design area since ITAAC must be completed before core load, as required by 10 CFR 52.103. This requirement makes it impossible to implement an ITAAC covering the as-built condition of the core. Additionally, the safety aspects of the as-built core design will be verified through start-up testing, thereby addressing the same safety concerns that an ITAAC would address. Therefore, the staff found that developing and implementing ITAAC for the core design is not necessary.

For fuel system design, the staff found that developing ITAAC to verify fuel rod design aspects is also not necessary because the prior staff approval of the fuel rod design (located in the staff's FSER to the specific fuel rod design topical report) included review of testing associated with the proper functioning of the fuel rod. Furthermore, other regulations, such as 10 CFR Part 50, Appendix B, require the appropriate quality assurance standards to be implemented for the fuel prior to its loading into a core. Therefore, the staff found that it is not necessary to develop an ITAAC for the fuel system design due to the testing, inspection, and analyses that have already been reviewed and approved by the staff as part of the applicant's topical report submittal.

Lastly, the staff found that control rod design ITAAC verifying the as-built condition are similarly constrained by 10 CFR 52.103 in that the as-built condition cannot be inspected via ITAAC since all ITAAC must be completed prior to fuel load. However, the staff does note that other inspection and testing programs ensure that the control rod assembly is manufactured to the specifications of the NRC approved design (e.g. the QA inspection) and that the safety function is met (e.g. the scram tests and startup physics tests). Therefore, the staff found that developing and implementing ITAAC for the control rod design is not necessary.

The loose parts monitoring system is a nonsafety-related system and does not perform any safety-related function; it only provides for monitoring; therefore, the staff found it acceptable to not have any ITAAC for this system. The applicant also provided a markup to DCD Tier 2, Section 14.3.4.2 indicating that fuel, control rods, and the loose parts monitoring system will be deleted from the sentence describing what the Tier 1 reactor systems ITAAC is comprised of. The staff finds the applicant's response acceptable and concludes that the applicant adequately identified the general aspects to be verified through ITAAC, including the ITAAC to verify the top-level design features, as discussed in RG 1.206 Section C.II.1.2.4. The staff confirmed that the DCD contained the appropriate revisions, which were proposed as part of the applicant's response to RAI 83-7962, Question 14.03.04-1. Therefore, RAI 83-7962, Question 14.03.04-1 was resolved and closed.

14.3.4.4.2 Reactor Systems Tier 1

The staff reviewed the Tier 1 material for each APR1400 reactor system using the guidance provided in SRP Section 14.3 including Appendix C, "Detailed Review Guidance, Fluid Systems Review Checklist," and SRP Section 14.3.4. The staff's detailed review of each reactor system's Tier 1 material is contained within the section of this SER that corresponds to the Tier 2 Section for the reactor system, as described in the cross reference Table 14.3-4.

In performing the evaluation of the Tier 1 material, and determining whether the ITAAC appropriately verify the top-level design features, the staff considered the safety function significance in light of the results of transient and accident analyses, core cooling in all modes of operation and shutdown conditions, anticipated transient without scram (ATWS), and severe accident assessments. Specifically, DCD Tier 2, Table 14.3.4-1, "Design Basis Accident Analysis Key Design Features," DCD Tier 2, Table 14.3.4-2, "PRA and Severe Accident Analysis Key Design Features," and DCD Tier 2, Table 14.3.4-5, "ATWS Analysis Key Design Features," were reviewed to confirm that the table entries are complete with respect to the safety analyses in DCD Tier 2, Chapter 4, "Reactor," DCD Tier 2, Chapter 5, "Reactor Coolant System And Connected Systems," DCD Tier 2, Chapter 6, "Engineered Safety Features," and DCD Tier 2, Chapter 15, "Transient And Accident Analyses," and consistent with DCD Tier 2, Section 14.2, "Initial Plant Test Program."

In addition, the staff used the SRP sections identified in SRP Section 14.3.4 that have a potential impact on the reactor systems ITAAC sections. These included the following SRP sections that provide information related to SRP Section 14.3.4: SRP Section 14.3 (general guidance on ITAAC), SRP Section 14.3.2 (structures, systems, and components' (SSCs') ability to withstand various natural phenomena), SRP Section 14.3.3 (piping design), SRP Section 14.3.5 (instrumentation and controls), SRP Section 14.3.6 (electrical systems and components), and SRP Chapter 19 (SSCs' design features and functions that should be addressed based on severe accident, PRA, and shutdown safety evaluations).

Also, in accordance with SRP Section 14.3.4, the staff reviewed Chapter 15 systems' sequence of events and reviewed the SSCs' functional responses to each abnormal event described in the transient and accident analysis. The staff confirmed that the required actions of the SSCs are tested in DCD Tier 1, Section 2.4.1 from initiating test signals that simulate the reactor conditions to the actuation of the systems that mitigate the abnormal events. The staff's findings related to the testing and acceptance criteria of each reactor system's ITAAC are documented in the section of this SER associated with that reactor system. In general, the staff concludes the ITAAC included the SSCs that are required to mitigate or terminate the abnormal events to be sufficient in demonstrating functional operability as described in DCD Tier 2.

The staff assessed the reactor systems Tier 1 material (including ITAAC) for the following DCD Tier 2 sections in accordance with the applicable procedures and guidance provided in SRP Sections 14.3 and 14.3.4:

- Section 5.2.2, "Overpressure Protection."
- Section 5.4.7, "Shutdown Cooling System."
- Section 5.4.11, "Pressurizer Relief Tank."
- Section 5.4.12, "Reactor Coolant System High Point Vents."
- Section 6.3, "Safety Injection System."
- Section 9.3.4, "Chemical and Volume Control System."

The staff's specific evaluation results of the above sections relating to the adequacy of the Tier 1 material are presented in the individual technical evaluation of each of the above sections in

this report, but one issue common to ITAAC in several reactor systems is addressed in the following subsection.

14.3.4.4.3 General Issue Common to ITAAC in Several Reactor Systems

In the review of all Reactor Systems ITAAC items, the staff observed that Tier 1 Tables 2.4.1-4, "Reactor Coolant System ITAAC," 2.4.2-4, "In-containment Water Storage System ITAAC," 2.4.3-4, "Safety Injection System ITAAC," 2.4.4-4, "Shutdown Cooling System ITAAC," 2.4.5-4, "Reactor Coolant Gas Vent System ITAAC," and 2.4.6-4, "Chemical and Volume Control System ITAAC," each contain an ITAAC item labeled 6.c which commits to separation being provided "between Class 1E divisions, and between Class 1E division and non-Class 1E division." The applicant's associated Acceptance Criteria, 6.c., requires:

physical separation or electrical isolation exists in accordance with NRC RG 1.75 between these Class 1E divisions, and also between class 1E division and non-Class 1E division.

The staff noted that the applicant's Acceptance Criteria, which incorporates by reference RG 1.75, did not accurately capture what is required by RG 1.75. RG 1.75 states:

the underlying separation criteria are that (1) physical separation and (2) electrical isolation must be provided to maintain the independence of safety related circuits and equipment so that the safety functions required during and following any design-basis event can be accomplished.

Therefore, the staff issued RAI 83-7962, Question 14.03.04-5 (ML15197A267), to address this issue. In its response to RAI 83-7962, Question 14.03.04-5 (ML15259A765) and supplemented (ML16081A340), the applicant stated that the ITAAC items which address physical separation and electrical isolation in accordance with RG 1.75 will be revised to accurately reflect what is required by RG 1.75. Also in its response to the staff, the applicant presented how the revision will look in the next DCD revision. Based upon the staff's review, the staff finds that the applicant's Tier 1 Reactor Systems ITAAC revision is acceptable and accurately captures what is stated in RG 1.75; furthermore, the staff concludes that this Tier 1 revision supports meeting 10 CFR 52.47(b)(1). The staff confirmed that the DCD contained the appropriate revisions, which were proposed as part of the applicant's response to RAI 83-7962, Question 14.03.04-5. Therefore, RAI 83-7962, Question 14.03.04-5, was resolved and closed.

14.3.4.4.4 Reactor Coolant System

The staff notes that the RCS is a safety-related system whose primary function is to remove heat generated in the reactor core and transfer it to the steam generators. The RCS forms part of the pressure and fission product boundary between the reactor coolant and the containment building atmosphere. The RCS is equipped with overpressure protection and provides cooling during all plant evolutions and anticipated operational occurrences to preclude significant core damage. The staff's review of the RCS Tier 1 information is contained in Chapter 5 of this SER.

14.3.4.4.5 In-containment Water Storage System

The staff notes that the in-containment water storage system (IWSS) is a safety related system and includes the in-containment refueling water storage tank (IRWST), holdup volume tank (HVT), and the cavity flooding system (CFS). The IRWST provides borated water for the safety

injection system and the containment spray system and is the primary heat sink for the RCS depressurization and vent system. The HVT collects water released in containment during design basis events and returns it to the IRWST. The CFS provides water to flood the reactor cavity in response to beyond design basis events. The IWSS is located in containment. The staff's review of the IWSS Tier 1 information is contained in Chapter 6 of this SER.

14.3.4.4.6 Safety Injection System

The staff notes that the safety injection system (SIS) is a safety-related system, whose primary function is to provide emergency core cooling and reactivity control in response to a design basis accident. The SIS consists of four safety injection pumps, four safety injection tanks, and associated piping and valves. The staff's review of the SIS Tier 1 information is contained in Chapter 6 of this SER.

14.3.4.4.7 Shutdown Cooling System

The staff notes that the shutdown cooling system (SCS) provides the APR1400 a safety-related function of removing decay heat from the RCS and transferring that heat to the component cooling water system during normal shutdown and accident conditions. The SCS consists of two independent, mechanical trains with associated heat exchangers, pumps, and piping and valves. The staff's review of the SCS Tier 1 information is contained in Chapter 5 of this SER.

14.3.4.4.8 Reactor Coolant Gas Vent System

The staff notes that the Reactor Coolant Gas Vent System (RCGVS) is a safety related system which provides the RCS with the capability to vent non-condensable gases and steam from the high points of the RCS (e.g. the reactor vessel head and the pressurizer steam space). The RCGVS provides a safety-related means to depressurize the RCS when pressurizer sprays are unavailable. The RCGVS consists of piping and valves to vent non-condensable gases and/or steam directly to the IRWST. The staff's detailed review of the RCGVS Tier 1 information is contained in Chapter 5 of this SER.

14.3.4.4.9 Chemical and Volume Control System

The staff notes that the chemical and volume control system (CVCS) provides mostly non-safety-related functions of purity, volume, and chemistry control for the APR1400. The CVCS also provides backup spray water to the pressurizer and cooling water to the RCP seals. The safety-related functions of the CVCS consist of maintaining integrity of components in the reactor coolant pressure boundary, containment isolation, and limiting the magnitude of boron dilution sources. The CVCS consists of charging pumps, regenerative and non-regenerative heat exchangers, purification filters and ion exchangers, the volume control tank, and associated piping and valves. The staff's detailed review of the CVCS Tier 1 information is contained in Chapter 9 of this SER.

14.3.4.4.10 Leakage Detection System

The staff notes that the leakage detection system provides a means for detecting and monitoring reactor coolant system leakage. Indications of leakage are provided by containment sump level indicators, containment airborne particulate radiation monitors, and containment atmospheric humidity indicators. Alarms and displays in the main control room alert the

operators of reactor coolant pressure boundary leakage. The staff's detailed review of the Tier 1 information for the leakage detection system is contained in Chapter 5 of this SER.

14.3.4.4.11 Interface Requirements

The staff notes that interface requirements are defined for: (a) systems that are entirely outside the scope of the design, and (b) the out-of-scope portions of those systems that are only partially within the scope of the standard design. The applicant included the reactor systems' designs within the complete scope of the standard design, thus precluding the necessity of having interface requirements for these systems. The staff accepted that interface requirements are not needed for reactor systems.

14.3.4.5 Combined License Information Items

There are no COL items associated with Section 14.3.2.4 of the APR1400 DCD.

14.3.4.6 Conclusion

In general, the staff concludes that the applicant has adequately identified the reactor systems which need to have ITAAC requirements. The review of each reactor system's ITAAC to determine necessity and sufficiency in regards to 10 CFR 52.47(b)(1) can be found in the associated reactor system's section of this SER. The review completed in this section of the SER supports the 10 CFR 52.47(b)(1) findings made in the system specific sections of the SER.

14.3.5 Instrumentation and Controls– Inspections, Tests, Analyses, and Acceptance Criteria

14.3.5.1 Introduction

Inspections, tests, analyses, and acceptance criteria (ITAAC) information is contained in Tier 1 of the APR1400 DCD. The ITAAC evaluation includes a review of the commitments to be verified by ITAAC inspection. These commitments also define the scope of the APR1400 design and are identified in the design description for each system that establishes the scope of ITAAC.

The scope of review for instrumentation and controls (I&C) ITAAC includes I&C systems involving reactor protection and control, engineered safety features (ESF) actuation, and other systems using I&C equipment. The review also addresses information related to the design process of digital computers in I&C systems and selected interface requirements related to I&C issues.

14.3.5.2 Summary of Application

DCD Tier 1: There are two material categories in Tier 1: Design descriptions and ITAAC.

- Design descriptions address the most safety-significant features of a system. Design descriptions are in the form of descriptions, tables, and figures, and are binding for the lifetime of a facility.

- ITAAC will be used to verify the APR1400 as-built features. ITAAC material is in tabular format only and will no longer constitute requirements for a facility once the 10 CFR 52.103(g) finding is made for that facility.

Title 10 CFR 52.47(b)(1) requires a DC application to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC is built and should operate in accordance with the DC, the provisions of the Atomic Energy Act, and the NRC's regulations. SRP Section 14.3 provides guidance on the type of information that should be provided in Tier 1 of the application in order to meet the requirements of 10 CFR 52.47(b)(1), including top-level information that describe the principal performance characteristics and safety functions of the structures, systems, and components (SSC)s. Based on the description of Tier 1 information included, the staff finds that additional information is needed to demonstrate that safety functions performed by I&C systems are adequately described. Specifically, the staff requested in RAI 317-8271, Question 14.03.05-13 (ML15321A293) for the applicant to include the safety functions performed by each safety-related I&C systems in the APR1400 DCD Tier 1 descriptions.

In its response to RAI 317-8271, Question 14.03.05-13 (ML16062A317), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.1.1, to include design descriptions of the safety functions performed by the Auxiliary Processing Cabinet-Safety (APC-S), Core Protection Calculator System (CPCS), Excore Neutron Flux Monitoring System (ENFMS), the Plant Protection System (PPS), and Reactor Trip Switchgear System (RTSS). Based on the commitment to revise APR1400 DCD Tier 1, Section 2.5.1.1 to include the safety functions performed by these systems, the staff finds the APR1400 DCD Tier 1 adequately describes the safety functions performed by I&C systems to meet the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-13 resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1. As such, RAI 317-8271, Question 14.03.05-13 was resolved and closed.

DCD Tier 2: DCD Tier 2, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," discusses the selection criteria and methods used to develop the DCD Tier 1 design descriptions and the ITAAC. The applicant states in APR1400 DCD Tier 2, Section 14.3 that the design descriptions, interface requirements, and site parameters are derived from Tier 2 information and that Tier 1 information includes:

- Definitions and general provisions
- Design descriptions
- ITAAC
- Significant interface requirements
- Significant site parameters

ITAAC: The APR1400 I&C-related ITAAC are provided in DCD Tier 1, Section 2.5, "Instrumentation and Control Systems."

Technical Specifications: DCD Tier 2, Sections 3.3 and B.3.3 provide technical specifications for instrumentation and control systems.

14.3.5.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Sections 14.3 and 14.3.5 of NUREG-0800. Review interfaces with other SRP sections can also be found in SRP Section 14.3.5.

The applicable regulatory requirements are as follows:

- Title 10 CFR 52.47(b)(1), "Contents of applications; technical information," as it relates to the requirement that a DC application contain the ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations.

The applicable acceptance criteria used to meet the above relevant requirement of the NRC regulations as described in SRP Section 14.3.5, are summarized below:

1. The methodology for selecting SSCs that will be subject to ITAAC, as well as the criteria for establishing the necessary and sufficient ITAAC should be appropriate for, and consistently applied to, I&C systems.
2. DCD Tier 1 design descriptions and ITAAC should describe the top-level I&C design features and performance characteristics that are significant to safety. For safety systems, this should include a description of system purpose, safety functions, equipment quality (e.g., meet the functional requirements of IEEE Std 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations," and the digital system life cycle design process), equipment qualification, automatic decision-making and trip logic functions, manual initiation functions, and design features (e.g., system architecture) provided to achieve high functional reliability. The functions and characteristics of other I&C systems important to safety should also be discussed to the extent that the functions and characteristics are necessary to support remote shutdown, support required operator actions or assessment of plant conditions and safety system performance, maintain safety systems in a state that assures their availability during an accident, minimize or mitigate control system failures that would interfere with or cause unnecessary challenges to safety systems, or provide diverse back-up to protection systems.
3. SRP Section 14.3, Appendix A, "Information on Prior Design Certification Reviews," provides additional guidance on the content of DCD Tier 1 design descriptions and ITAAC.
4. ITAAC should identify the I&C system features upon which the staff is relying to assure compliance with NRC requirements and guidance identified in SRP Appendix 7.1-A, "Acceptance Criteria and Guidelines for Instrumentation and Control Systems Important to Safety." Tests, analyses, and acceptance criteria associated with each commitment should, when taken together, be sufficient to provide reasonable assurance that the final as-built I&C system fulfills NRC requirements. SRP Appendix 7.1-C, "Guidance for Evaluation of Conformance to

IEEE Std 603,” provides an expanded discussion of SRP acceptance criteria for safety system compliance with 10 CFR 50.55a(h). SRP Appendix 7.1-D, “Guidance for Evaluation of the Application of IEEE Std 7-4.3.2,” further discusses SRP acceptance criteria for safety and protection systems using digital computer-based technology. SRP Section 14.3, Appendix A, provides additional guidance on the expected scope, content, and format of ITAAC.

5. For APR1400 applications, DCD Tier 1 design descriptions and ITAAC should be based on and consistent with the DCD Tier 2 material.

The specific areas of review are as follows:

1. DCD Tier 1 information on I&C systems involving reactor protection and control, ESF actuation, and other systems using I&C equipment.
2. DCD Tier 1 information related to design process of digital computers in I&C systems.
3. Selected interface requirements related to I&C issues.
4. Functional requirements of IEEE Std 603-1991 and General Design Criteria (GDC) when implementing the safety system.

14.3.5.4 Technical Evaluation

The applicant provided design information, including associated tables and figures, in accordance with the selection methodology for APR1400 DCD Tier 1, as described in APR1400 DCD Tier 2, Section 14.3 to support the ITAAC for the APR1400 SSCs. The applicant organized the DCD Tier 1 information in the systems, structures, and topical areas format shown in the DCD Tier 1, “Table of Contents.” The staff reviewed the DCD Tier 1 information provided by the applicant in accordance with SRP Section 14.3.5.

14.3.5.4.1 Reactor Trip System and Engineered Safety Features Initiation Systems

The applicant provided design descriptions and ITAAC verifying design features for systems that perform reactor trip (RT) and ESF initiation functions in DCD Tier 1, Section 2.5.1, “Reactor Trip System and Engineered Safety Features Initiation.” In this section, the applicant provided design information, including associated tables, in the manner described in DCD Tier 2, Section 14.3 to identify necessary and sufficient ITAAC for APR1400 systems that perform RT and ESF initiation functions. The staff reviewed the design descriptions and ITAAC to ensure compliance with 10 CFR 52.47(b)(1).

APR1400 DCD Tier 1, Section 2.5.1, includes a description of systems that perform RT and ESF initiation functions. APR1400 DCD Tier 1, Section 2.5.1.1 states that the RT system (RTS) consists of four channels of sensors, APC-S cabinets, ENFMS cabinets, and four divisions of CPCS cabinets, the reactor protection system (RPS) portion of PPS cabinets, and RTSS cabinets. The ESF system consists of four channels of sensors, APC-S cabinets, and four divisions of the engineered safety features actuation system (ESFAS) portion of the PPS cabinets and engineered safety feature-component control system (ESF-CCS) cabinets. The ESF initiation is performed by sensors, the APC-S and the ESFAS portion of the PPS. In RAI 317-8271, Question 14.03.05-33 (ML15321A293), the staff requested the applicant to

clarify the use of the term “ESF initiation.” Specifically, it appears that APR1400 DCD Tier 1, Section 2.5.1.1 uses the term ESF initiation as a portion of the ESFAS from sensors to the output of the PPS. However, the term “initiation” typically refers to a function and not a system. As such, the staff requested the applicant to modify the use of this term to reflect the intent of referencing a portion of the ESFAS. In its response to RAI 317-8271, Question 14.03.05-33 (ML16036A374), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-5 so that “RTS and ESF system” is used considering the system perspective, and “RT and ESF initiation” is used considering the functional perspective. For consistency, the applicant committed to revising APR1400 DCD Tier 1, Section 2.5.4.1 and the applicable ITAAC in Table 2.5.4-5 to modify “ESFAS initiation” to “ESF initiation.” Based on the proposed changes to the DCD to clarify the use of the term “initiation,” the staff finds the issues related to RAI 317-8271, Question 14.03.05-33 resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Sections 2.5.1 and 2.5.4. As such, RAI 317-8271, Question 14.03.05-33 was resolved and closed.

The APR1400 DCD Tier 1, Table 2.5.1-1, “Reactor Trip System and Engineered Safety Features Initiation Equipment Location and Classification,” lists the location of equipment that performs RT and ESF initiation functions, seismic category, and IEEE Class 1E divisional power source and environmental qualification category.

The following tables are provided in APR1400 DCD Tier 1:

Table 2.5.1-1, “Reactor Trip System and Engineered Safety Features Initiation Equipment Location and Classification”

Table 2.5.1-2, “Reactor Trip System Variables”

Table 2.5.1-3, “Engineered Safety Features Initiation Variables”

Table 2.5.1-4, “Reactor Trip System and Engineered Safety Features Initiation Bypasses”

Table 2.5.1-5, “Reactor Trip System and Engineered Safety Features Initiation ITAAC”

Design Basis

Title 10 CFR 50.55a(h)(3) states, in part, that an application filed on or after May 13, 1999, for DCs must meet the requirements for safety systems in IEEE Std 603-1991 and the correction sheet dated January 30, 1995. Section 4 of IEEE Std 603-1991 is the design bases requirements for a safety I&C system. IEEE Std 603-1991, Clause 4.1, requires the identification of the design basis event (DBE) applicable to each mode of operation, and Clause 4.2, requires documentation of the safety functions and corresponding protective actions of the execute features for each DBE. The safety systems are designed to protect the health and safety of the public by limiting the release of radioactive material following anticipated operational occurrences (AOOs) and postulated accidents (PAs). IEEE Std 603-1991, Clause 4.4, requires the identification of variables or combinations of variables, or both, that are to be monitored to manually or automatically, or both, control each protective action; the analytical limit associated with each variable, the ranges (normal, abnormal, and accident conditions); and the rates of change of these variables to be accommodated until proper completion of the protective action is ensured. IEEE Std 603-1991, Clause 4.6, states that for those variables in Clause 4.4 that have a spatial dependence (that is, where the variable varies

as a function of position in a particular region), the minimum number and locations of sensors required for protective purposes shall be identified. IEEE Std 603-1991, Clause 4.12, requires the identification of any other special design basis that may be imposed on the system design (example: diversity, interlocks, and regulatory agency criteria).

APR1400 DCD Tier 1, Section 2.5.1.1, Item 4.a, states the “PPS provides an automatic [RT] and ESF initiation signals, as indicated in Tables 2.5.1-2 and 2.5.1-3, if plant process signals reach predetermined setpoints.” An ITAAC is provided to verify this design commitment in DCD Tier 1 Table 2.5.1-5, Item 4.a. DCD Tier 1, Section 2.5.1.1, Item 6, states that each local coincidence logic (LCL) receives trip signals from four channels of bistable processors (BPs) and utilizes a 2-out-of-4 coincidence logic to perform RPS and ESF initiation functions identified in Tables 2.5.1-2 and 2.5.1-3. An ITAAC is provided to verify this design commitment in DCD Tier 1 Table 2.5.1-5, Item 6. DCD Tier 1, Section 2.5.1.1, Item 15, states that the input signals of PPS through APC-S or ENFMS are derived from RT and ESF measurement instrumentation that measures monitored variables identified in Tables 2.5.1-2 and 2.5.1-3. An ITAAC is provided to verify this design commitment in DCD Tier 1 Table 2.5.1-5, Item 15. DCD Tier 1, Section 2.5.1.1, Item 18, states that the RTS and ESF initiation instrumentation (referenced in Tables 2.5.1-2 and 2.5.1-3) monitors the normal operating, AOO, and postulated PA events. Corresponding ITAAC to verify that the as-built system meets these design commitments are provided in APR1400 DCD Tier 1, Table 2.5.1-5. An ITAAC is provided to verify this design commitment in DCD Tier 1 Table 2.5.1-5, Item 18.

Based on verification that the applicant provided adequate design descriptions regarding the automatic functions performed by the RT and ESF initiation, signal input to the PPS, and the monitoring of normal operating, AOO and PA events, the staff finds that the APR1400 Tier 1 design descriptions and corresponding ITAAC identified in the preceding paragraph are adequate to demonstrate the as-built RT and ESF system meets the requirements of IEEE Std 603-1991, Clauses 4.1, 4.2, and 4.4. Therefore, the staff finds these ITAAC meet the requirements of 10 CFR 52.47(b)(1). However, the staff could not identify design descriptions and corresponding ITAAC to verify that the as-built PPS is provided with the minimum number and locations of sensors required for protective variables that have spatial dependence to meet the requirements of IEEE Std 603-1991, Clause 4.6. As such, in RAI 317-8271, Question 14.03.05-14 (ML15321A293), the staff requested the applicant to provide this information in Tier 1 of the APR1400 DCD. Further, the staff could not find design descriptions and corresponding ITAAC to verify that the as-built PPS provides interlocks when associated conditions are met in order to meet the requirements of IEEE Std 603-1991, Clause 4.12. As such, in RAI 317-8271, Question 14.03.05-15 (ML15321A293), the staff requested the applicant to provide this information in Tier 1 of the APR1400 DCD.

In its response to RAI 317-8271, Question 14.03.05-14 (ML16142A002), the applicant proposed to add a design description and corresponding ITAAC item to APR1400 DCD Tier 1, Section 2.5.1 for identification of the number and locations of the sensors required for protective purposes that have spatial dependence to meet the requirements of IEEE Std 603-1991, Clause 4.6. The number designation for the design description and ITAAC item were changed due to the added information provided in the response to RAI 301-8280, Question 07.01-44. DCD Tier 1, Table 2.5.1-2, “Reactor Trip System Variables,” will also be revised to identify the protective variables that have a spatial dependence to meet the requirements of IEEE Std 603-1991, Clause 4.6. Based on the proposed revision to APR1400 DCD Tier 1, Section 2.5.1 and corresponding ITAAC item in Table 2.5.1-5, Item 25 to verify the as-built PPS includes the

appropriate number of spatially dependence sensors at specified locations, the staff finds issues related to RAI 317-8271, Question 14.03.05-14 resolved. As such, the staff finds that the as-built PPS will be verified to meet IEEE Std 603-1991, Clause 4.6. Therefore, the staff finds the ITAAC provided in Table 2.5.1-5, Item 25 is adequate to meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1. As such, RAI 317-8271, Question 14.03.05-14 was resolved and closed.

In its response to RAI 317-8271, Question 14.03.05-15 (ML17163A171), the applicant states: "the revised response to RAI 46-7879, Question No. 07.06-2 has been submitted (ref. MKD/NW-16-1037L, ML16288A864) and includes the related design description, a table, and ITAAC items to be inserted into DCD Tier 1 Section 2.5.4 for interlock systems important to safety and are applicable to this question." The staff reviewed the response to RAI 46-7879, Question 07.06-2, in which the applicant proposed to revise APR1400 DCD Tier 1, to include a new Table 2.5.4-4, "ESF-CCS Interlocks Important to Safety"; and an Item 22 to DCD Tier 1, Section 2.5.4.1, "Design Descriptions," along with the corresponding ITAAC in Table 2.5.4-5. The original Table 2.5.4-4, "Engineered Safety Features-Component Control System ITAAC," is now Table 2.5.4-5. Based on the provision of a Tier 1 table containing the interlocks important to safety and a design description and ITAAC to verify these interlocks, the staff finds that the interlocks important to safety will be adequately verified in the as-built ESF-CCs to meet the requirements of 10 CFR 52.47(b)(1). The staff verified the incorporation of the proposed markups in APR1400 DCD Tier 1, Section 2.5.4. As such, the staff considers the issue identified in RAI 317-8271, Question 14.03.05-15, to be resolved and closed.

Completion of Protective Action

IEEE Std 603-1991, Clause 5.2 states that the safety systems shall be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion. Deliberate operator action shall be required to return the safety systems to normal.

APR1400 DCD Tier 1, Section 2.5.1.1, Item 4.b states that once RT is initiated (automatically or manually), the reactor trip breakers remain open until completion of the protective action, and do not automatically return to normal after the trip condition is reset. The corresponding ITAAC in DCD Tier 1, Table 2.5.1-5, Item 4.b verifies this design commitment in the as-built system. Based on the design commitment and corresponding ITAAC provided in DCD Tier 1, Table 2.5.1-5, Item 4.b, the staff finds that this ITAAC will verify that the as-built PPS and RTS meet completion of protective actions requirements for reactor trip initiation, and thus the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 4.b meet the requirements of 10 CFR 52.47(b)(1).

Quality Standards and Records

IEEE Std 603-1991, Clause 5.3, requires, in part, that components and modules be of a quality that is consistent with minimum maintenance requirements and low failure rates. This clause also states that "Safety system equipment shall be designed, manufactured, inspected, installed, tested, operated, and maintained in accordance with a prescribed quality assurance program." 10 CFR Part 50, Appendix A, GDC 1 requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the

importance of the safety functions to be performed. Branch Technical Position (BTP) 7-14 provides guidance on performing reviews for software-based safety-related, I&C systems.

The staff reviewed DCD Tier 1, Table 2.5.1-5, to ensure sufficient ITAAC were provided for systems that perform RTS and ESF initiation functions. Based on the information provided, the staff finds that additional information is needed to verify that the as-built system meets the quality requirements of IEEE Std 603-1991, Clause 5.3 and the inspectability requirements of 10 CFR 52.47(b)(1). Technical Report (TeR) APR1400-Z-J-NR-14003, Rev. 0, "Software Program Manual [SPM]," describes the software engineering process for digital computer-based I&C systems of the APR1400. Section 1.1 of this TeR states this report provides generic guidance for the software program plans based on the BTP 7-14. Section 2.2 of this TeR defines the software life cycle phases for the development of safety I&C system software, which includes the concept, requirements, design, implementation, test, installation and checkout, and operation and maintenance phases. APR1400 DCD Tier 1, Section 2.5.1.1, Item 11, states "RTS and ESF initiation software is implemented according to the software life cycle process." The staff finds that this section does not describe what lifecycle process (e.g. specific lifecycle phases of the lifecycle process) the RTS and ESF initiation software follow. In RAI 71-7906, Question 14.03.05-1 (ML15196A597), the staff requested the applicant to:

1. Identify and define the lifecycle phases for the lifecycle process in Tier 1 (design descriptions and ITAAC) of the APR1400 DCD and verify that these phases are consistent with the SPM TeR in order to demonstrate compliance to the requirements of IEEE Std 603-1991, Clause 5.3, and 10 CFR 52.47(b)(1).
2. Ensure the Tier 1 design description and ITAAC address all RTS and ESF software. The current description implies that the design commitment on following the software lifecycle development process only applies to the RTS and ESF initiation software and not all system software of the RTS and ESF system (e.g. self-diagnostic software, communications software).
3. For the Tier 1 design description and ITAAC, state that the output of each life cycle phase will conform to the requirements of that phase. The acceptance criterion for the corresponding ITAAC states that a summary report with the results of each phase exists and this summary report will conclude that the phase activities are performed. The staff finds that the acceptance criterion does not verify that the output of each phase meets the requirements of that phase. Modify the ITAAC to verify that the output of each phase meets the requirements of that phase.

In its response to RAI 71-7906, Question 14.03.05-1, the applicant committed to revise Item 11 of Section 2.5.1.1 and Table 2.5.1-5 of DCD Tier 1 to identify each phase of the software lifecycle as defined in the Software Program Manual Technical Report. In addition, the applicant clarified that the RTS and ESF initiation software implies the application software portion of the safety system. The initiation software utilizes the platform software, which has already been qualified, including self-diagnostic and communication in order to generate reliable reactor trip and ESF initiation signals and accomplish the intended safety functions within the safety system. The applicant committed to modify the term, "RTS and ESF initiation software", to "The application software for RTS and ESF initiation." In addition, the applicant committed to modify APR1400 DCD Section 2.5.1.1 and Table 2.5.1-5, Item 11 to verify by inspection and analysis that the outputs, including documentation, of each lifecycle phase in the software

development process conforms to the requirements of that phase. The staff finds the proposed changes to APR1400 DCD Section 2.5.1.1 and Table 2.5.1-5, Item 11 adequate to verify the as-built RTS and ESF system application software will conform to the requirements of each phase of the software lifecycle in the software development process. Thus, the staff finds the as-built PPS will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.3, and therefore, the staff finds the ITAAC in Table 2.5.1-5, Item 11 satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues related to RAI 71-7906, Question 14.03.05-1 resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1. As such, RAI 71-7906, Question 14.03.05-1 was resolved and closed.

Equipment Qualification

IEEE Std 603-1991, Clause 5.4, requires, in part, that safety system equipment be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis. GDC 2 requires, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches, without loss of capability to perform their safety functions. GDC 4 requires, in part, structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

APR1400 DCD Tier 1, Section 2.5.1.1, Item 1, and the corresponding ITAAC in Table 2.5.1-1, Item 1, states that the seismic Category I equipment, identified in Table 2.5.1-1 withstand seismic design basis loads without loss of safety function. In addition DCD Tier 1 Section 2.5.1.1, Item 2, states that the Class 1E equipment identified in Table 2.5.1-1 withstand the electrical surge, electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. A corresponding ITAAC for this design description is provided in Table 2.5.1-1, Item 2. DCD Tier 1, Section 2.5.1.1, Item 17, states that the Class 1E equipment listed in Table 2.5.1-1 is protected from accident related hazards such as missiles, pipe breaks, and flooding. A corresponding ITAAC for this design description is provided in Table 2.5.1-1, Item 17. DCD Tier 1, Section 2.5.1.1, Item 19, states that the Class 1E instrument identified in Table 2.5.1-1 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. A corresponding ITAAC for this design description is provided in Table 2.5.1-1, Item 19.

Based on the design commitments and corresponding ITAAC provided to verify that the as-built Class 1E equipment listed in APR1400 DCD Tier 1, Table 2.5.1-1 will be able to withstand seismic design basis loads, and EMI, RFI and ESD conditions, are protected from missiles pipes breaks and flooding, and are qualified for the expected environmental conditions, the staff finds that the as-built systems that perform RT and ESF initiation functions will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.4, GDC 2, GDC 4. Therefore, the staff finds the ITAAC in Table 2.5.1-1, Items 1, 2, 17, and 19 meet the requirements of 10 CFR 52.47(b)(1). However, it is unclear to the staff whether type tests,

analyses, or a combination of type test and analyses will be performed again for those types of Class 1E Common-Q equipment for plant-specific conditions or if the qualification tests performed for the approved Common-Q platform will be credited for the closure of ITAAC. As such, the staff issued RAI 323-8281, Question 07.03-9 (ML15334A336) for the applicant to clarify this information and provide supporting information in relevant DCD Tier 1 and Tier 2 sections. In its response to RAI 323-8281, Question 07.03-9 (ML16064A060), the applicant states, "The ITAAC associated with equipment quality or qualification in APR1400 DCD Tier 1, Tables 2.5.1-5, 2.5.3-3, and 2.5.4-5, includes all Class 1E equipment in the scope of the Common Q platform for the APR1400 system. The type tests, analyses, or combination of type test and analyses performed for all Class 1E equipment are not to be re-performed for the Common Q platform. The qualification of the NRC approved Common Q platform itself will be credited during the closure stage of the ITAAC. To verify the installation of Common Q in accordance with the approved Common Q topical report, Section 2.5 of DCD Tier 1 and Section 7.1 of DCD Tier 2 will be revised, as the response of the Question No. 07.01-44 of the RAI 301-8280." The staff finds this response needs to be clarified. Specifically, this response states the ITAAC associated with equipment quality includes all Class 1E equipment within the scope of the Common Q platform. However, it also states that the type tests, analyses, or combination of type test and analyses performed for all Class 1E equipment are not to be re-performed for the Common Q platform. It is unclear whether the applicant intends to state the qualification activities will only be done on Class 1E equipment implemented on the Common Q platform and independent qualification of the generic platform itself will not be performed. In its supplemental response to RAI 323-8281, Question 07.03-9 (ML17068A069), the applicant clarified that the type tests, analyses, or a combination of type test and analyses will be performed for the safety I&C system cabinets, including the Common Q platform, for plant-specific conditions. However, the tests and analyses for the Common Q platform itself are not expected to be re-performed because the original components of the Common Q platform have already been qualified, as described in the Common Q topical report. Based on this clarification made in this supplemental response to RAI 323-8281, Question 07.03-9 (i.e. tests and analyses for the Common Q platform itself will not be re-performed), the staff finds the issues identified in RAI 323-8281, Question 07.03-9, to be resolved and closed.

System Integrity

IEEE Std 603-1991, Clause 5.5, requires that the safety system accomplishes its safety functions under the full range of applicable conditions enumerated in the design basis. GDC 23 requires that the protection system be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy, or postulated adverse environments are experienced.

APR1400 DCD Tier 1, Section 2.5.1.1, Item 13, and the corresponding ITAAC in DCD Tier 1, Table 2.5.1-5, state that the RT logic of the PPS is designed to fail to a safe state such that loss of electrical power to a division of PPS results in a trip condition for that division but the ESFAS logic of the PPS is designed to fail to a safe state such that loss of electrical power to a division of PPS does not result in ESF initiation for that division. Based on the information provided, the staff finds that additional information is required to determine whether the as-built system will fail in a safe state during conditions indicative of a PPS processor lock-up. As such, in RAI 317-8271, Question 14.03.05-16 (ML15321A293), the staff requested the applicant to provide design descriptions and corresponding ITAAC to verify that failures of the PPS that result in lock-up of the PPS processors would be detected (e.g. via watchdog timers) and the

PPS would be designed to fail in a safe state upon these conditions in order to demonstrate that the requirements of IEEE Std 603-1991, Clause 5.5 are met for the as-built PPS.

In its response to RAI 317-8271, Question 14.03.05-16 (ML16062A319), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.1.1, Item 13 to include descriptions of PPS testing to ensure fail-safe conditions are achieved on a processor lock-up. The applicant also committed to include corresponding ITAAC to demonstrate acceptability of the as-built system. Based on the proposed revisions to the APR1400 DCD Tier 1 to verify that the as-built PPS will fail in a safe state upon processor lock-ups, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-16 resolved. As such, the staff finds that the as-built PPS will be verified to meet IEEE Std 603-1991, Clause 5.5. Therefore, the staff finds the ITAAC provided in Tier 1, Table 2.5.1-5, Item 13 meets the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Sections 2.5.1 and 2.5.4. As such, RAI 317-8271, Question 14.03.05-16 was resolved and closed.

New Common Q Platform watchdog timer design information was submitted to the NRC via a Westinghouse Nuclear Safety Advisory Letter (NSAL)-17-2, dated July 5, 2017 (ML17213A208). The NSAL-17-2 information states that for the NRC approved Common Qualified Platform Topical Report, Revision 3:

- The software stall timer was never activated in the AC160 base software, as designed;
- The inactivated software stall timer also disabled the hardware stall timer.

Therefore, due to the new and conflicting design information presented in NSAL-17-2 and the docketed APR1400 DC application information, the staff issued RAI 555-9163, Question 07.02-19, requesting the applicant to review the applicable safety Common Q platform based systems design descriptions of the APR1400 DC application and demonstrate that the APR1400 DC application is not affected by the design information contained within NSAL-17-2. As part of this RAI request, the staff requested the applicant to expand the design descriptions in DCD Tier 1, Sections 2.5.1.1, Item 13 and 2.5.4.1, Item 10 and corresponding ITAAC in Tier 1, Tables 2.5.1-5, Item 13 and 2.5.4-5, Item 10, respectively, to verify that the WDTs used to generate trip and fail-safe conditions for reactor trip and ESFAS functions, respectively, are hardware based.

In the applicant's April 12, 2018 response to this RAI (ML18102B220), the applicant provided markups to show the expanded and additional design descriptions to be added to DCD Tier 1, Section 2.5.1.1 design descriptions and its corresponding ITAAC Table 2.5.1-5, Item 13, as well as Tier 1, Section 2.5.4.1 design descriptions and its corresponding ITAAC Table 2.5.4-5, Item 10. The design descriptions and ITAAC clarify that a hardware-based window watchdog timer from the NRC approved safety I&C platform located in the processor module will be used to achieve the trip condition in the PPS and alarms in the ESF-CCS. Subsequently, the applicant provided a supplemental response to this RAI (ML18124A146) to clarify the design description and corresponding ITAAC in Table 2.5.1-5, Item 13, to separate the design information for RT logic versus ESFAS logic. The staff finds the applicant's proposed changes to ITAAC Table 2.5.1-5, Item 13 and Table 2.5.4-5, Item 10 acceptable because the implementation of the watchdog timer will be consistent with the approved NRC topical report for the Common Q platform. As such, the staff finds the revised ITAAC in Table 2.5.1-5, Item 13 and ITAAC Table 2.5.4-5, Item 10 meet the requirements of 10 CFR 52.47(b)(1). Based on the

review of the DCD, the staff has confirmed incorporation of the changes described above; therefore RAI 555-9163, Question 07.02-19 was resolved and closed.

The staff finds that due to the applicant taking a deviation from the approved WCAP-10697-P-A, Revision 3, "Common Q Platform Topical Report," for the CPCS central processing units (CPU)s by increasing the CPU maximum load limit from 70 percent to 75 percent, and requiring that the CPCS be designed and developed with sixteen (16) additional programming configuration restrictions and several additional tests to assure deterministic operations (i.e., ensure all safety function tasks are performed within the required response time) above the 70 percent CPU load limit, the staff finds that the additional sixteen configuration restrictions, as listed in Section 2 of the Common Q Supplemental TeR, are safety significant. SRP Section 14.3.5, "Instrumentation and Controls - Inspections, Tests, Analyses, And Acceptance Criteria," Section II, "Acceptance Criteria," Item 2 states that:

Tier 1 Design Descriptions ... and ITAAC Design Descriptions ... should describe the top-level I&C design features and performance characteristics that are significant to safety. For safety-related systems, this should include a description of system purpose, safety functions, equipment quality ... equipment qualification ... and design features ... provided to achieve high functional reliability.

Therefore, the staff issued RAI 554-9146, Question 07.02-18 (ML17261B310), requesting the applicant to either:

- Include the 16 configuration restrictions in Section 2.5.1, "Reactor Trip System and Engineered Safety Features Initiation," Tier 1, of the DCD or,
- Incorporate by reference, the proprietary APR1400-A-J-NR-14004, "Common Q Platform Supplemental Information in Support of APR1400 Design Certification," Technical Report (Common Q Supplemental TeR), and identify it as a "Tier 1" document.

The applicant submitted its response to RAI 554-9146, Question 07.02-18 (ML17331A231). In its response, the applicant provided DCD Tier 1 markups that contained a modified listing (i.e., paraphrased and simplified) of the 16 configuration restrictions for increasing maximum CPU load, as DCD Tier 1, Section 2.5.1.1, Item 27. This modified listing of the configuration restrictions combined the original sixteen configuration restriction criteria items 12 and 13 into one criteria item such that DCD Tier 1, Section 2.5.1.1, Item 27 consists of listing of fifteen (15) design criteria (Note: This Tier 1 modification does not affect or change the original 16 configuration restrictions listed in Section 2 of the Common Q Supplemental TeR). In addition, the applicant also provided a DCD Tier 1, Table 2.5.1-5, ITAAC Item 27 markup that will verify that the 16 configuration restrictions have been properly and correctly implemented in the as-built plant. The applicant provided a supplemental response to RAI 554-9146, Question 07.02-18 (ML18142A303) to correct the reference to Item 28 in ITAAC Table 2.5.1-5. The applicant modified this ITAAC to correctly reference Item 28 in Section 2.5.1.1, DCD Tier 1 and specify that the inspection will be performed on the "as-built" CPCS. The staff finds this correction is acceptable. Based on the proposed revisions to DCD Tier 1, Section 2.5.1.1 to include the configuration restrictions for the CPCS, and the proposed additional ITAAC in Table 2.5.1-5, Item 28, the staff finds that the issues identified in RAI 554-9146, Question 07.02-18 are resolved. As such, the staff finds that the as-built CPCS will be verified to meet IEEE Std 603-

1991, Clause 5.5. Therefore, the staff finds the ITAAC provided in Tier 1, Table 2.5.1-5, Item 28 meets the requirements of 10 CFR 52.47(b)(1). Based on a review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 554-9146, Question 07.02-18 was resolved and closed.

Independence

IEEE Std 603-1991, Clause 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std 603-1991, Clause 5.6.3, requires that the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. IEEE Std 603-1991, Clause 5.6.3.1, states, in part, "Isolation devices used to effect a safety system boundary shall be classified as part of the safety system." GDC 24 states requires that the protection system be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired. The DCD Tier 1 design descriptions and ITAAC discussed in the three subsections below on physical separation, electrical isolation and communications independence address the independence requirements discussed in this paragraph.

Physical Separation

APR1400, DCD Tier 1, Section 2.5.1.1, states, "The RTS and ESF initiation equipment is located in the auxiliary building and reactor containment building." APR1400, DCD Tier 1, Section 2.5.1.1, Item 3.b, states, "Redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment are physically separated and electrically independent form each other and physically separated and electrically independent form Class 1E equipment." The acceptance criteria states, in part, "The physical separation of as-built redundant Class 1E divisions identified in Table 2.5.1-1 and associated filed equipment is provided by distance or barriers in accordance with NRC [Regulatory Guide (RG)] 1.75." IEEE Std 603-1991, Clause 5.6.1, requires physical separation between redundant portions of safety systems, and Clause 5.6.3, requires physical separation between Class 1E equipment and non-safety systems. RG 1.75 provides guidance for meeting the physical separation requirements of IEEE Std 603-1991, Clause 5.6. Based on the information presented in APR1400 DCD Tier 1, Table 2.5.1-1, the staff could not identify where in the auxiliary building and reactor containment building the redundant divisions of safety equipment will reside in order to demonstrate that sufficient separation exists between the redundant divisions of safety equipment or between safety and non-safety equipment in order to meet the requirements of IEEE Std 603-1991, Clause 5.6. As such, in RAI 71-7906, Question 14.03.05-3 (ML15196A597), the staff requested the applicant to include this information in Tier 1 of the DCD and modify the corresponding ITAAC accordingly to verify via inspection that the as-built system meets the design commitment in order to demonstrate compliance to 10 CFR 52.47(b)(1).

In its response to RAI 71-7906, Question 14.03.05-3 (ML15281A303), the applicant stated the redundant Class 1E divisions and associated equipment listed in Table 2.5.1-1 of APR1400 Tier 1 are located in a separated I&C equipment room for each division and the location configuration meets the independence requirements of IEEE Std 603-1991, Clause 5.6. Also, the ex-core neutron detectors are located in the reactor containment building in a manner that the detectors for each measurement channel meet the independence requirements of IEEE Std 603-1991, Clause 5.6. The applicant committed to revise APR1400 DCD Tier 1, Table 2.5.1-1 to include the specific locations of redundant Class 1E divisions and associated equipment. The staff finds the proposed changes to APR1400 DCD Tier 1, Table 2.5.1-1 to include the location configuration of Class 1E divisions and associated equipment acceptable to support verification that as-built redundant Class 1E divisions are sufficiently separated to meet the requirements of IEEE Std 603-991, Clause 5.6. Therefore, the ITAAC provided in DCD Tier 1, Table 2.5.1-5, Item 3.b meets the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 71-7906, Question 14.03.05-3 resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-1. As such, RAI 71-7906, Question 14.03.05-3 was resolved and closed.

Electrical Isolation

APR1400 DCD Tier 1, Section 2.5.1.1, Item 3.a, and the associated ITAAC state “Class 1E equipment identified in Table 2.5.1-1 is powered from its respective Class 1E train.” DCD Tier 1, Section 2.5.1.1, Item 3.b states “Redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment are physically separated and electrically independent from each other and physically separated and electrically independent from non-Class 1E equipment.” The associated acceptance criteria in DCD Tier 1, Table 2.5.1-5, Items 3.b.ii and 3.b.iii, state “A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.1-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, qualified isolation devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.” The staff finds that additional information is needed to clarify whether the qualified isolation devices at interfaces between redundant divisions and at interfaces between safety and non-safety systems are Class 1E qualified. In addition, an ITAAC was not provided to verify via inspection that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems. As such, the staff requested in RAI 317-8271, Question 14.03.05-17 (ML15321A293) for the applicant to modify the DCD Tier 1, Table 2.5.1-5, Items 3.b.ii and 3.b.iii, to clarify that these qualified isolation devices are Class 1E as required by IEEE Std 603-1991, Clause 5.6, and to provide an ITAAC to verify via inspection that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems.

In its response to RAI 317-8271, Question 14.03.05-17 (ML16208A563), the applicant proposed to revise the design description in Item 3.b of APR1400 DCD Tier 1, Section 2.5.1.1 to state Class 1E qualified isolation devices such as fiber optic modems or interposing relays will be applied at interfaces of redundant safety divisions and at interfaces between safety and non-safety systems. Accordingly, inspection and acceptance criteria will be added in APR1400 DCD Tier 1, Table 2.5.1-5, Item 3.b to verify the inclusion of these qualified isolation devices in the as-built system. Based on the proposed changes to Tier 1 to include descriptions of Class 1E qualified isolation devices and corresponding ITAAC to verify inclusion of these isolation devices in the as-built system, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-

17 resolved. As such, the staff finds that the as-built PPS will be verified to meet the electrical requirements in IEEE Std 603-1991, Clause 5.6, and therefore, the ITAAC provided in DCD Tier 1, Table 2.5.1-5, Items 3.a and 3.b meets the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-5. As such, RAI 317-8271, Question 14.03.05-17 was resolved and closed.

Communications Independence

APR1400 DCD Tier 1, Section 2.5.1.1, Item 3.c, states, "Communication independence is achieved between redundant divisions of the Class 1E equipment listed in Table 2.5.1-1 or between non-safety systems and the Class 1E equipment listed in Table 2.5.1-1." This design commitment implies that communication independence will either be achieved between redundant divisions of Class 1E equipment or between non-safety systems and Class 1E equipment. The staff believes the wording should be modified to "Communication independence is achieved between redundant divisions of the Class 1E equipment listed in Table 2.5.1-1 and between non-safety systems and the Class 1E equipment listed in Table 2.5.1-1" in order to demonstrate that communications independence will be achieved between redundant divisions of Class 1E equipment and between non-safety systems and Class 1E equipment. The staff finds that the design commitment and the associated ITAAC do not provide sufficient design information to demonstrate how communications independence will be achieved in the as-built system (e.g. types of communications faults that will be mitigated, key safety I&C features that will be used to mitigate these faults) in order to meet the requirements of 10 CFR 52.47(b)(1). For instance, the design description and the ITAAC should be more specific as to how communication independence is achieved for the various interdivisional communication links. Further, the staff did not find ITAAC to verify the uni-directional gateway between the maintenance and test panel (MTP) and the information processing system (IPS), and between the integrated test panel (ITP) and qualified information and alarm system - non-safety (QIAS-N) in order to verify that communications independence is achieved between safety and non-safety systems. In RAI 71-7906, Question 14.03.05-2 (ML15196A597), the staff requested the applicant to modify Tier 1 of the DCD, including the ITAAC to resolve these issues related to communication independence.

In its response to RAI 71-7906, Question 14.03.05-2 (ML15281A303), the applicant clarified "A report" as specified in item 3.c of the Acceptance Criteria in APR1400 DCD Tier 1, Table 2.5.1-5 refers to the Safety I&C System Technical Report, which provides the detailed design information on how there is communications independence between redundant divisions of the Class 1E equipment listed in Table 2.5.1-1 and between the Class 1E equipment listed in Table 2.5.1-1 and the non-safety systems. Sections C.4.1.5 and C.4.2 of the Safety I&C System Technical Report provide detailed descriptions on communication from the MTP to the IPS and the ITP to the QIAS-N, which is all unidirectional. The applicant clarified Item 3.c of the design description in APR1400 DCD Tier 1, Section 2.5.1.1 includes both "between redundant divisions of the Class 1E equipment listed in Table 2.5.1-1" and "between Class 1E equipment listed in Table 2.5.1-1 and non-safety systems." The applicant committed to revise Item 3.c of the design description in APR1400 DCD Tier 1, Section 2.5.1.1 to provide the design description only for communication "between redundant divisions of the Class 1E equipment listed in Table 2.5.1-1." In addition, Item 3.d will be added to DCD Tier 1, Section 2.5.1.1 and Table 2.5.1-5 to provide the design description for communication from non-safety systems and Class 1E equipment listed in APR1400 DCD Tier 1 Table 2.5.1-1. In its supplemental response to RAI

71-7906, Question 14.03.05-2 (ML16180A280), the applicant committed to revise the design description to incorporate additional communications independence features into the proposed ITAAC. Specifically, the verification of key design and software features (e.g. use of dual port RAM, separate communication and function processor, only accepting predefined messages and error checking) for ensuring communications independence will be included as acceptance criteria to Items 3.c and 3.d in Table 2.5.1-5. Based on the proposed changes to APR1400 DCD Tier 1, Section 2.5.1.1 and Table 2.5.1-5, Items 3.c and 3.d, the staff finds communications independence will be adequately verified in the as-built system to meet the requirements of IEEE Std 603-1991, Clause 5.6. Therefore, the staff finds the ITAAC provided in Table 2.5.1-5, Items 3.c and 3.d satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 71-7906, Question 14.03.05-2, to be resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-5. As such, RAI 71-7906, Question 14.03.05-2 was resolved and closed.

DI&C-ISG-04, Revision 1, “Highly-Integrated Control Rooms – Communications Issues (HICRc),” provides guidance for achieving communications independence to meet the requirements of IEEE Std 603-1991, Clause 5.6. Under interdivisional communications, Staff Position 10, the staff states that a physical cable disconnect, or a keylock, which can physically open the data transmission circuit or interrupt the hardwired logic connection should be used to protect software from unintended modifications. Based on the staff’s review of the information provided in DCD Tier 1, Section 2.5, the staff could not locate design commitments or associated ITAAC to verify that a physical cable disconnect, or a keylock, which can physically open the data transmission circuit or interrupt the hardwired logic connection are employed in the as-built safety system to protect safety system software from unintended modifications. In RAI 317-8271, Question 14.03.05-18 (ML15321A293), the staff requested the applicant to modify Tier 1 of the DCD to include this information.

In its response to RAI 317-8271, Question 14.03.05-18 (ML16182A581), the applicant proposed to add the following ITAAC items to each system in Section 2.5 of the APR1400 DCD Tier 1: “Hardwired disconnections exist between the PPS, CPCS, QIAS-P, ESF-CCS cabinets, and the portable workstation used to download the PPS, CPCS, QIAS-P, ESF-CCS software. The hardwired disconnections protect the PPS, CPCS, QIAS-P, ESF-CCS software from unintended modifications.” Based on the proposed additional ITAAC in DCD Tier 1, Table 2.5.1-5, Item 26 to verify that hardwired disconnections exist between portable workstation used to download safety system software and the cabinets of these systems, the staff finds software modification controls will be adequately verified in the as-built system to meet the requirements of IEEE Std 603, Clause 5.6. Therefore, the staff finds the ITAAC provided in DCD Tier 1, Table 2.5.1-5, Item 26 satisfies the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-18, to be resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Sections 2.5.1, 2.5.3, and 2.5.4 and Tables 2.5.1-5, 2.5.3-3 and 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-18 was resolved and closed.

Capability for Test and Calibration

IEEE Std 603-1991, Clause 5.7, states, in part, the capability for testing and calibration of safety system equipment shall be provided while retaining the capability of the safety systems to accomplish their safety functions. BTP 7-17 provides guidance on self-test and surveillance test

provisions to meet the requirements of IEEE Std 603-1991, Clause 5.7. APR1400 DCD Tier 1, Section 2.5.1.1, Item 22 and the corresponding ITAAC in Tier 1, Table 2.5.1-5, Item 22, state that input sensors from each channel of the RTS and ESF initiation as identified in Tables 2.5.1-2 and 2.5.1-3 are compared continuously in the IPS to allow detection of out-of-tolerance sensors. APR1400 DCD Tier 1, Section 2.5.1.1, Item 20, and the corresponding ITAAC in Tier Table 2.5.1-5, Item 20, state, "The PPS providing RTS and ESF initiation signals has the testing functions." It is not clear to the staff what is meant by the design description in Section 2.5.1.1, Item 20. Specifically, it is not clear whether this design description intends to state that the capability to test and calibrate the PPS exists or there are self-testing functions within PPS. In addition, the design description regarding testing functions does not include criteria for testing features included in the design to meet the requirements of IEEE Std 603-1991, Clause 5.7 (e.g. ability to detect faults in a manner that meets the design requirements of the PPS). In RAI 71-7906, Question 14.03.05-4 (ML15196A597), the staff requested the applicant to modify the design description in Tier 1 of the APR1400 DCD to address these issues (including the acceptance criteria to the corresponding ITAAC) in order to meet the requirements of IEEE Std 603-1991, Clause 5.7 and 10 CFR 52.47(b)(1).

In its response to RAI 71-7906, Question 14.03.05-4 (ML15281A303), the applicant clarified the "testing functions" described in item 20 of the design description in APR1400 DCD Tier 1, Section 2.5.1.1 and design commitment in APR1400 DCD Tier 1, Table 2.5.1-5 means the testing function that can be manually initiated for periodic surveillance tests during power operation. The testing function includes a bistable processing logic test and a coincidence processing logic test. This testing function is initiated via the maintenance and test panel (MTP) and the test request and test values are transmitted to the bistable processor and coincidence processor to confirm the intended safety functions of those processors. The applicant committed to revise the design description in APR1400 DCD Tier 1, Section 2.5.1.1 and design commitment in APR1400 DCD Tier 1, Table 2.5.1-5, Item 20 to reflect this clarification. The staff finds the proposed changes to APR1400 DCD Tier 1, Section 2.5.1.1 and Table 2.5.1-5 to clarify the meaning of testing functions acceptable, and thus finds the issues identified in RAI 71-7906, Question 14.03.05-4, to be resolved. The staff also finds the design description in Tier 1, Section 2.5.1.1, Item 22 and the corresponding ITAAC in Tier 1, Table 2.5.1-5, Item 22 will adequately verify the as-built IPS will detect out of range sensors. As such, the staff finds that the as-built PPS will be verified to meet IEEE Std 603-1991, Clause 5.7, and therefore, the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 20 and Item 22 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-5, Item 20. As such, RAI 71-7906, Question 14.03.05-4 was resolved and closed.

Information Displays

IEEE Std 603-1991, Clause 5.8.1, states that the display instrumentation provided for manually controlled actions for which no automatic control is provided and the display instrumentation required for the safety systems to accomplish their safety functions shall be part of the safety systems. The design shall minimize the possibility of ambiguous indications that could be confusing to the operator. IEEE Std 603-1991, Clause 5.8.2, states, in part, that display instrumentation shall be provide accurate, complete, and timely information pertinent to safety system status. This information shall include indication and identification of protective actions of the sense and command features and execute features. IEEE Std 603-1991, Clause 5.8.3, states, in part, that if the protective actions of some part of a safety system have been bypassed

or deliberately rendered inoperative for any purpose other than an operating bypass, continued indication of this fact for each affected safety group shall be provided in the control room.

APR1400 DCD Tier 1, Section 2.5.1.1, Item 5 and the corresponding ITAAC in Tier 1, 2.5.1-5, Item 5, state, "The [Operator Module (OM)] in the MCR displays the status information of the variables listed in Table 2.5.1-2 and 2.5.1-3." APR1400 DCD Tier 1, Section 2.5.1.1, Item 7.c and the corresponding ITAAC in Tier 1, Table 2.5.1-5, Item 7.c, state that "The PPS provides indications of the bypassed or inoperable status indication (BISI) on the OM in the MCR for the variables identified in Tables 2.5.1-2 and 2.5.1-3 for RT and ESF initiation." The staff finds that the design commitments in Tier 1 Section 2.5.1.1, Item 5, and associated ITAAC in Table 2.5.1-5, Item 5 adequately verifies that the status of plant variables are displayed on the as-built OM to meet IEEE Std 603-1991, Clause 5.8.2. The staff finds that design commitment in Section 2.5.1.1, Item 7.c, and associated ITAAC in Table 2.5.1-5, Item 7.c adequately verifies that BISI is provided for the as-built PPS to meet IEEE Std 603-1991, Clause 5.8.3. Therefore the staff finds the ITAAC in Table 2.5.1-5, Items 5 and 7.c meet the requirements of 10 CFR 52.47(b)(1). The staff's evaluation on demonstrating conformance to IEEE Std 603-1991, Clauses 5.8.1 is provided in Section 14.3.5.4.4 of this safety evaluation.

Control of Access

IEEE Std 603-1991, Clause 5.9, states "The design shall permit the administrative control of access to safety system equipment. These administrative controls shall be supported by provisions within the safety systems, by provision in the generating station design, or by a combination thereof." APR1400 DCD Tier 1, Section 2.5.1.1, Item 12 and the corresponding ITAAC in Table 2.5.1-5, Item 12 state, "The cabinets listed in Table 2.5.1-1 have key locks and door open alarms, and are located in a vital area of the facility." Based on this design commitment and associated ITAAC in DCD Tier 1, Table 2.5.1-5, Item 12, the staff finds that the control of access features for the as-built equipment listed in Table 2.5.1-1 are verified to meet the requirements of IEEE Std 603-1991, Clause 5.9. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 12 meet the requirements of 10 CFR 52.47(b)(1).

Identification

IEEE Std 603-1991, Clause 5.11, requires, in part, that safety system equipment be distinctly identified for each redundant portion of a safety system in accordance with the requirements of IEEE Std 384-1981 and IEEE Std 420-1982. APR1400 DCD Tier 1, Section 2.5.1.1, Item 14, and the corresponding ITAAC in Table 2.5.1-5, Item 14 state that redundant safety equipment listed in Table 2.5.1-1 is provided with means of identification. Based on this design commitment and associated ITAAC in DCD Tier 1, Table 2.5.1-5, Item 14, the staff finds that identification for the as-built equipment listed in Table 2.5.1-1 will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.11. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 14 meet the requirements of 10 CFR 52.47(b)(1).

Automatic Control

IEEE Std 603-1991, Clause 6.1 states, in part, that "Means shall be provided to automatically initiate and control all protective actions except as justified in [Clause] 4.5. The safety system design shall be such that the operator is not required to take any action prior to the time and plant conditions specified in [Clause] 4.5 following the onset of each design basis event."

APR1400 DCD Tier 1, Section 2.5.1.1, Item 4a and the corresponding ITAAC in DCD Tier 1 Table 2.5.1-5, Item 4.a, state “The PPS provides an automatic RT and ESF initiation signals, as indicated in Tables 2.5.1-2 and 2.5.1-3, if plant process signals reach predetermined setpoints.” The associated acceptance criterion for this design commitment states, “Each as-built RTSS opens upon receipt of the automatic reactor trip signal identified in Table 2.5.1-2 from respective division of the as-built RTS, and as-built ESF initiation signals are sent to ESF-CCS upon receipt of the automatic ESF initiation signal identified in Table 2.5.1-3.” Based on the design commitment and associated ITAAC presented, it is not clear whether a reactor trip signal and a ESF actuation signal are automatically initiated for each function listed in DCD Tier 1, Table 2.5.1-2 and Table 2.5.1-3, respectively. As such, in RAI 317-8271, Question 14.03.05-19 (ML15321A293), the staff requested the applicant to clarify this information in Tier 1 of the APR1400 DCD in order to demonstrate that the as-built system meets the requirements of IEEE Std 603-1991, Clause 6.1.

In its response to RAI 317-8271, Question 14.03.05-19 (ML16036A374), the applicant proposed to clarify APR1400 DCD Tier 1, Section 2.5.1.1, and the associated ITAAC Item 4.a in Table 2.5.1-5 to indicate that each condition listed in APR1400 DCD Tier 1, Tables 2.5.1-2 and 2.5.1-3 will provide a reactor trip and ESF initiation signal. Based on this proposed revision to APR1400 DCD Tier 1, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-19, to be resolved. As such, the staff finds that the as-built PPS will be verified to meet IEEE Std 603-1991, Clause 6.1, and therefore, the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 4.a meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.1 and Table 2.5.1-5, Item 4.a. As such, RAI 317-8271, Question 14.03.05-19 was resolved and closed.

Manual Control

IEEE Std 603-1991, Clause 6.2.1, states, in part, that means shall be provided in the control room to implement manual initiation at the division level of the automatically initiated protective actions. APR1400 DCD Tier 1, Section 2.5.1.1, Item 4.c and the corresponding ITAAC in Tier 1, Table 2.5.1-5, Item 4.c, state, “Manual reactor trip switches are provided in the MCR and the RSR for reactor trip.” Based on the provision of design descriptions in APR1400 DCD Tier 1, Section 2.5.1.1, Item 4.c and corresponding ITAAC in Table 2.5.1-5, Item 4.c to verify the as-built MCR and RSR will contain manual reactor switches to trip the reactor, the staff finds the requirements of IEEE Std 603-1991, Clause 6.2.1 are met for reactor trip functions. Therefore, the staff finds the ITAAC provided in Table 2.5.1-5, Item 4.c meet the requirements of 10 CFR 52.47(b)(1).

Bypasses

IEEE Std 603-1991, Clause 6.6, states, in part, that “Whenever the applicable permissive conditions are not met, a safety system shall automatically prevent the activation of an operating bypass or initiate the appropriate safety function.” IEEE Std 603-1991, Clause 6.7, states, in part, that “Capability of a safety system to accomplish its safety function shall be retained while sense and command features equipment is in maintenance bypass. During such operation, the sense and command features shall continue to meet the requirements of [Clauses] 5.1 and 6.3.” APR1400 DCD Tier 1, Section 2.5.1.1 and the corresponding ITAAC in Tier 1, Table 2.5.1-5 provide the following design commitments with respect to operating and maintenance bypasses.

- Item 7.a states “The PPS provides manual trip bypasses on the MTP switch panel, for RT and ESF initiation identified in Tables 2.5.1-2 and 2.5.1-3, respectively.”
- Item 7.b states “The PPS automatically removes the operating bypasses listed in Table 2.5.1-4 when permissive conditions are not met.”
- Item 9 states “The PPS utilizes a 2-out-of-4 coincidence logic when no channels are in trip channel bypass. The PPS converts to a 2-out-of-3 coincidence logic whenever a trip channel bypass is present.”
- Item 21 states “A single channel of RTS and ESF initiation is bypassed to allow testing, maintenance or repair and this capability does not prevent the RTS and ESF initiation from performing its safety function.”

Based on the above design commitments and associated ITAAC in DCD Tier 1, Table 2.5.1-5 Items 7.a, 7.b, 9, and 21, the staff finds that operating and manual bypass functions will be adequately verified in the as-built PPS to meet the requirements of IEEE Std 603-1991, Clauses 6.6 and 6.7. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.1-5 Items 7.a, 7.b, 9, and 21 meet the requirements of 10 CFR 52.47(b)(1).

Setpoints

IEEE Std 603-1991, Clause 4.10, requires the identification of critical points in time or the plant conditions, after the onset of a design basis event. APR1400 DCD Tier 1, Section 2.5.1.1, Item 10 and the corresponding ITAAC in Tier 1, Table 2.5.1-1, Item 10, state that “accuracy, response time testing, surveillance testing, and maintenance are applied to determine setpoints for variables of RT and ESF initiation.” Section 2.5.1.1, Item 16 and the corresponding ITAAC in Tier 1, Table 2.5.1-1, Item 16, state, that “The PPS provides RT and ESF initiation signals to meet the required response time for trip and initiation conditions identified in Tables 2.5.1-2 and 2.5.1-3.” The acceptance criteria in the corresponding ITAAC in DCD Tier 1 Table 2.5.1-5 states, “A report exists and concludes that the PPS initiates the RT and the ESF initiation signals identified in Tables 2.5.1-2 and 2.5.1-3 within the response time requirements as described in the design basis.” Based on the design commitment and the associated ITAAC provided, it is not clear to the staff where the response time will be measured from (e.g. from output of sensors to the RTSS breakers/ESF-CCS input). In RAI 317-8271, Question 14.03.05-20 (ML15321A293), the staff requested the applicant to clarify where the response time will be measured from to verify this design commitment.

In its response to RAI 317-8271, Question 14.03.05-20 (ML16062A317), the applicant states, “Section A.3.1 of the Response Time Analysis of Safety I&C System technical report, the allocated response time covers not only the internal and external communication delays caused by communication modules and cables, but also includes adequate communication margins between equipment. Accordingly, the descriptions of the inspections, tests, analyses and the acceptance criteria for Item 16.a in Table 2.5.1-5 will include the communication delays from the BP to the LCL. The description of the acceptance criteria for Item 20.a in Table 2.5.4-5 will include the communication delays from the LCL of the PPS to group controllers of the ESF-CCS.” Based on the proposed changes to ITAAC Item 16.a in APR1400 DCD Tier 1, Table 2.5.1-5 and Item 20.a in Table 2.5.4-5 to clarify the response time will include the

communication delays from the BP to the LCL and from the LCL of the PPS to the group controllers of the ESF-CCS, the staff finds the response time of the entire ESFAS actuation path will be verified, and thus demonstrates the requirements of IEEE Std 603-1991, Clause 4.10 will be met in the as-built system, and thus these ITAAC (Item 16 in APR1400 DCD Tier 1, Table 2.5.1-5 and Item 20 in Table 2.5.4-5) satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-20 resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Tables 2.5.1-5 and 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-20 was resolved and closed.

Diversity

GDC 22 states “The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.” APR1400 DCD Tier 1, Section 2.5.1.1, Item 23 and the corresponding ITAAC in Tier 1, Table 2.5.1-5, Item 23, state that two sets of RTSS which consists of four RTSGs are diverse each other. The acceptance criterion for the corresponding ITAAC identified in APR1400 DCD Tier 1, Table 2.5.1-5, Item 23, states, “Two sets of the as-built RTSS which consists of our RTSGs are diverse each other: One set of RTSGs is supplied from a different manufacturer than the other set of RTSGs.” APR1400 DCD Tier 2, Section 7.2.1.9, states that for additional diversity, the RTSS consists of one set of four RTSGs (RTSS 1) and another set of four RTSGs (RTSS 2) with diverse design features. However, this section does not provide description of the attributes that make the design diverse (e.g. RTSGs supplied by different manufacturer). As such, in RAI 317-8271, Question 14.03.05-21 (ML15321A293), the staff requested the applicant to provide descriptions of the attributes that make the design diverse in APR1400 DCD Tier 2 to support the design descriptions in APR1400 DCD Tier 1. Further, the staff requested the applicant to define the acronym “RTSG” as it is not defined in Tier 1 of this application.

In its response to RAI 317-8271, Question 14.03.05-21 (ML16036A374), the applicant committed to revise APR1400 DCD Tier 2, Section 7.2.1.9 to include a description of the design and manufacturing differences that make the two different sets of RTSS diverse. Further, the applicant committed to add the term “RTSG (reactor trip switchgear)” to the acronym and abbreviation list in the APR1400 DCD Tier 1. Based on the added description in APR1400 DCD Tier 2 to support the information in Tier 1 regarding the diversity between the two RTSS sets, and the definition of the acronym for RTSG in Tier 1, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-21, to be resolved. As such, the staff finds that the as-built RTSS will be verified to meet GDC 22, and thus the ITAAC in DCD Tier 1, Table 2.5.1-5, Item 23 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, acronym and abbreviation list and DCD Tier 2, Section 7.2.1.9. As such, RAI 317-8271, Question 14.03.05-21 was resolved and closed.

Control Room

Title 10 CFR Part 50, Appendix A, GDC 19, states, in part, “A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal

conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents...Equipment at appropriate locations outside the control room shall be provided: (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.”

APR1400 DCD Tier 1, Section 2.5.1.1, Item 8, and the corresponding design commitment in DCD Tier 1, Table 2.5.1-5, Item 8, state, “Each PPS division is controlled from either the MCR or RSR, as selected from MCR/RSR master transfer switches.” The ITA of this ITAAC states, “A test of the as-built PPS will be performed to demonstrate the transfer function between the MCR and RSR.” The acceptance criteria for this ITAAC states, “The as-built master transfer switches transfer controls between the MCR and RSR separately for each as-built PPS division, as follows: [1] Controls at the RSR are disabled when controls are active in the MCR. [2] Controls at the MCR are disabled when controls are active in the RSR.” Based on the above descriptions, it is unclear whether this ITAAC is intended to verify the RSR will have controls for the PPS to meet the requirements of the GDC 19 since the design description and corresponding ITAAC only focuses on verifying the operation of the transfer switch. As such, in RAI 317-8271, Question 14.03.05-22 (ML15321A293), the staff requested the applicant to provide design descriptions and corresponding ITAAC to verify that the as-built RSR contain sufficient controls to meet the requirements of GDC 19.

In its response to RAI 317-8271, Question 14.03.05-22 (ML16142A002), the applicant proposes to revise APR1400 DCD Tier 1, Table 2.5.1-5, ITAAC Item 8 to include the control functions based on the transfer capability between the MCR and the RSR to be consistent with the design commitment, Section 2.5.1.1, Item 8 and in compliance with GDC 19. Based on the proposed revision to APR1400 DCD Tier 1 to include verification of the control functions in addition to the transfer capability between the MCR and RSR in the as-built PPS, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-22, to be resolved. As such, the staff finds that the as-built PPS will be verified to meet the requirements of GDC 19, and thus the ITAAC in Tier 1, Table 2.5.1-5, Item 8 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Tables 2.5.1-5 and 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-22 was resolved and closed.

The staff also identified the following ITAAC regarding safe shutdown systems and the RSR:

- DCD Tier 1, Table 2.4.1-4, Items, 8.b, 8.d, 8.e, and 8.f
- DCD Tier 1, Table 2.4.2-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.4.3-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.4.4-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.4.5-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.4.6-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.5.1-5, Items 4.c

- DCD Tier 1, Table 2.5.4-5, Items 8 and 11
- DCD Tier 1, Table 2.5.5-2, Item 3
- DCD Tier 1, Table 2.6.1-3, Items 3.b and 3.d
- DCD Tier 1, Table 2.6.2-3, Items 6.b and 6.d
- DCD Tier 1, Table 2.6.3-3, Item 11.b
- DCD Tier 1, Table 2.6.4-3, Item 3.b
- DCD Tier 1, Table 2.7.1-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.1.4-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.1.5-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.1.8-3, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.2.1-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.2.2-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.2.3-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.2.5-4, Items 7.b and 7.d
- DCD Tier 1, Table 2.7.2.6-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.3.1-3, Items 5.b and 5.d
- DCD Tier 1, Table 2.7.3.2-3, Items 5.b and 5.d
- DCD Tier 1, Table 2.7.3.3-3, Items 4.b and 4.d
- DCD Tier 1, Table 2.7.3.5-3, Items 5.b and 5.d
- DCD Tier 1, Table 2.7.4.3-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.7.5.2-3, Item 8.b
- DCD Tier 1, Table 2.7.6.4-3, Item 3
- DCD Tier 1, Table 2.11.2-4, Items 8.b and 8.d
- DCD Tier 1, Table 2.11.3-2, Items 8.b and 8.d
- DCD Tier 1, Table 2.11.4-3, Items 5.b and 5.d

The staff reviewed DCD Tier 1, Table 2.7.6.2-4 and DCD Tier 1, Table 2.7.6.5-3, and could not identify any ITAAC to verify that indications and alarms exist in the RSR for the Gaseous Radwaste System (GRS) or the Area Radiation Monitoring System (RMS). As such, the staff issued RAI 276-8304, Question 07.04-07 (ML15302A317), to request the applicant to resolve this issue.

In its response to RAI 276-8304, Question 07.04-07 (ML15365A574), the applicant proposed to revise the ITAAC in APR1400 DCD Tier 1, Sections 2.7.6.2.1 and 2.7.6.5.1, and Tables 2.7.6.2-4 and 2.7.6.5-3 to include verification that indications and alarms exist in the RSR for the GRS and Area RMS. Based on the proposed DCD changes to verify the as-built plant RSR contains indications and alarms for the GRS and Area RMS, the staff finds the issues identified in RAI 276-8304, Question 07.04-07, to be resolved. As such, the staff finds that the as-built system will be verified to meet IEEE GDC 19, and therefore the ITAAC identified in the list above and the proposed ITAAC addition to Tables 2.7.6.2-4 and 2.7.6.5-3 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Sections 2.7.6.2.1 and 2.7.6.5.1, and Tables 2.7.6.2-4 and 2.7.6.5-3. As such, RAI 276-8304, Question 07.04-07 was resolved and closed.

14.3.5.4.2 Diverse Actuation System

The applicant provided design descriptions and ITAAC verifying design features for the diverse actuation system (DAS) in APR1400 DCD Tier 1, Section 2.5.2, "Diverse Actuation System." APR1400 DCD Tier 1, Section 2.5.2, states that the DAS is a non-safety system which provides a diverse mechanism to decrease risk from the anticipated transients without scram (ATWS) events. The DAS also assists the mitigation of the effects of a postulated software common cause failure (CCF) within the PPS and the engineered safety features component control system (ESF-CCS). The DAS equipment is located in the auxiliary building as described in APR1400 DCD Tier 1, Table 2.5.2-1. The DAS consists of the diverse protections system (DPS) the diverse manual ESF actuation (DMA) switches, and the diverse indication system (DIS). The DPS initiates reactor trip, turbine trip, auxiliary feedwater actuation, and safety injection actuation. The DPS consists of four channels of non-safety equipment. The DMA switches are provided to permit the operator to actuate ESF systems from the MCR after a postulated software CCF of the PPS and ESF-CCS. The DIS provides functions to monitor critical variables and to control heated junction thermocouple (HJTC) heater power when the CCF of digitalized safety I&C systems occurs.

The following APR1400 DCD Tier 1 tables are provided for the DAS:

- Table 2.5.2-1, "Diverse Actuation System Equipment Location and Classification"
- Table 2.5.2-2, "DPS Automatic Functions and Actuation Signals"
- Table 2.5.2-3, "Functions manually Actuated by the DMA Switches"
- Table 2.5.2-4, "Variables Monitored and Controlled by the DIS"
- Table 2.5.2-5, "Diverse Actuation System ITAAC"

GDC 1 states in part that "structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the

importance of the safety functions to be performed.” BTP 7-14 provides guidance for software reviews for I&C systems. The SPM TeR describes the software engineering process for digital computer-based I&C systems of the APR1400. Section 1.1 of this TeR states that this report provides generic guidance for the software program plans based on the BTP 7-14. Section 2.2 of this technical report defines the software life cycle phases for the development of I&C system software, which includes the concept, requirements, design, implementation, test, installation and checkout, and operation and maintenance phases. This TeR applies to both protection class software and important-to-safety (ITS) software. Appendix A of this TeR indicates that the DPS and DIS contain ITS software. Tier 1, Section 2.5.2.1, Item 6, and the corresponding ITAAC in Table 2.5.2-5, Item 6 state, “The DPS software is implemented according to the software lifecycle process.” The staff finds that the design commitment does not state that the output of each life cycle phase will conform to the requirements of that phase. In addition, the acceptance criterion for the corresponding ITAAC states that a summary report with the results of each phase exists and this summary report will conclude that the phase activities are performed. However, the staff finds that this acceptance criterion does not verify that the output of the phase meet the requirements of that phase. Further, no design description and ITAAC exists to verify the DIS is implemented in accordance to a software development lifecycle process, if it contains programmable technology. In RAI 71-7906, Question 14.03.05-5 (ML15196A597), the staff requested that the applicant modify Tier 1 of the DCD, including the corresponding ITAAC, to resolve these issues in order to demonstrate compliance to GDC 1 and 10 CFR 52.47(b)(1).

In its response to RAI 71-7906, Question 14.03.05-5 (ML16139B055), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.2.1 to clarify the design commitment, inspections, tests, analyses, and acceptance criteria for each phase of the software lifecycle, as defined in the SPM. The applicant committed to add a design description and ITAAC to verify the DIS is implemented according to each development phase of the software lifecycle process. The outputs, including documentation, of each development phase of the software lifecycle process will be verified by inspection and analysis to conform to the requirements of that phase. The staff finds the proposed changes to APR1400 DCD Tier 2 Section 2.5.2.1, and Table 2.5.2-5, Item 6, and the addition of Item 9 to Table 2.5.2-5 adequate to verify the as-built DPS and DIS software will conform to the requirements of each phase of the software lifecycle in the software development process. Thus, the staff finds the as-built DIS and DPS will be verified to meet the quality requirements of GDC 1, and therefore, the ITAAC in Tier 1, Table 2.5.2-5, Items 6 and 9 satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues related to RAI 71-7906, Question 14.03.05-5, to be resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.2 and Table 2.5.2-5. As such, RAI 71-7906, Question 14.03.05-5 was resolved and closed.

GDC 2 requires, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches, without loss of capability to perform their safety functions. GDC 4 requires, in part, structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. APR1400 DCD Tier 1, Section 2.5.2.1, Item 1 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 1, state, “The seismic Category I equipment identified in Table 2.5.2-1 can withstand seismic design basis loads without loss of protective function.” APR1400 DCD Tier 1, Section 2.5.2.1, Item 5 and the corresponding ITAAC in Tier 1,

Table 2.5.2-5, Item 5, state, "The DPS cabinets listed in Table 2.5.2-1 are located in separate rooms." Based on the provision of design descriptions in APR1400 DCD Tier 1, Section 2.5.2.1, Items 1 and 5, and ITAAC in Table 2.5.2-5, Items 1 and 5 to verify that the as-built DPS can withstand seismic loads and the DPS cabinets are located in separate rooms to prevent the effects of natural phenomena from affecting multiple DPS cabinets, the staff finds the as-built DPS meet the requirements of GDC 2 and 4. Therefore, the staff finds the ITAAC in Table 2.5.2-5, Items 1 and 5 meet the requirements of 10 CFR 52.47(b)(1).

GDC 22 states: "The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function." The SRM to SECY-93-087, Item II.Q, provides requirements for addressing software common cause failures within safety I&C systems. Point 3 of this item states, "If a postulated common-mode failure could disable a safety function, then a diverse means, with a documented basis that the diverse means is unlikely to be subject to the same common-mode failure, shall be required to perform either the same function or a different function. The diverse or different function may be performed by a non-safety system if the system is of sufficient quality to perform the necessary function under the associated event conditions." Point 4 of the SRM to SECY-93-087, Item II.Q, state, "A set of displays and controls located in the main control room shall be provided for manual, system level actuation of critical safety functions and monitoring of parameters that support the safety functions. The displays and controls shall be independent and diverse from the safety computer system identified in items 1 and 3 above." BTP 7-19 provides guidance on meeting the requirements of GDC 22 and SRM to SECY-93-087, Item II.Q. Section 3.1 of BTP 7-19 states, "For each anticipated operational occurrence [(AOO)] in the design basis occurring in conjunction with each single postulated CCF, the plant response calculated using realistic assumptions should not result in radiation release exceeding 10 percent of the applicable siting dose guideline values or violation of the integrity of the primary coolant pressure boundary."

APR1400 DCD Tier 1, Section 2.5.2.1, Item 2 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 2, state, "The DPS is physically separate, electrically independent, and diverse from the PPS and ESF-CCS including a diverse method for the reactor trip, the turbine trip, the auxiliary feedwater actuation and safety injection actuation." APR1400 DCD Tier 1, Section 2.5.2.1, Item 3 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 3, state, "The DPS provides the automatic functions as shown in Table 2.5.2-2, if plant process signals exceed predetermined setpoints." APR1400 DCD Tier 1, Section 2.5.2.1, Item 4 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 4, state, "The DPS utilizes a 2-out-of-4 coincidence logic for the initiation of automatic functions shown in Table 2.5.2-2."

The staff reviewed APR1400 DCD Tier 1, Section 2.5.2, and could not identify design commitments or corresponding ITAAC that verify the response time of the as-built DPS will be sufficient to demonstrate that the plant response will not result in radiation release exceeding 10 percent of the applicable siting dose guideline values or violation of the integrity of the primary coolant pressure boundary. In RAI 71-7906, Question 14.03.05-6 (ML15196A597), the staff requested the applicant to modify APR1400 DCD Tier 1 to provide a design commitment and corresponding ITAAC to verify that the as-built DPS response time from sensor output through equipment actuation is less than the value required to satisfy the diverse actuation function response time assumptions.

In its response to RAI 71-7906, Question 14.03.05-6 (ML15281A303), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.2.2 and Table 2.5.2-5 to add an Item 10 with the following design description and ITAAC to verify the response time of the DPS:

“The DPS initiates diverse [RT], auxiliary feedwater actuation signal (AFAS), and safety injection actuation signal (SIAS) within the required response time for trip/initiation conditions identified in Table 2.5.2-2.”

The staff finds the proposed revisions to APR1400 DCD Tier 1, Section 2.5.2.1 and Table 2.5.2-5, Item 10 is acceptable because this ITAAC item ensure the verification of the response time of the as-built DPS meets the timing requirements for the functions performed by the DPS. As such, the staff finds the issues identified in RAI 71-7906, Question 14.03.05-6, to be resolved. The staff finds the proposed design description in APR1400 DCD Tier 1, Section 2.5.2.1, Item 10 and ITAAC in Tier 1, Table 2.5.2-5, Item 10 will verify the as-built DPS meets the requirements of GDC 22.

In its supplemental response provided by the applicant to RAI 33-7880, Question 07.08-1 (ML18029A859), the applicant provided further clarification in support of its claim that the PPS and DPS are diverse. The applicant stated that the field programmable gate array (FPGA) logic devices for the DAS use hardware in the FPGA that is diverse from the hardware in the EEPROM-based programmable logic devices (EPLDs) used in the common safety programmable logic controller (PLC) platform. In addition to this, the FPGA for the DAS is programmed by a diverse programming tool as compared to the tool used to program the EPLDs for the common safety PLC platform. The applicant committed to revise DCD Tier 1, Table 2.5.2-5, Item 2 to incorporate the diversity attributes described in this RAI response. Since the DPS and PPS are implemented using two diverse technologies the staff finds there is adequate design diversity between the DPS and PPS. The staff also finds the proposed changes to DCD Tier 1 Table 2.5.2-5, Item 2 are acceptable and thus this ITAAC meets the requirements of 10 CFR 52.47(b)(1). Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 33-7880, Question 07.08-1 was resolved and closed.

The staff finds the design description in APR1400 DCD Tier 1, Section 2.5.2.1, Items 2, 3, and 4 and corresponding ITAAC in Tier 1, Table 2.5.2-5, Items 2, 3, and 4 will verify the as-built DPS is diverse and independent from the PPS and ESF-CCS, and the as-built DPS will perform the protective functions required with sufficient reliability to meet the requirements of Point 3 to the SRM to SECY-93-087. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.2-5, Items 2, 3, 4, and 10 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.2 and Table 2.5.2-3. As such, RAI 71-7906, Question 14.03.05-6 was resolved and closed.

APR1400 DCD Tier 1, Section 2.5.2.1, Item 7 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 7, state, “The DMA switches in the MCR are used to provide the functions identified in Table 2.5.2-3.” APR1400 DCD Tier 1, Section 2.5.2.1, Item 12 and the corresponding ITAAC in Tier 1, Table 2.5.2-5, Item 12, state, “The DIS is diverse and independent from the QIAS-P.” Section 5.2 of Technical Report APR1400-Z-J-NR-14002, Revision 0, “Diversity and Defense-in Depth [D3],” states, “The DIS is a single channel of non-safety equipment to meet the requirements of BTP 7-19, Point 4, position on D3 for the safety I&C systems.” This section of the TeR states that the DIS is diverse from the QIAS-P and

QIAS-N. In addition, this section of the TeR states that the typical DIS variables are listed in Appendix C of this TeR and the display parameters include inadequate core cooling monitoring information, accident monitoring information, and emergency operation-related information. The DIS independently calculates a representative core exit temperature, saturation margins and reactor vessel levels for the display. It also provides the heated junction thermo-couple heater power control function for the reactor vessel level detector as a backup of the QIAS-P calculated function which is potentially lost due to a postulated CCF of the safety I&C systems. The staff reviewed APR1400 DCD Tier 1, and could not find any design commitments and corresponding ITAAC to verify that the as-built DIS performs the functions stated in the D3 TeR. The staff also could not find design commitments and corresponding ITAAC to verify that the as-built DIS is diverse and independent from the QIAS-P and QIAS-N to address the SRM to SECY-93-087 and GDC 22. The staff requested in RAI 71-7906, Question 14.03.05-7 (ML15196A597), for the applicant to provide design commitments and ITAAC in Tier 1 of the APR1400 DCD to verify that the as-built DIS performs these functions and is diverse and independent QIAS-P and QIAS-N to meet the requirements of 10 CFR 52.47(b)(1).

In its response to RAI 71-7906, Question 14.03.05-7 (ML15281A303), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.2.1 and Table 2.5.2-5 to describe the diversity and independence of the DIS. Specifically, Section 2.5.2.1, "Design Description," Item 8 will be revised, and Item 9 and 11 will be added, to indicate that the DIS monitors and displays the variables presented in Tier 1, Table 2.5.2-4, and is independent and diverse from the QIAS-P. The staff finds the proposed revisions to APR1400 DCD Tier 1, Section 2.5.2.1 and Table 2.5.2-5, Items 8, 9, and 11 are acceptable because these ITAAC will verify the functions performed by the DIS and verify the DIS is independent and diverse from the QIAS-P are acceptable. As such, the staff finds the issues identified in RAI 71-7906, Question 14.03.05-7 are resolved. Based on the provision of ITAAC in DCD Tier 1, Table 2.5.2-5, Items 8, 9, and 11 to verify the as-built DIS satisfy the diversity requirements of GDC 22, the staff finds these ITAAC meet 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.2.1 and Table 2.5.2-3. As such, RAI 71-7906, Question 14.03.05-7 was resolved and closed.

Based on the provision of design descriptions in Tier 1, Section 2.5.2.1, Item 7 and the corresponding ITAAC in DCD Tier 1, Table 2.5.2-5, Item 7 to verify the as-built DMA switches will provide the capability for manual actuation of protective functions list in Table 2.5.2-3, the staff finds the manual controls requirements in Point 4 of the SRM to SECY-93-087 are met. Based on the provision of design descriptions in Tier 1, Section 2.5.2.1, Item 12 and the corresponding ITAAC in DCD Tier 1, Table 2.5.2-5, Item 12 to verify the as-built DIS is diverse and independent from the QIAS-P, the staff finds the diverse and independent display requirements of Point 4 of the SRM to SECY-93-087 are met. Therefore, the staff finds the ITAAC in Table 2.5.2-5, Items 7 and 12, meet the requirements of 10 CFR 52.47(b)(1).

14.3.5.4.3 Qualified Indication and Alarm System

The applicant provided design descriptions and ITAAC verifying design features for the qualified indication and alarm system (QIAS) in APR1400 DCD Tier 1, Section 2.5.3, "Qualified Indication and Alarm System." APR1400 DCD Tier 1, Section 2.5.3, states that the QIAS is a monitoring system that is used to display safety-related information and non-safety information. The QIAS consists of two subsystems, the QIAS-P, Divisions A and B, and the QIAS-N. The QIAS-P is safety-related and the QIAS-N is non-safety. APR1400 DCD Tier 1, Section 2.5.3.1 provides design descriptions for the QIAS-P.

The following APR1400 DCD Tier 1 tables are provided for the QIAS-P:

- Table 2.5.3-1, “Qualified Indication and Alarm System-P Equipment Classification and Location”
- Table 2.5.3-2, “Accident Monitoring Instrumentation Variables”

The staff reviewed the design descriptions and ITAAC to ensure compliance with 10 CFR 52.47(b)(1).

Quality Standards and Records

IEEE Std 603-1991, Clause 5.3, requires, in part, components and modules to be of a quality that is consistent with minimum maintenance requirements and low failure rates. This clause also states that "Safety system equipment shall be designed, manufactured, inspected, installed, tested, operated, and maintained in accordance with a prescribed quality assurance program." 10 CFR Part 50, Appendix A, GDC 1, requires structures, systems, and components (SSCs) important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Branch Technical BTP 7-14 provides guidance on performing reviews for software-based safety-related, I&C systems.

The SPM TeR describes the software engineering process for digital computer-based I&C systems of the APR1400. Section 1.1 of this TeR states that this report provides generic guidance for the software program plans based on the BTP 7-14. Section 2.2 of this TeR defines the software lifecycle phases for the development of safety I&C system software, which includes the concept, requirements, design, implementation, test, installation and checkout, and operation and maintenance phases. These lifecycle phases apply to both protection class software and important-to-safety software. This TeR states that the QIAS-P contains important-to-safety software. APR1400 DCD Tier 1, Section 2.5.3.1, Item 5, states “The QIAS-P software is implemented according to the software lifecycle process.” However, this Tier 1 section does not describe what this lifecycle process will be (e.g. the different lifecycle phases). The applicant should define the specific lifecycle phases within this lifecycle process and this information should be consistent with the SPM TeR in order to demonstrate compliance to the requirements of IEEE Std 603-1991, Clause 5.3. The staff finds that the design commitment does not state that the output of each lifecycle phase will conform to the requirements of each lifecycle phase. Further, the acceptance criterion for the corresponding ITAAC states that a summary report with the results of each phase exists and this summary report will conclude that the phase activities are performed. The staff finds that this acceptance criterion does not verify that the output of each phase meets the requirements of that phase. The staff requested in RAI 71-7906, Question 14.03.05-8 (ML15196A597), that the applicant modify Tier 1 of the DCD, including the ITAAC to resolve these issues.

In its response to RAI 71-7906, Question 14.03.05-8 (ML16139B055), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.3.1 to clarify the design commitment, inspections, tests, analyses, and acceptance criteria for each phase of the software lifecycle for the QIAS-P, as defined in the SPM will be verified by inspection and analysis to ensure the outputs, including documentation, of each lifecycle phase in the software development process conforms to the requirements of that phase. The staff finds the proposed changes to APR1400 DCD Tier 1,

Section 2.5.3.1, and Table 2.5.3-3, Item 5 adequate to verify the as-built QIAS-P software will conform to the requirements of each phase of the software lifecycle in the software development process. As such, the staff finds the issues related to RAI 71-7906, Question 14.03.05-8, to be resolved. The staff finds the as-built QIAS-P will be verified to meet the quality requirements in IEEE Std 603-1991, Clause 5.3, and therefore, the ITAAC in DCD Tier 1, Table 2.5.3-3, Item 5 satisfy the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3. As such, RAI 71-7906, Question 14.03.05-8 was resolved and closed.

APR1400 DCD Tier 1, Section 2.5.3.1, Item 7 and the corresponding ITAAC in Tier 1, Table 2.5.3-3, Item 7, state “The QIAS-P is installed in accordance with the dedicated process of commercial grade hardware and software.” The staff finds this design description and ITAAC are adequate to verify the as-built QIAS-P will meet the requirement for use of commercial grade hardware and software to meet the requirements of GDC 1. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.3-3, Item 7 meet 10 CFR 52.47(b)(1).

Equipment Qualification

IEEE Std 603-1991, Clause 5.4, requires, in part, that safety system equipment to be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis. GDC 2 requires, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches, without loss of capability to perform its safety functions. GDC 4 requires, in part, structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

APR1400 DCD Tier 1, Section 2.5.3.1, Item 1, and the corresponding ITAAC in Table 2.5.3-3, Item 1, state that the seismic Category I equipment, identified in Table 2.5.3-1 can withstand seismic design basis loads without loss of safety function. In addition, DCD Tier 1, Section 2.5.3.1, Item 2, and the corresponding ITAAC in Table 2.5.3-3, Item 2, state that QIAS-P equipment, identified in Table 2.5.3-1, can withstand the electrical surge, EMI, RFI, and ESD conditions that would exist before, during, and following a postulated accidents without loss of its safety function for the time required to perform the safety function. Based on the design commitments and corresponding ITAAC provided to verify that the as-built Class 1E equipment listed in APR1400 DCD Tier 1, Table 2.5.3-1, will be able to withstand seismic design basis loads, and EMI, RFI and ESD conditions, and are protected from missiles pipes breaks and flooding, the staff finds that the as-built QIAS-P will be verified to meet IEEE Std 603-1991, Clause 5.4, GDC 2, GDC 4. Therefore the staff finds the ITAAC in Table 2.5.3-3, Items 1 and 2 meet the requirements of 10 CFR 52.47(b)(1).

Independence

IEEE Std 603-1991, Clause 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std 603-1991, Clause 5.6.3, requires

that the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. IEEE Std 603-1991, Clause 5.6.3.1 states, in part, "Isolation devices used to effect a safety system boundary shall be classified as part of the safety system."

APR1400 DCD Tier 1, Section 2.5.3.1, Item 3.a and the corresponding ITAAC in Table 2.5.3-3, Item 3.a, state that Class 1E equipment identified in Table 2.5.3-1 is powered from its respective Class 1E train. APR1400 DCD Tier 1, Section 2.5.3.1, Item 3.b and the corresponding ITAAC in Table 2.5.3-3, Item 3.b, state that the Class 1E equipment identified in Table 2.5.3-1, and associated equipment are physically separated and electrically independent from each other and physically separated and electrically independent from non-Class 1E equipment. APR1400 DCD Tier 1, Table 2.5.3-1 lists QIAS-P Processors A and B, and QIAS-P Flat Panel Display (FPD), Division A and B. It is not clear based on the design commitment which equipment within Table 2.5.3-1 will be physically separated and electrically independent from each other (e.g. redundant divisions of QIAS-P equipment listed in Table 2.5.3-1 are physically separated and electrically independent from each other). In addition, the acceptance criteria provided for the corresponding ITAAC in APR1400 DCD, Table 2.5.3-3, Item 3.b.i, states, "the physical separation of as-built redundant Class 1E equipment identified in Table 2.5.3-1 and associated field equipment is provided by distance or barriers." The acceptance criteria provided for the corresponding ITAAC in APR1400 DCD, Table 2.5.3-3, Item 3.b.ii, states, "a report exists and concludes that independence of as-built redundant Class 1E equipment identified in Table 2.5.3-1, and associated field equipment is achieved by independent power sources and electrical circuits for each channel, and by fiber optic cable interfaces, conventional isolators, or other proven isolation methods or devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems." It is unclear to the staff what the specific acceptance criteria will be to ensure that the amount of distance or barriers provided is adequate to ensure physical separation (e.g. in accordance with RG 1.75). In addition, it is not clear to the staff whether the conventional isolators or other proven isolation methods or devices will be Class 1E qualified as required by IEEE Std 603-1991, Clause 5.6.3. As such, the staff requested the applicant to provide the following in RAI 317-8271, Question 14.03.05-23 (ML15321A293):

1. Clarify whether APR1400 DCD Tier 1, Section 2.5.3.1, Item 3.b, are intended to address physical separation and electrical isolation requirements for redundant divisions of safety equipment identified in APR1400 DCD Tier 1, Table 2.5.3-1.
2. Provide criteria for determining what sufficient distance or barrier is adequate to meet the physical separation requirements of IEEE Std 603-1991, Clause 5.6.
3. Amend the acceptance criteria for physical separation to address physical separation of QIAS-P equipment from non-Class 1E equipment.
4. Clarify whether the conventional isolators, or other prevent isolation methods or devices used will be Class 1E qualified.

In its response to RAI 317-8271, Question 14.03.05-23 (ML16036A374), the applicant clarified:

1. APR400 DCD Tier 1, Section 2.5.3.1, Item 3.b and the design commitment of Item 3.b in Table 2.5.3-3 are intended to address the physical separation and

electrical isolation requirements for redundant divisions of the QIAS-P equipment listed in DCD Tier 1, Table 2.5.3-1, as well as the physical separation and electrical isolation requirements of them from non-Class 1E equipment (Refer to DCD Tier 2, Sections 7.5.2.1 a.1 and 7.5.2.1.a.3). The applicant committed to revise both DCD Tier 1, Section 2.5.3.1 Item 3.b, and the design commitment of Item 3.b in Table 2.5.3-3 to include this clarification. The phrase 'and associated field equipment' will be deleted from all the related descriptions in DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3, because the associated field equipment is not within the QIAS-P boundary.

2. The acceptance criteria of Item 3.b.i in DCD Tier 1, Table 2.5.3-3 will be revised to provide the criteria on the amount of distance or barrier that is adequate to meet the physical separation requirements.
3. The acceptance criteria of Item 3.b.i and 3.b.ii in DCD Tier 1, Table 2.5.3-3 will be revised to address the physical separation of QIAS-P equipment from the non-Class 1E equipment.
4. As stated in DCD Tier 2, Section 7.5.2.1 a.4, all of the isolation devices used between the QIAS-P and IPS and between the QIAS-P and QIAS-N meet the requirements of IEEE Std 384. For clarification, the acceptance criteria of Item 3.b.ii in DCD Tier 1, Table 2.5.3-3 will be revised to verify the application of Class 1E qualified isolation devices.

Based on the above proposed changes to APR1400 DCD Tier 1, Section 2.5.3.1 and associated ITAAC in DCD Tier 1, Table 2.5.3-3, Item 3.b, the staff finds these items will adequately verify the as-built QIAS-P will meet the physical separation and electrical isolation requirements in IEEE Std 603-1991, Clause 5.6. As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-23, to be resolved. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.3-3, Items 3.a and 3.b satisfy the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3. As such, RAI 317-8271, Question 14.03.05-23 was resolved and closed.

Information Display

IEEE Std 603-1991, Clause 5.8.1, states that the display instrumentation provided for manually controlled actions for which no automatic control is provided and the display instrumentation required for the safety systems to accomplish their safety functions shall be part of the safety systems.

In RAI 38-7878, Question 07.05-1 (ML15169A320) the staff requested the applicant to justify why Type A variables are not required for this design when it appears that manually controlled actions were credited for cases where no automatic controls exist during several events analyzed in Chapter 15. As such, if the applicant determines that Type A variables are needed in response to this RAI, the staff requested the applicant to provide design descriptions and a corresponding ITAAC to verify that the as-built design provides indications for manually controlled actions for which no automatic control is provided as required by IEEE Std 603-1991, Clause 5.8.1, as documented in RAI 317-8271, Question 14.03.05-24 (ML15321A293).

In its response to RAI 317-8271, Question 14.03.05-24 (ML16181A324), the applicant stated in response to RAI 38-7878, Question 07.05-1, a list of Type A variables as well as Type B and C variables are provided. The applicant stated that the revised response will address all of the related changes associated with incorporating Type A variables into the APR1400 design, including the list of monitored variables in APR1400 DCD Tier 1, Table 2.5.3-2 and corresponding design descriptions and ITAAC in Section 2.5.3.1, Item 4 and Table 2.5.3-3, Item 4, respectively. Although the applicant referenced the response to RAI 38-7878, Question 07.05-1, the staff finds that the response to RAI 317-8271, Question 14.03.05-30, provides the needed information to respond to this RAI. The staff's evaluation to RAI 317-8271, Question 14.03.05-30, is provided in Section 14.3.5.4.4 of this safety evaluation report. As such, RAI 317-8271, Question 14.03.05-24, is considered to be resolved and closed. Based on the provision of Type A variables in Table 2.5.3-2 and ITAAC in Table 2.5.3-3, Item 4 to verify the as-built QIAS-P displays the variables listed in Table 2.5.3-2, the staff finds the as-built QIAS-P will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.8.1. Therefore, the staff finds the ITAAC in Table 2.5.3-3, Item 4 meet the requirements of 10 CFR 52.47(b)(1).

Control of Access

IEEE Std 603-1991, Clause 5.9 states: "The design shall permit the administrative control of access to safety system equipment. These administrative controls shall be supported by provisions within the safety systems, by provision in the generating station design, or by a combination thereof."

The staff could not identify any design descriptions or corresponding ITAAC to verify that the control of access features exist for the QIAS-P equipment identified in APR1400 DCD Tier 1, Table 2.5.3-1. As such, in RAI 317-8271, Question 14.03.05-25 (ML15321A293), the staff requested the applicant to clarify whether any control of access features are employed to prevent unauthorized or unintended access of QIAS-P equipment identified in APR1400 DCD Tier 1, Table 2.5.3-1. If such features exist, the staff requested the applicant to provide an ITAAC that verifies that control of access features exist for the QIAS-P equipment identified in APR1400 DCD Tier 1, Table 2.5.3-1. Otherwise, the staff requested the applicant to justify why such features are not required.

In its response to RAI 317-8271, Question 14.03.05-25 (ML16181A324), the applicant stated the as-built QIAS-P will have the control of access features in accordance with IEEE Std 497-2002, Clause 6.10 as described in APR1400 DCD Tier 2, Section 7.5.2.1.a.7. Specifically, the QIAS-P cabinets listed in APR1400 DCD Tier 1, Table 2.5.3-1 will have key locks and door open alarms and are located in a vital area of the facility which is a controlled access area. The applicant proposed to include design descriptions and corresponding ITAAC in APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3, Item 8, respectively, to verify that control of access features exist for the as-built QIAS-P equipment identified in DCD Tier 1, Table 2.5.3-1. Based on the proposed addition of design descriptions APR1400 DCD Tier 1, Section 2.5.3.1, Item 8 and corresponding ITAAC in Table 2.5.3-3, Item 8, to verify control of access features for QIAS-P equipment, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-25, to be resolved. In addition, as discussed in Section 14.3.5.4.1 of this report, in response to RAI 317-8271, Question 14.03.05-18 (ML16182A581) the applicant proposed to add Item 9 to the design description in Tier 1, Section 2.5.3.1 and corresponding ITAAC in Table 2.5.3-3, Item 9, to state, "Hardwired disconnections exist between the QIAS-P cabinets, and the portable workstation

used to download the QIAS-P software. The hardwired disconnections protect the QIAS-P software from unintended modifications.” The staff finds this design description and corresponding ITAAC are adequate to verify the as-built QIAS-P will have controls for software modification. As such, the staff finds that the as-built QIAS-P will be verified to meet the control of access requirements in IEEE Std 603-1991, Clause 5.9. Therefore, the staff finds the ITAAC in Table 2.5.3-3, Items 8 and 9 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3. As such, RAI 317-8271, Question 14.03.05-25 was resolved and closed.

Identification

IEEE Std 603-1991, Clause 5.11, requires, in part that safety system equipment shall be distinctly identified for each redundant portion of a safety system in accordance with the requirements of IEEE Std 384-1981 and IEEE Std 420-1982. The staff could not identify any design descriptions or corresponding ITAAC to verify that the as-built QIAS-P equipment are distinctly identified for each redundant portion of the QIAS-P to meet the requirements of IEEE Std 603-1991, Clause 5.11. As such, in RAI 317-8271, Question 14.03.05-26 (ML15321A293), the staff requested the applicant to provide design descriptions and a corresponding ITAAC to verify that the as-built QIAS-P equipment are distinctly identified for each redundant portion of the QIAS-P.

In its response to RAI 317-8271, Question 14.03.05-26 (ML16036A374) the applicant proposed to include an Item 6 in APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3 that provides design description and corresponding ITAAC to verify the as-built QIAS-P equipment are distinctly identified for each redundant portion of the QIAS-P. Based on these proposed changes to the DCD including an Item 6 in APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3 to address identification requirements in IEEE Std 603-1991, Clause 5.11, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-26, to be resolved. As such, the staff finds that the as-built QIAS-P will be verified to meet the equipment identification requirements in IEEE Std 603-1991, Clause 5.11. Therefore, the staff finds the ITAAC in Table 2.5.3-3, Item 6 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.3.1 and Table 2.5.3-3. As such, RAI 317-8271, Question 14.03.05-26 was resolved and closed.

Post-Accident Monitoring

Title 10 CFR Part 50, Appendix A, GDC 13, requires in part that instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Regulatory Guide 1.97, “Criteria for Accident Monitoring Instrumentation for Nuclear Power Plant,” provides guidance for complying with the requirements of GDC 13.

APR1400 DCD Tier 1, Section 2.5.3.1, Item 4, and the corresponding ITAAC in Table 2.5.3-3, Item 4, state that the QIAS-P monitors and displays the accident monitoring instrumentation variables identified in Table 2.5.3-2. Based on the design commitments and corresponding ITAAC provided to verify that the QIAS-P will monitor and display accident monitoring

instrumentation variables, the staff finds that the as-built QIAS-P will be verified to meet GDC 13. Therefore, the staff finds the ITAAC in Table 2.5.3-3, Item 4 meet the requirements of 10 CFR 52.47(b)(1).

14.3.5.4.4 Engineered Safety Features-Component Control System

The applicant provided design descriptions and ITAAC verifying design features for the ESF-CCS in APR1400 DCD Tier 1, Section 2.5.4, "Engineered Safety Features-Component Control System." APR1400 DCD Tier 1, Section 2.5.4.1, states that the ESF-CCS provides automatic actuation of ESF systems. The ESF-CCS performs the NSSS ESFAS function, balance of plant (BOP) ESFAS function, and emergency diesel generator (EDG) loading sequencer function. The ESF-CCS generates the NSSS ESF actuation signals upon receipt of ESFAS initiation signals from the PPS. The ESF-CCS generates the BOP ESF actuation signals upon receipt of initiation signals from the process and effluent RMS. The ESF-CCS generates the EDG loading sequencer signals upon receipt of loss of power to Class 1E train buses, safety injection actuation signal (SIAS), containment spray actuation signal (CSAS), and auxiliary feedwater actuation signal (AFAS). The ESF-CCS provides the capability for manual actuation of ESF systems and manual control of ESF components. The ESF-CCS consists of four divisions of group controller cabinets and loop controller cabinets. The ESF-CCS equipment and manual control components are identified in Table 2.5.4-1. The ESF-CCS components are located in auxiliary building.

The following APR1400 DCD Tier 1 tables are provided for the ESF-CCS:

- Table 2.5.4-1, "ESF-CCS Equipment and Components Classification"
- Table 2.5.4-2, "Functions Automatically Actuated by the ESF-CCS"
- Table 2.5.4-3, "ESF-CCS Manual ESF Actuation Switches"
- Table 2.5.4-4, "ESF-CCS Interlock Important to Safety"
- Table 2.5.4-5, "Engineered Safety Features-Component Control System ITAAC"

The staff reviewed the design descriptions and ITAAC to ensure compliance with 10 CFR 52.47(b)(1) as documented below.

Design Basis

The IEEE Std 603-1991, Clause 4.2, requires documentation of the safety functions and corresponding protective actions of the execute features for each DBE. APR1400 DCD Tier 1, Section 2.5.4.1, provides the following design descriptions with corresponding ITAAC in DCD Tier 1, Table 2.5.4-5 regarding safety functions and corresponding protective features performed by the ESF-CCS:

- DCD Tier 1 Section 2.5.4.1, Item 4 and Table 2.5.4-5, Item 4: Each ESF-CCS division receives ESFAS initiation signals from four divisions of the PPS and performs selective 2-out-of-4 coincidence logic to perform NSSS ESF actuation functions identified in Table 2.5.4-2.

- DCD Tier 1, Section 2.5.4.1, Item 5 and Table 2.5.4-5, Item 5: Each ESF-CCS division receives ESFAS initiation signals from two divisions of the RMS as shown in Tables 2.7.6.4-2 and 2.7.6.5-2 and performs 1-out-of-2 logic taken twice except the fuel handling area emergency ventilation actuation signal which has one 1-out-of-2 logic to perform the BOP ESF actuation functions identified in Table 2.5.4-2.
- DCD Tier 1, Section 2.5.4.1, Item 6 and Table 2.5.4-5, Item 6: Upon receipt of a SIAS, CSAS, or AFAS, the ESF-CCS initiates an automatic start of the EDGs and automatic EDG loading sequencer of ESF loads identified in Table 2.5.4-2.
- DCD Tier 1, Section 2.5.4.1, Item 7 and Table 2.5.4-5, Item 7: Upon detecting loss of power to Class 1E buses, the ESF-CCS initiates startup of the EDGs, shedding of electrical loads, transfer of Class 1E bus connections to the EDGs, and EDG loading sequencer to the reloading of safety-related loads to the Class 1E buses.

Based on the design descriptions provided in DCD Tier 1 Section 2.5.4.1, Items 4, 5, 6, and 7 and corresponding ITAAC provided in Table 2.5.4-5, Items 4, 5, 6, and 7, respectively, regarding the performance of NSSS ESF actuation functions and BOP ESF actuation functions, the initiation of automatic EDG load sequencing, and the performance of load shedding and sequencing upon loss of power, the staff finds that the as-built ESF-CCS will be verified to meet the requirements of IEEE Std 603-1991, Clause 4.2. As such, the staff finds the ITAAC in Table 2.5.4-5, Items 4, 5, 6, and 7, meet the requirements of 10 CFR 52.47(b)(1).

Completion of Protective Action

The IEEE Std 603-1991, Clause 5.2, states that the safety systems shall be designed so that, once initiated automatically or manually, the intended sequence of protective actions of the execute features shall continue until completion. Deliberate operator action shall be required to return the safety systems to normal.

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 9, and the corresponding ITAAC states “Once a BOP ESF actuation has been actuated (automatically or manually), the ESF actuation logic is latched in the actuated state and is not reset automatically.” The corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 9, verifies this design commitment in the as-built ESF-CCS. Based on the design commitment and corresponding ITAAC provided in DCD Tier 1, Table 2.5.4-5, Item 9, the staff finds that this ITAAC will verify that the as-built ESF-CCS meet completion of protective actions requirements for BOP ESF functions, and thus the ITAAC in Table 2.5.4-5, Item 9 meet the requirements of 10 CFR 52.47(b)(1). However, the staff could not find design descriptions and corresponding ITAAC to verify the as-built ESF-CCS meets completion of protection requirements for other ESFAS functions (e.g. NSSS ESF actuation functions identified in DCD Tier 1, Table 2.5.4-2).

As such, in RAI 317-8271, Question 14.03.05-27 (ML15321A293), the staff requested the applicant to provide design descriptions and ITAAC to verify that the as-built ESF-CCS meets completion of protection requirements for these ESFAS functions. In its response to RAI 317-8271, Question 14.03.05-27 (ML16062A317), the applicant proposed to add a design description and ITAAC for the NSSS ESFAS actuation to APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5, Item 9.b, respectively. The description and ITAAC will confirm that once the

NSSS ESFAS has been actuated, the logic is latched in the actuated state and can be manually reset once the initiating condition has been cleared. The new ITAAC Item 9 in Table 2.5.4-5 will contain an Item 9.a to address BOP ESF functions and Item 9.b to address NSSS ESF functions. Based on the proposed design description and ITAAC to verify that the as-built ESF-CCS will ensure completion of NSSS ESFAS functions in Table 2.5.4-5, Item 9.b, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-27, to be resolved. As such, the staff finds that the as-built ESF-CCS will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.2, and thus the ITAAC in DCD Tier 1, Table 2.5.4-5, Items 9.a and 9.b, meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-27 was resolved and closed.

Quality Standards and Records

The IEEE Std 603-1991, Clause 5.3, requires, in part, components and modules to be of a quality that is consistent with minimum maintenance requirements and low failure rates. This clause also states that "Safety system equipment shall be designed, manufactured, inspected, installed, tested, operated, and maintained in accordance with a prescribed quality assurance program." 10 CFR Part 50, Appendix A, GDC 1, requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

The SPM TeR describes the software engineering process for digital computer-based I&C systems of the APR1400. Section 1.1 of this TeR states that this report provides generic guidance for the software program plans based on the BTP 7-14. Section 2.2 of this TeR defines the software lifecycle phases for the development of safety I&C system software, which includes the concept, requirements, design, implementation, test, installation and checkout, and operation and maintenance phases. APR1400 DCD Tier 1, Section 2.5.4.1, Item 15, states, "The ESF-CCS software is implemented according to the software lifecycle process." The staff finds that this section does not describe what this lifecycle process will be (e.g. the different lifecycle phases). The applicant should define the lifecycle phases within this lifecycle process and ensure that they are consistent with the SPM TeR in order to demonstrate compliance to the requirements of IEEE Std 603-1991, Clause 5.3. The staff also finds that the design commitment does not state that the output of each lifecycle phase will conform to the requirements of each lifecycle phase. Further, the acceptance criterion for the corresponding ITAAC states that a summary report with the results of each phase exists and this summary report will conclude that the phase activities are performed. The staff finds that this acceptance criterion does not verify that the output of the phase meet the requirements of each phase. As such, in RAI 71-7906, Question 14.03.05-9 (ML15196A597), the staff requested that the applicant modify Tier 1 of the DCD, including the ITAAC to resolve these issues.

In its response to RAI 71-7906, Question 14.03.05-9 (ML16069A389), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.4.1 and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 15 to clarify the design commitment, inspections, tests, analyses, and acceptance criteria for each phase of the software lifecycle for the ESF-CCS, as defined in the SPM. For each development phase of the software lifecycle process, inspection and analysis will be performed on the outputs, including documentation of that phase to verify conformance to the requirements of that phase. The staff finds the proposed changes to APR1400 DCD Section 2.5.4.1 and Table 2.5.4-5, Item 15 adequate to verify the as-built ESF-CCS software will

conform to the requirements of each phase of the software lifecycle in the software development process. As such, the staff finds the issues related to RAI 71-7906, Question 14.03.05-9, to be resolved. Thus, the staff finds the as-built ESF-CCS will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.3, and therefore the ITAAC in Table 2.5.4-5, Item 15 satisfy the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5. As such, RAI 71-7906, Question 14.03.05-9 was resolved and closed.

In addition, the applicant provided design description in Tier 1, Section 2.5.4.1, Item 24 and corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 24, to state, "The ESF-CCS is installed in accordance with the dedicated process of commercial grade hardware and software." The staff finds this design description and ITAAC are adequate to verify the as-built ESF-CCS will meet the requirement for use of commercial grade hardware and software to meet the requirements of GDC 1. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.4-5, Item 24 meet 10 CFR 52.47(b)(1).

Equipment Qualification

The IEEE Std 603-1991, Clause 5.4, requires, in part, that safety system equipment to be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis. GDC 2 requires, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches, without loss of capability to perform their safety functions. GDC 4 requires, in part, structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 1 and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 1, state: "The seismic Category I equipment components identified in Table 2.5.4.1 withstand seismic design basis loads without loss of the safety function." DCD Tier 1, Section 2.5.4.1, Item 16 and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 16, state: "The ESF-CCS equipment and components identified in Table 2.5.4-1 withstand the electrical surge, [EMI], [RFI], and [ESD] conditions that would exist before, during, and following a design basis event without loss of its safety function for the time required to perform the safety function." DCD Tier 1, Section 2.5.4.1, Item 18 and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 18, state, "The Class 1E equipment and components listed in Table 2.5.4-1 are protected from accident related hazards such as missiles, pipe breaks and flooding."

Based on the design commitments and corresponding ITAAC provided to verify that the as-built Class 1E equipment listed in APR1400 DCD Tier 1, Table 2.5.4-1 will be able to withstand seismic design basis loads, and EMI, RFI and ESD conditions, and these equipment are protected from hazards such as missiles pipes breaks and flooding, the staff finds that the as-built ESF-CCS will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.4, GDC 2, GDC 4. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.4-5, Items 1, 16, and 18 meet the requirements of 10 CFR 52.47(b)(1).

System Integrity

The IEEE Std 603-1991, Clause 5.5, requires that the safety system accomplishes its safety functions under the full range of applicable conditions enumerated in the design basis. GDC 23 requires that the protection system be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy, or postulated adverse environments are experienced.

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 10 and the corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 10, state that loss of power in an ESF-CCS division results in the respective ESF-CCS division output assuming fail-safe output condition. Based on the information provided, the staff could not identify design descriptions and corresponding ITAAC to verify that the ESF-CCF will fail in a safe state upon conditions indicative of an ESF-CCF processor lock-up. As such, the staff requested in RAI 317-8271, Question 14.03.05-16 (ML15321A293), that design descriptions and corresponding ITAAC be provided to verify that failures of the ESF-CCF that result in lock-up of the ESF-CCF processors would be detected (e.g. via watchdog timers) and the ESF-CCF would be designed to fail in a safe state upon these conditions in order to demonstrate that the requirements of IEEE Std 603-1991, Clause 5.5 are met for the as-built ESF-CCF.

In its response to RAI 317-8271, Question 14.03.05-16 (ML16062A317), the applicant committed to revise APR1400 DCD Tier 1, Section 2.5.1.1, Item 13 and Section 2.5.4.1, Item 10 to include descriptions of ESF-CCS testing to ensure fail-safe conditions are achieved on a processor lock-up. The applicant also committed to include corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 10 to demonstrate acceptability of the as-built system. Based on the proposed revisions to the APR1400 DCD Tier 1 to verify that the as-built ESF-CCS will fail in safe state upon processor lock-ups, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-16, to be resolved. As such, the staff finds that the as-built ESF-CCS will be verified to meet the system integrity requirements of IEEE Std 603-1991, Clause 5.5. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.4-5, Item 10 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Sections 2.5.1 and 2.5.4. As such, RAI 317-8271, Question 14.03.05-16 was resolved and closed.

Independence

The IEEE Std 603-1991, Clause 5.6.1, requires redundant portions of safety systems provided for a safety function be independent of and physically separated from each other to the degree necessary to retain the capability to accomplish the safety function during and following any design basis event requiring that safety function. IEEE Std 603-1991, Clause 5.6.3, requires that the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. IEEE Std 603-1991, Clause 5.6.3.1, states, in part, "Isolation devices used to effect a safety system boundary shall be classified as part of the safety system." GDC 24 requires that the protection system be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the

protection and control systems shall be limited so as to assure that safety is not significantly impaired.

Physical Separation and Electrical Isolation:

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 2 and the corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 2, states that redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment are physically separated and electrically isolated from each other and physically separated and electrically isolated from non-Class 1E equipment. The associated acceptance criteria in DCD Tier 1, Table 2.5.4-5, Items 2.b and 2.c, state “A report exists and concludes that independence of as-built redundant Class 1E divisions listed in Table 2.5.4-1 and associated field equipment is achieved by independent power sources and electrical circuits for each division, and by fiber optic cable interfaces, qualified isolation devices at interfaces between redundant divisions, and at interfaces between safety and non-safety systems.” APR1400 DCD Tier 1, Section 2.5.4.1, Item 3, and the corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 3, state that the Class 1E equipment and components identified in Table 2.5.4-1 are powered from its respective Class 1E train.

The staff finds that additional information is needed to clarify whether the qualified isolation devices at interfaces between redundant divisions and at interfaces between safety and non-safety systems are Class 1E. In addition, it is not clear whether an inspection will be performed to verify that that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems in the as-built ESF-CCS. As such, the staff requested in RAI 317-8271, Question 14.03.05-28 (ML15321A293), for the applicant to modify APR1400 DCD Tier 1, Table 2.5.4-5, Item 2, to clarify that these qualified isolation devices are Class 1E as required by IEEE Std 603-1991, Clause 5.6.3.1, and to verify via inspection that Class 1E qualified isolation devices exist between redundant portions of safety systems and between safety and non-safety systems. In its response to RAI 317-8271, Question 14.03.05-28 (ML16142A002), the applicant committed to revise the design description in APR1400 DCD Tier 1, Section 2.5.4.1, Item 2, and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 2 to clearly identify and verify that the isolation devices used in these applications are Class 1E and are installed to prevent fault propagation. Based on the proposed changes, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-28, to be resolved. The staff also finds design description in APR1400 DCD Tier 1, Section 2.5.4.1, Item 3, and the corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 3 will adequately verify the as-built Class 1E equipment will be powered from its respective Class 1E train. As such, the staff finds design description and corresponding ITAAC in APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5, Items 2 and 3, respectively, will adequately verify the as-built ESF-CCS and Class 1E equipment in Table 2.5.4-1, meet the electrical isolation requirements of IEEE Std 603-1991, Clause 5.6. Therefore, the staff finds the ITAAC in Table 2.5.4-5, Items 2 and 3 satisfy the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-28 was resolved and closed.

Communications Independence:

Technical Report APR1400-Z-J-NR-14001, Rev. 0, “Safety I&C System Technical Report,” Section 4.2.4, states, “The PPS sends the ESFAS initiation signals to the ESF-CCS GCs [group controllers] in all ESF-CCS divisions through the fiber optic SDL [safety data link].” In addition,

Section 4.4.2 of this TeR states: “The ESCM [(ESF-Soft Control Module)] provides the operators with primary manual control means for other safety components as well as ESF components. There is one ESCM per division at each operator console in the MCR [main control room] and RSR [remote shutdown room] and SC [Safety Console] in the MCR. The divisionalized ESCM has access to all ESF safety components within its division. The ESCMs on the operator consoles work in conjunction with the IPFDs [(Information Flat Panel and Display)], but the ESCMs on the SC work independently of the IPFDs. DI&C-ISG-04 compliance for communication between the IPFD and ESCM is described in Appendix C.5.1.5.” These design descriptions indicate that data communications exist between redundant divisions of ESF-CCS and between the ESF-CCS and non-safety systems. However, the staff could not identify any Tier 1 descriptions or corresponding ITAAC to verify that communications independence is achieved between these interfaces. As such, in RAI 71-7906, Question 14.03.05-11 (ML15196A597), the staff requested the applicant to modify Tier 1 of the DCD, including the ITAAC to include this information to verify communication independence is achieved in the as-built ESF-CCS. The design commitment and associated ITAAC should include sufficient information regarding the types of data communications faults that the system will be protected from and software features to mitigate these faults.

In its response to RAI 71-7906, Question 14.03.05-11 (ML17004A014), the applicant committed to add a design description Items 23 and 28 to APR1400 DCD Tier 1, Section 2.5.4.1 and corresponding ITAAC in Table 2.5.4-5 to provide the key features used to mitigate data communication faults and ensure that communications independence is achieved between redundant divisions of the ESF-CCS and between the ESF-CCS and non-safety systems. The staff finds the added items to include key features used to mitigate data communications faults and ensure data communications independence between redundant portions of the ESF-CCF and between the ESF-CCF and non-safety systems are adequate because these features are consistent with the guidance of DI&C-ISG-04. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 71-7906, Question 14.03.05-11 was resolved and closed.

DI&C-ISG-04, Section 2, “Command Prioritization,” provides guidance on use of priority modules in safety I&C systems. Position 3 of this section states: “Safety-related commands that direct a component to a safe state must always have the highest priority and must override all other commands. Commands that originate in a safety-related channel but which only cancel or enable cancellation of the effect of the safe-state command (that is, a consequence of a Common-Cause Failure in the primary system that erroneously forces the plant equipment to a state that is different from the designated “safe state.”), and which do not directly support any safety function, have lower priority and may be overridden by other commands...The priority module itself should be shown to apply the commands correctly in order of their priority rankings, and should meet all other applicable guidance.” APR1400 DCD Tier 1, Section 2.5.4.1, Item 13, and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 13, state, “The component interface module (CIM) provides state-based priority logic to prioritize the ESF-CCS and DPS signals.” APR1400 DCD Tier 1, Section 2.5.4.1, Item 14, and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 14, state “The CIM provides system-based priority logic for the front panel control switch signals on the CIM, the signals generated by the DMA switches, the signals from the ESF-CCS, and the signals from the DPS. The front panel control switches have the highest priority, and the signals from the DMA switches have priority over signals from the ESF-CCS and DPS.” The staff finds that the applicant has provided adequate design descriptions and corresponding ITAAC to verify the priority scheme of

the as-built CIM. Thus the staff finds the ITAAC in Table 2.5.4-5, Items 13 and 14, meet the requirements of 10 CFR 52.47(b)(1). However, the staff could not find any design descriptions or corresponding ITAAC to verify the priority scheme of the ESF-CCS for commands from the automatic safety functions and the manual controls from the ESCM and IFPD. Technical Report APR1400-Z-J-NR-14001, Rev. 0, "Safety I&C System Technical Report," Section 4.4.2 states, "The priority interlock in the LC [(loop controller)] is used to block any effect on ESF control from the control demand signals generated from the ESCM. The ESF actuation signals from the GC [(group controller)] overrides the control demand signal of the ESCM at any time." In RAI 317-8271, Question 14.03.05-29 (ML15321A293), the staff requested the applicant to provide design descriptions and corresponding ITAAC to verify this design feature.

In its response to RAI 317-8271, Question 14.03.05-29 (ML16062A317), the applicant stated the ESF-CCS LC performs prioritization logic between automatically actuated ESFAS signals and manually actuated component control signals from the minimum inventory (MI) switch and ESCM. The ESFAS signals always have priority over manually actuated component control signals from the MI switch and ESCM. The ESF-CCS LC implements this ESFAS signal priority by blocking the opposite state command from the MI switch and ESCM until the protective actions are completed. The applicant proposed to add a description in APR1400 DCD Tier 1, Section 2.5.4.1 to state that the ESF-CCS LC provides the priority logic to assure the actuation of automatically actuated ESFAS signals. In addition, a corresponding ITAAC, Item 22 will be added to DCD Tier 1, Table 2.5.4-5 to verify by test the prioritization logic of the ESF-CCS LC. Based on the propose revisions to APR1400 DCD Tier 1 Section 2.5.4.1 and Table 2.5.4-5, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-29, to be resolved. The staff finds the proposed additional design descriptions in Tier 1, Section 2.5.4.1, Item 22 and corresponding ITAAC in Table 2.5.4-5, Item 22 to verify the as-built ESF-CCS implements priority logic to assure the actuation of automatically actuated ESFAS signals meet the requirements of IEEE Std 603-1991, Clause 5.6. Therefore, the staff finds the ITAAC in Table 2.5.4-5, Item 22 meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5, Item 25. Note, because the applicant inserted other ITAAC in Table 2.5.4-5, the original numbering of Item 22 proposed by the applicant in the RAI response has changed to Item 25. As such, RAI 317-8271, Question 14.03.05-29 was resolved and closed.

Capability for Test and Calibration

The IEEE Std 603-1991, Clause 5.7, states, in part, the capability for testing and calibration of safety system equipment shall be provided while retaining the capability of the safety systems to accomplish their safety functions. APR1400 DCD Tier 1, Section 2.5.4.1, Item 21, and the corresponding ITAAC in Table 2.5.4-5, Item 21, state, "The ESF-CCS has the testing functions." It is not clear to the staff what is meant by the design description, "the testing functions." Specifically, it is not clear whether this design description intends to state that the capability to test and calibrate the ESF-CCS exists or the ESF-CCS system has self-testing functions within it. Further, the design description does not include criteria for the testing features included in the ESF-CCS (e.g. ability to detect faults in a manner that meets the design requirements of the ESF-CCS). As such, in RAI 71-7906, Question 14.03.05-10 (ML15196A597), the staff requested the applicant to modify the design description and corresponding ITAAC in APR1400 DCD Tier 1 to address these issues.

In its response to RAI 71-7906, Question 14.03.05-10 (ML15281A303), the applicant clarified the “testing functions” described in Item 21 of the design description in Section 2.5.4.1 and design commitment of Table 2.5.4-5 in DCD Tier 1 means the testing function of the ESF-CCS, which can be manually initiated during an authorized surveillance test. The applicant committed to revise design description in APR1400 DCD Tier 1, Section 2.5.4.1 and design commitment in APR1400 DCD Tier 1, Table 2.5.4-5 to reflect this clarification. The staff finds the proposed changes to APR1400 DCD Tier 1, Section 2.5.4.1, Item 21 and Table 2.5.4-5, Item 21 to clarify the meaning of testing functions acceptable. Thus, the staff finds the as-built ESF-CCS will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.7. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.4-5, Item 21, satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 71-7906, Question 14.03.05-10, to be resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.4.1 and Table 2.5.4-5. As such, RAI 71-7906, Question 14.03.05-10 was resolved and closed.

Information Display

The IEEE Std 603-1991, Clause 5.8.2, states, in part, that display instrumentation shall be provide accurate, complete, and timely information pertinent to safety system status. This information shall include indication and identification of protective actions of the sense and command features and execute features.

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 12, and the associated ITAAC in DCD Tier 1, Table 2.5.4-5, Item 12 state:

The operator modules (OMs) in the MCR display ESF actuation status, manual ESF actuation status, and ESF-CCS status information including the test status for ESF actuations identified in Tables 2.5.4-2 and 2.5.4-3.

Based on the verification that information for ESF actuation and test status will be displayed on the OM, the staff finds that the as-built design meets the requirements of IEEE Std 603-1991, 5.8.2. Therefore, the ITAAC in Table 2.5.4-5, Item 12 meet the requirements of 10 CFR 52.47(b)(1).

Control of Access

The IEEE Std 603-1991, Clause 5.9, states “The design shall permit the administrative control of access to safety system equipment. These administrative controls shall be supported by provisions within the safety systems, by provision in the generating station design, or by a combination thereof.” APR1400 DCD Tier 1, Section 2.5.4.1, Item 19, states, “The ESF-CCS cabinets listed in Table 2.5.4-1 have key locks and door position alarms, and are located in a vital area of the facility.” Based on this design commitment and associated ITAAC in DCD Tier 1, Table 2.5.4-5, Item 19, the staff finds that the control of access features for the as-built equipment listed in Table 2.5.4-1 will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.9. In addition, as discussed in Section 14.3.5.4.1 of this report, in response to RAI 317-8721, Question 14.03.05-18 (ML16182A581), the applicant proposed to add Item 27 to the design description in Tier 1, Section 2.5.4.1 and corresponding ITAAC in Table 2.5.4-5, Item 27, to state, “Hardwired disconnections exist between the ESF-CCS cabinets, and the portable workstation used to download the ESF-CCS software. The

hardwired disconnections protect the ESF-CCS software from unintended modifications.” The staff finds this design description and corresponding ITAAC are adequate to verify the as-built ESF-CCS will have controls for software modification to meet the requirements of IEEE Std 603-1991, Clause 5.9. Therefore, the staff finds the ITAAC in Table 2.5.4-5, Items 19 and 27, meet the requirements of 10 CFR 52.47(b)(1).

Identification

The IEEE Std 603-1991, Clause 5.11, requires, in part that safety system equipment shall be distinctly identified for each redundant portion of a safety system in accordance with the requirements of IEEE Std 384-1981 and IEEE Std 420-1982. APR1400 DCD Tier 1, Section 2.5.4.1, Item 17 and the corresponding ITAAC in Tier 1, Table 2.5.4-5, Item 17, states “redundant safety equipment and components of the ESF-CCS listed in Table 2.5.4-1 and related field equipment are provided with means of identification.”

Based on this design commitment and associated ITAAC in DCD Tier 1, Table 2.5.4-5, Item 17 the staff finds that the identification of as-built equipment listed in Table 2.5.4-1 will be verified to meet the requirements of IEEE Std 603-1991, Clause 5.11. Therefore, the staff finds the ITAAC in Table 2.5.4-5, Item 17, meet the requirements of 10 CFR 52.47(b)(1).

Manual Control

IEEE Std 603-1991, Clause 6.2.1, states, in part, that means shall be provided in the control room to implement manual initiation at the division level of the automatically initiated protective actions. IEEE Std 603-1991, Clause 6.2.2, states “Means shall be provided in the control room to implement manual initiation and control of the protective actions identified in [Clause] 4.5 that have not been selected for automatic control under 6.1. The displays provided for these actions shall meet the requirements of [Clause] 5.8.1.” APR1400 DCD Tier 1, Section 2.5.4.1, Item 11, states, “Manual ESF actuation switches are provided in the MCR and RSR for the manual ESF actuations identified in Table 2.5.4-3.” In addition, DCD Tier 1, Table 2.5.4-1, indicates that the Manual ESF actuation switch are divisionalized. Based on this design description and the corresponding ITAAC in DCD Tier 1, Table 2.5.4-5, Item 11, the staff finds that the operation of the as-built manual ESF-actuation switches will be verified to meet the manual control requirements in IEEE Std 603-1991, Clause 6.2.1, and thus meet the requirements of 10 CFR 52.47(b)(1). In RAI 38-7878, Question 07.05-1 (ML15169A320), the staff requested the applicant to justify why Type A variables are not required for this design when it appears that manually controlled actions were credited for cases where no automatic controls exist during several events analyzed in Chapter 15. As such, if the applicant determines that Type A variables are needed in response to this RAI, the staff requested the applicant to provide design descriptions and a corresponding ITAAC to verify means are provided for manual initiation and control of the protective actions that have not been selected for automatic control as required by IEEE Std 603-1991, Clause 6.2.2, as documented in RAI 317-8271, Question 14.03.05-30.

In its response to RAI 317-8271, Question 14.03.05-30 (ML17174B279), the applicant stated:

In response to RAI 294-8302 Question 07.05-6, KHNP has determined that Type A variables are to be included in the APR1400 design. The applicable Type A variables, (e.g., related operator actions), pertain to the component and are listed in a new Table 2.5.4-6 to be added to the APR1400 [DCD], Tier 1. Steam

Generator Level is being clarified in Table 2.5.4-6 to specify that the wide range level is the credited variable. A description will be added to Section 2.5.4.1 of APR1400 [DCD], Tier 1 to state that means are provided for manual initiation and control of the protective actions that have not been selected for automatic control. A corresponding ITAAC, Item 26, will be added to Table 2.5.4-[5] to detail.

The staff reviewed the response to RAI 294-8302, Question 07.05-6 (ML16153A476) and found it acceptable. The staff's detailed review of the response to RAI 294-8302, Question 07.05-6, is in Section 7.5 of this safety evaluation report. Because the staff found the list of Type A variables acceptable and the applicant committed to provide a list of Type A variables, corresponding design descriptions for safety-related division level manual controls and ITAAC to verify these features in the as-built system, the staff finds the requirements of IEEE Std 603-1991, Clause 6.2.1 have been met. As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-30, to be resolved. Thus, the ITAAC in Tier 1, Table 2.5.4-5, Item 26 meets the requirements of 10 CFR 52.47(b)(1). Based on a review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 294-8302, Question 07.05-6 was resolved and closed.

Setpoints

The IEEE Std 603-1991, Clause 4.10, requires the identification of critical points in time or the plant conditions, after the onset of a design basis event.

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 20, states that "The ESF-CCS provides ESF actuation within required response time for ESF functions identified in Table 2.5.4-2." The corresponding inspections, tests, and analyses in DCD Tier 1, Table 2.5.4-5, Items 20.b states, "An inspection will be performed on the as-built ESF-CCS to determine if the response time of ESF actuation functions identified in Table 2.5.4-2." The corresponding acceptance criterion states, "The as-built ESF actuation functions identified in Table 2.5.4-2 with response time requirements are bounded by type tests or a combination of a type test." Based on the design commitment and the associated ITAAC provided, it is not clear to the staff where the response time will be measured from (e.g. from the input of the group controller to the output of CIM). In addition, it is not clear whether this ITAAC item in combination with ITAAC Item 16 in DCD Tier 1, Table 2.5.1-5, provides full coverage of ESFAS function response times verification since it is unclear whether the communication path between the ESF portion of the PPS and the ESF-CCF group controllers are covered in either ITAAC. Further, the ITA identified in DCD Tier 1, Table 2.5.4-5, Item 20.b, does not appear to be a complete sentence. In RAI 317-8271, Question 14.03.05-20 (ML15321A293), the staff requested the applicant to address these issues.

In its response to RAI 317-8271, Question 14.03.05-20 (ML16062A317), the applicant stated:

As described in Section A.3.1 of the Response Time Analysis of Safety I&C System technical report, the allocated response time covers not only the internal and external communication relays caused by communication modules and cables, but also includes adequate communication margins between equipment. Accordingly, the descriptions of the inspections, tests, analyses and the acceptance criteria for Item 16.a in Table 2.5.1-5 will include the communication

delays from the BP to the LCL. The description of the acceptance criteria for Item 20.a in Table 2.5.4-[5] will include the communication delays from the LCL of the PPS to group controllers of the ESF-CCS.

Based on the proposed changes to ITAAC Item 16.a in APR1400 DCD Tier 1, Table 2.5.1-5 and Item 20.a in Table 2.5.4-5 to clarify the response time will include the communication delays from the BP to the LCL and from the LCL of the PPS to the group controllers of the ESF-CCS, the staff finds the response time of the entire ESFAS actuation path will be verified, and thus demonstrates the requirements of IEEE Std 603-1991, Clause 4.10 will be met in the as-built system. Therefore, the staff finds the ITAAC in Table 2.5.1-5, Item 16.a and Table 2.5.4-5, Item 20.a, satisfy the requirements of 10 CFR 52.47(b)(1). As such, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-20, to be resolved. The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Table 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-20 was resolved and closed.

Control Room

Title 10 CFR Part 50, Appendix A, GDC 19, states, in part, “A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents...Equipment at appropriate locations outside the control room shall be provided: (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.”

The APR1400 DCD Tier 1, Section 2.5.4.1, Item 8, and the corresponding design commitment in DCD Tier 1, Table 2.5.4-5, Item 8, state: “Each ESF-CCS division is controlled from either the MCR or RSR, as selected from MCR/RSR master transfer switches.” The ITA of this ITAAC states, “A test of the as-built system for one control within each ESF-CCS division will be performed to demonstrate the transfer of control capability between the MCR and RSR.” The acceptance criteria for this ITAAC states, “The as-built master transfer switches transfer controls between the MCR and RSR separately for each as-built ESF-CCS division, as follows: [1] Controls at the RSR are disabled when controls are active in the MCR. [2] Controls at the MCR are disabled when controls are active in the RSR.” Based on the above descriptions, it is unclear whether this ITAAC is intended to verify the RSR will have controls for the ESF-CCS to meet the requirements of the GDC 19 since the design description and corresponding ITAAC only focuses on verifying the operation of the transfer switch. As such, in RAI 317-8271, Question 14.03.05-22 (ML15321A293), the staff requested the applicant to provide design descriptions and corresponding ITAAC to verify that the as-built RSR contain sufficient controls to meet the requirements of GDC 19. The applicant also provided APR1400 DCD Tier 1, Section 2.5.4.1, Item 11, and the corresponding design commitment in DCD Tier 1, Table 2.5.4-5, Item 11, state, “Manual ESF actuation switches are provided in the MCR and RSR for the actuations identified in Table 2.5.4-3.”

In its response to RAI 317-8271, Question 14.03.05-22 (ML16142A002), the applicant proposes to revise APR1400 DCD Tier 1, Table 2.5.4-5, Item 8 to include the control functions based on the transfer capability between the MCR and the RSR for the ESF-CCS to demonstrate compliance with GDC 19. Based on the proposed revision to APR1400 DCD Tier 1 to include

verification of the control functions in addition to the transfer capability between the MCR and RSR in the as-built ESF-CCS, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-22, to be resolved. As such, the staff finds that the as-built ESF-CCS will be verified to meet the requirements of GDC 19, and therefore, the ITAAC in Tier 1, Table 2.5.4-5, Item 8, meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Table 2.5.4-5. As such, RAI 317-8271, Question 14.03.05-22 was resolved and closed.

14.3.5.4.5 Control Systems

The applicant provided design descriptions and ITAAC verifying design features for the control systems in APR1400 DCD Tier 1, Section 2.5.5, "Control System Not Required for Safety." APR1400 DCD Tier 1, Section 2.5.5.1, states control systems which are not required for safety consists of power control system (PCS) and process-component control system (P-CCS). The PCS includes the reactor regulating system (RRS), the digital rod control system (DRCS), and the reactor power cutback system (RPCS). The P-CCS includes nuclear steam supply system (NSSS) process control system (NPCS) and balance of plant (BOP) control systems. The NPCS consists of the feedwater control system (FWCS), the steam bypass control system (SBCS), the pressurizer pressure control system (PPCS), the pressurizer level control system (PLCS), and other miscellaneous NSSS control systems which include reactor makeup control function of the chemical and volume control system (CVCS). The PCS and P-CCS provide control of functions to maintain the plant within its normal operating range for all normal modes of plant operation.

The following APR1400 DCD Tier 1 tables are provided for control systems:

- Table 2.5.5-1, "Controller Group Arrangement of the PCS and NPCS"
- Table 2.5.5-2, "Control System Not Required for Safety ITAAC"

The staff reviewed the design descriptions and ITAAC to ensure compliance with 10 CFR 52.47(b)(1) as documented below.

Instrumentation and Controls

The 10 CFR Part 50, Appendix A, GDC 13 states, "Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges." GDC 1 requires SSCs important to safety to be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

The APR1400 DCD Tier 1, Section 2.5.5.1, Item 2, and the corresponding design commitment in DCD Tier 1, Table 2.5.5-2, Item 2 state: "The digital equipment and software used in the PCS and P-CCS are independent from those of the [PPS] and the [ESF-CCS]." The acceptance for this ITAAC will verify that the PCS and P-CCS use a platform which is independent from the platform used in the PPS and ESF-CCS and the design group(s) which developed the PCS and

P-CCS software is independent from the design group(s) which developed the PPS and ESF-CCS software. APR1400 DCD Tier 2, Section 7.7.1.1, states that the control systems are implemented on a digital platform that is diverse in both hardware and software from the safety common platform. Section 4.1 of Technical Report APR1400-Z-J-NR-14002, Rev. 0, "Diversity and Defense-in-Depth" states: "The plant-wide data networks are composed of safety networks and non-safety networks. The safety network is independent and diverse from the non-safety network. The non-safety network utilizes different communication hardware, software and communication protocol from the safety network." Section 6.1.2 of this technical report states, "In addition, to correspond with the hardware diversity of these fluid/mechanical systems, the APR1400 employs both hardware and software diversity between control and protection I&C systems to eliminate the potential for CCFs." The staff could not find discussion of how the plant control system platform and software is diverse from the safety common platform in APR1400 DCD Tier 2 or its referenced documents to support the acceptance criteria in DCD Tier 1, Table 2.5.5-2, Item 2. In addition, APR1400 DCD Tier 2 does not use the term "independent" when discussing the differences between platform and software used for the control system and the platform and software used for the PPS and ESF-CCS. As such, in RAI 317-8271, Question 14.03.05-31 (ML15321A293), the staff requested the applicant to resolve this discrepancy in terminology and provide additional information in Tier 2 to support the Tier 1 descriptions regarding the platforms used for the PCS and P-CCS.

In its response to RAI 317-8271, Question 14.03.05-31 (ML16036A374), the applicant stated KHNP had previously addressed the discrepancies related the term "independent" in the response for RAI 68-7892, Question 07.07-1, where the applicant proposed to revise APR1400 DCD Tier 1, Section 2.5.5 and Table 2.5.5-2 to remove references to the term "independent." The DCD will state, "The digital equipment and software used in the PCS and P-CCS are diverse from those of the [PPS] and [ESF-CCS]". In addition, the applicant clarified, in this response, that the non-safety related I&C system of the APR1400 will be designed by using different hardware and software from the Common Q platform to achieve diversity in the design. Adequate diversity will be verified in ITAAC Item 2, in DCD Tier 1, Table 2.5.5-5.

Because the applicant proposed changes to replace the term "independent" with "diverse" in accordance with the guidance of NUREG/CR 6303, "Method for Performing Diversity and Defense-in-Depth Analyses of Reactor Protection Systems," and the clarification on how adequate diversity will be verified in the as-built system, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-31, to be resolved. The staff finds the design description in Tier 1 Section 2.5.5.1, Item 2 and the corresponding ITAAC in DCD Tier 1, Table 2.5.5-1, Item 2, are adequate to verify the as-built PCS and P-CCS are diverse from the PPS and ESF-CCS to meet the requirement of GDC 13. As such, the staff finds the ITAAC in DCD Tier 1, Table 2.5.5-1, Item 2 meet the requirements of 10 CFR 52.47(b)(1). The staff verified the proposed markups have been incorporated into the APR1400 DCD Tier 1, Table 2.5.5-2. As such, RAI 317-8271, Question 14.03.05-31 was resolved and closed.

Technical Report APR1400-Z-J-NR-14001, Rev. 0, "Safety I&C System Technical Report," Section 4.4.2 of this TeR states

The ESCM provides the operators with primary manual control means for other safety components as well as ESF components. There is one ESCM per division at each operator console in the MCR and RSR and SC in the MCR. The divisionalized ESCM has access to all ESF safety components within its division.

The ESCMs on the operator consoles work in conjunction with the IFPDs, but the ESCMs on the SC work independently of the IFPDs.

It appears that the IFPD is used as the primary control and indication (including alarms), during normal, abnormal, and accident conditions. As such, the staff considers the IFPD important-to-safety. As such, in RAI 317-8271, Question 14.03.05-32 (ML15321A293), the staff requested the applicant to provide design descriptions, including corresponding ITAAC regarding the system development of the IFPD in order to demonstrate that the requirements GDC 1 and 13 are met for the as-built IFPD. In addition, the staff requested the applicant to modify the APR1400 DCD to provide a description of what augmented quality is associated with the IFPD, including its classification in Technical Report, APR1400-Z-J-NR-14003, Rev. 0, "Software Program Manual."

In its response to RAI 317-8271, Question 14.03.05-32 (ML16279A538), the applicant stated that the IFPD will be used during all plant conditions for control and indications. However, the IFPD are not the credited control and display to meet the requirements of GDC 13. The applicant finds the requirements of GDC 1 are applicable to the IFPD. The IFPDs are considered important-to-safety device consistent with APR1400 DCD Tier 2, Section 3.2. The IFPDs are qualified to augmented quality grade, are seismic Category II, and adapted important to availability (ITA) software defined in Technical Report, APR1400-Z-J-NR-14003 APR1400, "Software Program Manual". The applicant proposed to modify the SPM, Table A-1. The applicant also proposed to modify DCD Tier 1, Section 2.5.5, Control System Not Required for Safety, with corresponding ITAAC added to Table 2.5.5-2, Items 4 and 6 to include ITAAC for validating the functionality and quality development of IFPDs, respectively. Because the applicant committed to meet the requirements of GDC 1 for the IFPDs, proposed inclusion of the IFPD software as ITA in the SPM, and added design descriptions and ITAAC to verify the functionality and quality development of IFPDs, the staff finds the quality and functionality of the as-built IFPD will be adequately verified. As such, the issues identified in RAI 317-8271, Question 14.03.05-32, are resolved. Therefore, the staff finds the ITAAC in Tier 1 Table 2.5.5-2, Items 2, 4 and 6, meet the requirement of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Section 2.5.5.1 and Table 2.5.5-2. As such, RAI 317-8271, Question 14.03.05-32 was resolved and closed.

Independence

IEEE Std 603-1991, Clause 5.6.3, requires that the safety system design to be such that credible failures in and consequential actions by other systems, as documented in Clause 4.8 of the design basis, shall not prevent the safety systems from meeting the requirements of this standard. APR1400 DCD Tier 1, Section 2.5.5.1, Item 5 and the corresponding ITAAC in Tier 1, Table 2.5.5-2, Item 5, state "The IFPDs are independent from Class 1E [Human Systems Interface (HSI)] devices." The staff finds this design description and ITAAC are adequate to verify the as-built IFPD are independent of Class 1E HSI devices to meet the requirements of IEEE Std 603-1991, Clause 5.6.3. Therefore, the staff finds the ITAAC in Tier 1, Table 2.5.5-2, Item 5, meet the requirement of 10 CFR 52.47(b)(1).

Equipment Qualification

GDC 2 requires, in part, that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches, without loss of capability to perform their safety functions. APR1400 DCD Tier 1, Section 2.5.5.1, Item 7 and the corresponding ITAAC in Tier 1, Table 2.5.5-2, Item 7, state “The IFPDs do not adversely affect safety devices in the MCR during seismic conditions that would exist before, during, and following a design basis event.” The staff finds this design description and ITAAC are adequate to verify the as-built IFPD will not adversely affect safety devices during design basis events to meet the requirements of GDC 2. As such, the staff finds the ITAAC in Tier 1, Table 2.5.5-2, Item 7, meet the requirements of 10 CFR 52.47(b)(1).

Control System Arrangement

IEEE Std 603-1991, Clause 4.8, requires the applicant to identify the conditions having the potential for functional degradation of safety system performance and for which provisions shall be incorporated to retain the capability for performing the safety functions (for example, missiles, pipe breaks, fires, loss of ventilation, spurious operation of fire suppression systems, operator error, failure in non-safety-related systems).

The APR1400 DCD Tier 1, Section 2.5.5.1, Item 1, and the corresponding ITAAC in DCD Tier 1, Table 2.5.5-2, Item 1, state: “The major controllers of the PCS and NPCS are arranged in separate controller groups as identified in Table 2.5.5-2.” Technical Report APR1400-Z-J-NR-14012, Rev. 0, “Control System CCF Analysis,” provides descriptions on how arranging PCS and NPCS functions into separate controller groups reduces the likelihood of control system failures in order to bound transients induced by such failures within the Chapter 15 safety analysis limits. Based on the provision of this ITAAC in DCD Tier 1, Table 2.5.5-2, Item 1, to verify that the major controllers of the PCS and NPCS are arranged in separate controller groups, the staff finds that the requirements of IEEE Std. 603-1991, Clause 4.8, are met for the PCS and NPCS. Therefore, the staff finds the ITAAC in DCD Tier 1, Table 2.5.5-2, Item 1 meet the requirements of 10 CFR 52.47(b)(1).

Control Room

The 10 CFR Part 50, Appendix A, GDC 19, states, in part, “A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents...Equipment at appropriate locations outside the control room shall be provided: (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.”

The APR1400 DCD Tier 1, Section 2.5.5.1, Item 3, and the corresponding design commitment in DCD Tier 1, Table 2.5.5-2, Item 3, state, “The PCS and P-CCS are controlled from either the MCR or RSR, as selected from master transfer switches.” The ITA of this ITAAC states, “A test of the as-built system will be performed to demonstrate the transfer of control capability between the MCR and RSR.” The acceptance criteria for this ITAAC states, “The as-built MCR/RSR master transfer switches transfer controls between the MCR and the RSR for as-built PCS and P-CCS, as follows: [1] Controls at the RSR are disabled when controls are active in the MCR for

the as-built PCS and P-CCS. [2] Controls at the MCR are disabled when controls are active in the RSR for the as-built PCS and P-CCS.” Based on the above descriptions, it is unclear whether this ITAAC is intended to verify the RSR will have controls for the PCS and P-CCS to meet the requirements of the GDC 19 since the design description and corresponding ITAAC only focuses on verifying the operation of the transfer switch. As such, in RAI 317-8271, Question 14.03.05-22 (ML15321A293), the staff requested the applicant to provide design descriptions and corresponding ITAAC to verify that the as-built RSR contain sufficient controls to meet the requirements of GDC 19.

In its response to RAI 317-8271, Question 14.03.05-22 (ML16142A002), the applicant proposes to revise APR1400 DCD Tier 1, Table 2.5.5-2, Item 3 to include the control functions based on the transfer capability between the MCR and the RSR for the PCS and P-CCS to demonstrate compliance with GDC 19. Based on the proposed revision to APR1400 DCD Tier 1 to include verification of the control functions in addition to the transfer capability between the MCR and RSR in the as-built PCS and P-CCS, the staff finds the issues identified in RAI 317-8271, Question 14.03.05-22 resolved. As such, the staff finds that the as-built PCS and P-CCS will be verified to meet the requirements of GDC 19, and thus the ITAAC in Tier 1, Table 2.5.5-2, Item 3, meet the requirements of 10 CFR 52.47(b)(1). The staff verified that the proposed markups have been incorporated into the APR1400 DCD Tier 1, Table 2.5.5-2. As such, RAI 317-8271, Question 14.03.05-22 was resolved and closed.

14.3.5.4.6 Standalone I&C Systems

The 10 CFR 52.47(b)(1) requires an application to contain the proposed inspections, tests, analyses, and acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the AEA, and the Commission's rules and regulations. The staff reviewed the Tier 1 descriptions and ITAAC and could not find information regarding the standalone safety I&C systems such as the RMS and the essential chiller condenser system. In RAI 71-7906, Question 14.03.05-12 (ML15196A597), the staff requested the applicant to modify Tier 1 of the APR1400 DCD to include this information.

In its response to RAI 71-7906, Question 14.03.05-12 (ML16113A416), the applicant stated that the design description for the safety-related divisional cabinet (SRDC) of the RMS is in the APR1400 DCD Tier 1, Subsection 2.7.6.4.1, Item 5 and Subsection 2.7.6.5.1, Item 6. The corresponding ITAAC are addressed in the Item 5 of Table 2.7.6.4-3 and the Item 6 of Table 2.7.6.5-3. The essential chilled water system is not a standalone I&C system, but a mechanical safety related process system which is controlled by the safety related I&C system ESF-CCS. The design description for the essential chilled water system controls is addressed in DCD Tier 1, Item 8 of Subsection 2.7.2.3 and the ITAAC is addressed in Item 8 of Table 2.7.2.3-4. Since the APC-S and the ENFMS are parts of the RTS and the ESF system, the design description and ITAAC for the APC-S and the ENFMS are not addressed individually in APR1400 DCD Tier 1, but are included in the Section 2.5.1 discussion of RTS and ESF Initiation. The design description for the APC-S and the ENFMS are addressed in APR1400 DCD Tier 1, Section 2.5.1.1, Item 15 of and the corresponding ITAAC is addressed in Item 15 of DCD Tier 1, Table 2.5.1-5. Although the response references to DCD Tier 1, Section 2.7.2 and Item 8 in DCD Tier 1, Table 2.7.2.3-4 for more information relating to the control of the essential chilled water system, the staff finds that additional information is needed in Tier 2 to support the verification of the as-built essential chilled water system controls. Specifically, Tier 2 of the APR1400 DCD

does not contain the information describing how the essential chilled water system is controlled in the ESF-CCS to support the design descriptions in APR1400 DCD Tier 1. The staff requested similar information in RAI 328-8281, Question 07.03-12 (ML15334A336). The staff's evaluation of the response to RAI 328-8281, Question 07.03-12, is in Section 7.3 of this SER.

14.3.5.5 Combined License Information Items

There are no COL items associated with Section 14.3.2.5 of the APR1400 DCD.

14.3.5.6 Conclusion

Based on the above discussion of I&C ITAAC, including the ITAAC discussions in Chapter 7 of this report, the staff finds the DCD Tier 1 design descriptions associated with the scope of SRP Section 14.3.5 for I&C system ITAAC acceptable. The staff concludes that, the design descriptions and I&C ITAAC discussed in APR1400 DCD Tier 1, Section 2.5 meet 10 CFR 52.47(b)(1), such that, if the inspections, tests, and analyses are performed and the acceptance criteria met, then a facility referencing the APR1400 certified design has been constructed, and will be operated, in compliance with the DC, the Atomic Energy Act of 1954, and applicable NRC regulations.

14.3.6 Electrical Systems– Inspections, Tests, Analyses, and Acceptance Criteria

14.3.6.1 Introduction

This section provides the criteria and processes used to review and evaluate the APR1400, DCD Tier 1 Section 2.6, "Electric Power," and DCD Tier 2 Section 14.3.2.6, "ITAAC for Electrical Systems." DCD Tier 2 Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," provided the bases, processes, and selection criteria used to develop Tier 1 information. DCD Tier 2 Section 14.3.2.6 also addressed the inspections, tests, and analyses, that the applicant proposes to perform as well as the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the proposed inspections, tests, and analyses are performed and the acceptance criteria are met, the facility has been constructed and will operate in conformance to the DC, and in compliance with the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations. The applicant proposes ITAAC in APR1400 DCD Tier 1 Section 2.6 and provides supporting information in DCD Tier 2 Section 14.3.2.6, which addressed the review guidance given in the NUREG-0800, SRP Section 14.3.6, "Electrical System, Inspections, Tests, Analyses, and Acceptance Criteria," and guidance of RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," for electrical systems.

14.3.6.2 Summary of Application

DCD Tier 1: In the APR1400 DCD Tier 1, Section 2.6, the applicant provided design descriptions for the alternating current (AC) electric power distribution system, emergency diesel generator system, DC power system, instrumentation and control power system, containment penetration assemblies, AAC source, lightning protection and grounding system, and lighting systems. DCD Tier 1 Section 2.6, which addresses electrical systems, was prepared in accordance with the guidance given in RG 1.206, SRP 14.3, and SRP 14.3.6. DCD Tier 1, Section 2.6 provided information related to whether electrical equipment is classified as Class 1E and whether electrical equipment is qualified for harsh environment.

DCD Tier 2: DCD Tier 2 Section 14.3 provided a general description and supporting information on ITAAC for Electrical Systems. In DCD Tier 2 Chapter 14, technical information on ITAAC were provided for the plant's electrical system, including Class 1E portions of the system, major portions of the non-Class 1E system, equipment qualification and portions of the plant lighting, grounding, lightning protection systems, and containment electrical penetrations. Specifically, DCD Tier 2 Section 14.3.2.6 provided the electrical criteria for which the ITAAC verify. Design descriptions for electrical systems follow NRC guidelines for electric systems ITAAC in Appendix C.II.1-A of RG 1.206.

These design descriptions address electrical equipment that is involved in performing safety functions. Such equipment includes the complete Class 1E electrical system, including power sources (which include offsite sources even though they are not Class 1E) and direct current (dc) and ac distribution equipment. Design descriptions also address additional relevant factors related to the electrical equipment that are not part of the Class 1E system, but are included to improve the reliability of the individual Class 1E divisions. Brief design descriptions are included for the non-Class 1E portions of the electrical system that power the balance of plant loads although these descriptions generally focus on the aspects needed to support the Class 1E portion.

Consistent with Appendix C.II.1-A of RG 1.206, the applicant has provided ITAAC entries in DCD Tier 1 Section 2.6 for verifying the electrical ITAAC for the following aspects of their design as stated in DCD Tier 2 Section 14.3.2.6: (1) equipment qualification for seismic and harsh environment; (2) redundancy and independence; (3) capacity and capability; (4) electrical protection features; (5) displays, controls, and alarms; (6) offsite power; (7) containment electrical penetrations; (8) AAC power source; (9) lighting; (10) electrical power for non-safety plant systems; and (11) physical separation and independence.

ITAAC: The applicant has provided ITAAC tables for each of the systems listed in Tier 1 Section 2.6 for which Tier 1 Design Descriptions were provided.

TS: There are no TS for the electrical ITAAC since the TS do not apply to ITAAC. DCD Tier 2 Chapter 16 Section 3.8, "Electrical Power Systems," addresses the TS related to electrical equipment and systems.

14.3.6.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Sections 14.3 and 14.3.6 of NUREG-0800. Review interfaces with other SRP sections also can be found in SRP Section 14.3.6. (The requirements listed in SRP Section 14.3.6 that are related to the technical adequacy of the ITAAC are not included here, as they are addressed in this report.)

The applicable regulatory requirements are as follows:

1. Title 10 CFR 52.47(b)(1), "Contents of the application; technical information," which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC is built and will operate in conformity with the DC, the

provisions of the Atomic Energy Act of 1954, as amended, and the NRC's rules and regulations.

2. Title 10 CFR 50.49, "Environmental qualification of electrical equipment important to safety for nuclear power plants," as it relates to the applicant establishing a program for qualifying electrical equipment important to safety located in a harsh environment.
3. Title 10 CFR 50.63, "Loss of all alternating current power," as it relates to an AAC power source (as defined in 10 CFR 50.2) provided for safe shutdown in the event of and the capability to withstand and recover from a Station Blackout (SBO).
4. Title 10 CFR Part 50, Appendix A, "General Design Criteria," GDC 2, "Design Basis for Protection against Natural Phenomena," as it relates to structures, systems and components (SSCs) of the ac power system being capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions.
5. GDC 17, "Electric power systems," as it relates to the offsite and onsite ac power system's: (1) capacity and capability to permit functioning of systems, structures, and components (SSCs) important to safety assuming no offsite power is available; (2) independence, redundancy, and testability to perform its safety function assuming a single failure; and (3) provisions to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit or the loss of power from the transmission network.
6. GDC 18, "Inspection and testing of electric power systems," as it relates to inspection and testing of the offsite and onsite power systems.

The associated acceptance criteria are summarized below:

1. RG 1.206, "Combined License Applications for Nuclear Power Plants," as it relates to power system analytical studies and stability studies to verify the capability of the offsite power systems and their interfaces with the onsite power system.
2. SRP 14.3.6 refers to SRP 14.3 for guidance on the content and format of ITAAC.

For DC applications, DCD Tier 1 Design Descriptions and ITAAC design commitments should be based on and consistent with the DCD Tier 2 material.

14.3.6.4 Technical Evaluation

The staff reviewed the following DCD information on Tier 1 and Tier 2. The DCD Tier 1, Section 2.6, provides design description, including the principal performance characteristics and safety functions of the SSCs. DCD Tier 1, Section 2.6 provides ITAAC to be used to provide reasonable assurance that the as-built plant will operate in conformity with the COL, and applicable NRC regulations. The DCD Tier 2 Section 14.3.2.6, provides information on the plant

electrical design description with more detail. Information contained in the Tier 1 document is derived from the Tier 2 document that supports ITAAC for the APR1400 DC application.

The staff reviewed the DCD Tier 1 system design descriptions, Section 2.6 and, DCD Tier 2 Section 14.3.2.6 to ensure, in part, that Tier 1 contains summary design, fabrication, testing, and performance requirements for SSCs important to safety. Also, the staff reviewed the information for conformance to the guidance given in RG 1.206, Section C.II.1.2.6, "ITAAC for Electrical Systems (SRP Section 14.3.6), and Appendix C.II.1-A, "General ITAAC Development Guidance," and SRP Chapter 14.3, "Inspections, Tests, Analysis, and Acceptance Criteria." The staff's review documented in this section, is limited to DCD Tier 1 Sections 2.6.1 through 2.6.8 and DCD Tier 2 Section 14.3.2.6, and addresses ITAAC for electrical systems and selection methodology for SSCs to be included in the ITAAC. DCD Tier 1 Section 2.6.9, "Communication Systems," and Table 2.6.9-1, "Communication Systems ITAAC," are evaluated in Sections 9.5.2 and 14.3.12 of this SER. Design descriptions and ITAAC proposed by the applicant were reviewed to verify that this information and Tier 2 requirements (or design commitments) are met when the plant is built.

14.3.6.4.1 ITAAC for Electrical Systems

The Class 1E electrical systems of the APR1400 design in DCD Tier 2, Section 14.3.2.6 include: (1) the Class 1E electrical power distribution system, (2) the emergency diesel generators (EDGs), (3) the Class 1E dc power supply, and (4) the Class 1E instrument and control power supplies. The staff reviewed the APR1400 design to determine whether the applicant established design commitments for the Class 1E electrical systems and that they are verified by ITAAC. The design commitments proposed by the applicant in DCD Tier 2 Section 14.3.2.6 for the electrical systems include design aspects related to the following, are discussed below: (1) equipment qualification for seismic and harsh environment; (2) redundancy and independence; (3) capacity and capability; (4) electrical protection features; (5) displays, controls, and alarms; (6) offsite power; (7) containment electrical penetrations; (8) AAC power source; (9) lighting; (10) electrical power for non-safety plant systems; and (11) physical separation and independence.

14.3.6.4.1.1 Equipment qualification for seismic and harsh environment

The staff identified the following ITAAC regarding equipment qualification for seismic and harsh environment:

Table 14.3-5 Equipment Qualification ITAAC

Table	Item Number
2.6.1-3	2
2.6.1-3	4
2.6.1-3	13a
2.6.1-3	13b
2.6.2-3	5a

Table	Item Number
2.6.2-3	5b
2.6.2-3	5c
2.6.2-3	24
2.6.2-3	25
2.6.3-3	2
2.6.3-3	3
2.6.3-3	4
2.6.4-3	2
2.6.4-3	9
2.6.5-1	2
2.6.5-1	3

The acceptance criteria in SRP 14.3.6, "Electrical System-ITAAC," identify equipment qualification for seismic and harsh environments to ensure that the seismic design requirement of GDC 2, and the EQ requirements of 10 CFR 50.49 are met. The staff reviewed the design descriptions and ITAAC listed above to ensure compliance with 10 CFR 52.47(b)(1).

The staff issued RAI 234-8284, Question 14.03.06-2 (ML15296A005), requesting the applicant to provide additional information regarding other buildings that house Class 1E equipment be classified as seismic Category 1 buildings, other than the auxiliary and EDG buildings.

In its response to RAI 234-8284, Question 14.03.06-2 (ML16020A513), the applicant stated that two Essential Service Water (ESW) buildings also house Class 1E equipment. The applicant also revised design commitment and ITAAC item 4 in DCD Tier 1, Section 2.6.1.1, "Design Description," and Table 2.6.1-3, "AC Electric Power Distribution System ITAAC," to incorporate the ESW buildings. The staff considers this issue resolved since the ITAAC ensures that all buildings that house Class 1E equipment are also seismic Category I buildings. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-2. Therefore, RAI 234-8284, Question 14.03.06-2, was resolved and closed.

The DCD Tier 1, Table 2.6.1-3, Design Commitment item 13 states that Class 1E electric power distribution system cables are routed in seismic Category I structures and in their respective raceway trains. The staff issued RAI 234-8284, Question 14.03.06-2 (ML15296A005), requesting the applicant to provide additional information to explain why analyses of the cables are not needed to show that seismic design basis requirements are bounded.

In its response to RAI 234-8284, Question 14.03.06-2 (ML16020A513), the applicant revised DCD Tier 1, Sections 2.6.1.1 and Table 2.6.1-3 to add an ITAAC Item 13 in DCD Tier 1, Table

2.6.1-3 to verify that the raceway systems for the Class 1E cables are designed to meet seismic Category I requirements. Since the ITAAC provides verification that raceway systems for Class 1E electric power distribution system cables are designed to meet seismic Category I requirements, the staff finds the response acceptable and considers the issue resolved. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-2. Therefore, RAI 234-8284, Question 14.03.06-2, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-3 (ML15296A005), requesting the applicant to provide additional information on whether the Class 1E EDGs are seismic Category I and can withstand seismic design basis loads without loss of safety function and to discuss how verification is achieved.

In its response to RAI 234-8284, Question 14.03.06-3 (ML16020A513), the applicant stated that Item 5a in DCD Tier 1, Table 2.6.2-3, "Emergency Diesel Generator System ITAAC," addressed verification of the seismic Category 1 diesel engines and generators and that they can withstand seismic design basis loads without loss of safety function. Since verification of the seismic classification of the EDGs is included in DCD Tier 1, Table 2.6.2, the staff finds the response acceptable and the issue resolved and closed.

In DCD Tier 2 Section 14.3.2.6, the applicant committed to have ITAAC to verify that the Class 1E equipment is seismic Category 1 and that equipment located in a harsh environment is qualified. The staff finds that the applicant, with this commitment, will meet the design requirements of GDC 2 and the EQ requirements of 10 CFR 50.49, therefore satisfying the NRC regulations. DCD Tier 1, Table 2.6.1-1, "AC Electric Power Distribution System Safety-related Equipment Characteristics," shows electrical and seismic classifications of major Class 1E ac electrical power distribution equipment. The applicant has identified in columns 2 and 3 of the DCD Tier 1, Table 2.6.1-1, the seismic and harsh environment classification of the major Class 1E ac electrical distribution equipment.

GDC 2 requires, in part, that SSCs of the electrical power system be capable of withstanding the effects of natural phenomena without the loss of the capability to perform their safety functions. The ITAAC listed above states that seismic Category I equipment can withstand seismic design basis loads without loss of safety function or that equipment is located in seismic Category 1 structures. Furthermore, the ITAAC listed above discuss qualification of equipment under expected environmental conditions. Based on the ITAAC provided to verify that the as-built equipment will be able to withstand seismic design basis loads and are qualified for the expected environmental conditions, the staff finds that the as-built systems will be verified to meet the requirements of 10 CFR 50.49 for EQ and GDC 2. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.2 Redundancy and independence

The applicant in DCD Tier 2 Section 14.3.2.6 has committed to have ITAAC to verify that the Class 1E electrical divisional equipment and systems are independent, i.e., meet the single failure requirements. The applicant proposed to have ITAAC to verify the Class 1E divisional assignments and independence of electric power by both inspections and tests. DCD Tier 1 Table 2.6.1-3 described the ITAAC for the onsite electric power system to assess the independence within Class 1E electric power distribution equipment, and between Class 1E electric power distribution equipment and non-safety-related electrical power distribution equipment.

The staff identified the following ITAAC regarding redundancy and independence for Class 1E equipment:

Table 14.3-6 Redundancy and Independence ITAAC

Table	Item Number
2.6.1-3	1
2.6.1-3	9
2.6.1-3	10a
2.6.1-3	10b
2.6.1-3	10c
2.6.1-3	16
2.6.1-3	17
2.6.2-3	1
2.6.2-3	7
2.6.2-3	16
2.6.3-3	1
2.6.3-3	8
2.6.3-3	9
2.6.3-3	10a
2.6.3-3	10b
2.6.3-3	10c
2.6.3-3	13
2.6.3-3	14
2.6.4-3	1
2.6.4-3	5
2.6.4-3	6
2.6.4-3	7

Table	Item Number
2.6.4-3	8
2.6.5-1	4
2.6.5-1	6

The staff issued RAI 234-8284, Question 14.03.06-4 (ML15296A005), requesting the applicant to provide additional information on why an ITAAC was not included to confirm that each redundant division of the Class 1E battery and associated charger is located in a separate room.

In its response to RAI 234-8284, Question 14.03.06-4 (ML16020A513), the applicant added two new ITAAC items 13 and 14 to DCD Tier 1, Section 2.6.3.1 and Table 2.6.3-3. Specifically, Item 13 confirms by inspection that each train of the Class 1E batteries is located in a separate room, and Item 14 confirms by inspection that each Class 1E train dc distribution panel, dc control center, and battery charger are located in a separate room. The staff finds the response acceptable and the issue resolved since DCD Tier 1 Table 2.6.3-3 includes two ITAAC for verification of physical separation of the Class 1E battery and associated equipment. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-4. Therefore, RAI 234-8284, Question 14.03.06-4, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-4 (ML15296A005), requesting the applicant to provide additional information regarding how the qualification of the isolation devices between Class 1E and non-Class 1E equipment is verified considering the isolation devices provide independence between the Class 1E dc system and the non-Class 1E dc loads.

In its response to RAI 234-8284, Question 14.03.06-4 (ML16020A513), the applicant added Items 10a, 10b, 10c, and 16 in DCD Tier 1, Table 2.6.3-3. Specifically, the applicant modified the ITAAC of the ac power system such that Items 10a, 10b, and 10c verify that: (1) independence is provided between each of the four trains of Class 1E dc distribution equipment and circuits, (2) independence is provided between Class 1E dc distribution equipment and circuits and non-Class 1E dc distribution equipment and circuits, and (3) Class 1E qualified isolation devices provide independence between Class 1E dc distribution equipment and non-Class 1E dc loads. ITAAC Item 16 was added to DCD Tier 1, Table 2.6.3-3 to confirm by inspection and analysis that the Class 1E protective devices (circuit breakers/fuses) in the dc power system are rated to supply their required loads and withstand fault currents for the time required to clear the fault from the power source. The staff finds that the revisions in DCD Tier 1 Table 2.6.3-3 discussed above, adequately address the independence between the dc system trains and between Class 1E and non-Class 1E equipment in the dc system and provide verification of the aforementioned independence. The staff finds the issue resolved. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-4. Therefore, RAI 234-8284, Question 14.03.06-4, was resolved and closed.

Accordingly, the staff finds that the subject ITAAC verify the divisional assignments and independence of the Class 1E electric power system equipment by both inspections and tests. Because the ITAAC verify the divisional assignments and independence of the Class 1E electric power system equipment, the staff finds that the as-built systems will meet the requirements of

GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.3 Capacity and Capability

To ensure that the electrical systems have the capacity and capability to supply the safety-related electrical loads, ITAAC are required to verify the adequate sizing of the electrical system equipment and its ability to respond (e.g., automatically in the time needed to support the accident analyses) to postulated events, as discussed in SRP Section 14.3.2.6. This includes the Class 1E portion and the non-Class 1E portion to the extent that it is involved in supporting the Class 1E system. The ITAAC analyze the as-built electrical system and installed equipment (EDGs, transformers, switchgear, dc systems, batteries, etc.) to verify its ability to power the loads. In addition, the ITAAC should include tests to demonstrate the operation of the equipment. Testing should be included in the ITAAC to verify EDG capacity and capability based on the TS. The ITAAC should verify the capacity and capability of the Class 1E equipment necessary to mitigate postulated events for which the equipment is credited (e.g., loss of coolant accident (LOCA), LOOP, and degraded voltage conditions). The ITAAC should be included to analyze the as-built electrical power system for its response to a LOCA, LOOP, combinations of LOCA and LOOP, and degraded voltage, including tests to demonstrate the actuation of the electrical equipment in response to postulated events. Analyses to demonstrate the acceptability of a voltage drop should be included in ITAAC to verify adequacy for supporting the accomplishment of a direct safety function. Testing should be included in ITAAC to verify the EDG voltage and frequency response to assure that it is acceptable, and is the same as that specified in the TS, DCD Tier 2, Chapter 16, "Technical Specification."

The staff identified the following ITAAC regarding capacity and capability for the Class 1E equipment and the non-Class 1E equipment to the extent that it is involved in supporting the Class 1E system:

Table 14.3-7 Capacity and Capability ITAAC

Table	Item Number
2.6.1-3	14
2.6.1-3	19
2.6.1-3	22
2.6.1-3	26
2.6.2-3	8a
2.6.2-3	8b
2.6.2-3	9
2.6.2-3	10
2.6.2-3	11

Table	Item Number
2.6.2-3	12
2.6.2-3	13
2.6.2-3	14
2.6.2-3	15
2.6.2-3	17
2.6.2-3	18
2.6.2-3	19
2.6.2-3	20
2.6.2-3	22
2.6.2-3	23
2.6.3-3	5
2.6.3-3	6
2.6.3-3	7
2.6.3-3	15
2.6.4-3	4
2.6.6-1	2
2.6.6-1	3
2.6.6-1	4
2.6.6-1	6
2.6.6-1	7
2.6.6-1	8a
2.6.6-1	8b
2.6.6-1	9
2.6.6-1	10
2.6.6-1	12

The staff issued RAI 234-8284, Question 14.03.06-2 (ML15296A005), requesting the applicant to provide additional information on verification that each Class 1E bus automatically connects to the EDG when both offsite power sources are not available.

In its response to RAI 234-8284, Question 14.03.06-2 (ML16020A513), the applicant stated that connection of the Class 1E EDGs during a LOOP is addressed in Item 15 of DCD Tier 1, Section 2.6.2, "Emergency Diesel Generator System." Specifically, Item 15 of DCD Tier 1, Table 2.6.2-3, addressed that a loss of power to a Class 1E medium voltage safety bus automatically starts its respective EDG and following attainment of required voltage and frequency, the EDG automatically connects to its respective train bus. The staff finds this response acceptable since a LOOP would result in a loss of power to the Class 1E bus, initiating the start of the EDG and subsequently, results in the connection of the EDG to the safety bus.

The staff issued RAI 234-8284, Question 14.03.06-2 (ML5296A005), requesting the applicant to provide additional information on verifying Class 1E cable sizing with consideration for derating due to ambient temperature and raceway loading.

In its response to RAI 234-8284, Question 14.03.06-2 (ML16020A513), the applicant revised DCD Tier 1 Section 2.6.1.1 and Table 2.6.1-3 to add new ITAAC Item 22 for Class 1E cable sizing to consider derating due to ambient temperature, cable grouping and other derating effects as applicable. The staff finds this acceptable and the issue resolved since: (1) Class 1E cables are sized to consider derating factors, and (2) inspections will be performed to verify that the as-built cable sizes bound the minimum sizes. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-2. Therefore, RAI 234-8284, Question 14.03.06-2, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-3 (ML15296A005), requesting the applicant to provide additional information to verify the air intake and exhaust system for the EDGs is capable of supplying combustion air and of disposing of exhaust gases.

In its response to RAI 234-8284, Question 14.03.06-3 (ML16020A513), the applicant revised DCD Tier 1, Section 2.6.2.1, "Design Description," and Table 2.6.2-3 to add ITAAC Item 23 in DCD Tier 1, Table 2.6.2-3 regarding the capability of the combustion air intake and exhaust system. The staff finds this acceptable and the issue resolved since the capability of each air intake and exhaust system for the Class 1E EDGs is verified by test. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-3. Therefore, RAI 234-8284, Question 14.03.06-3, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-3 (ML15296A005), requesting the applicant to provide additional information on verifying the fuel storage capacity of the EDGs and specifically, verification that the as-built storage tank capacity bounds the analysis.

In its response to RAI 234-8284, Question 14.03.06-3 (ML16020A513), the applicant revised ITAAC Item 9 in DCD Tier 1 Section 2.6.2 and Table 2.6.2-3 to verify that inspection will be performed to verify that each as-built fuel oil storage tank's capacity bounds the analysis. Since: (1) EDG fuel storage capacity is verified to operate the EDG for seven days with the EDG supplying the power requirements for the most limiting design basis event by analyses and inspection and (2) EDG is verified to have fuel to meet its intended function, the staff finds this acceptable and the issue resolved. The staff confirmed that the DCD was revised as committed

in the response to RAI 234-8284, Question 14.03.06-3. Therefore, RAI 234-8284, Question 14.03.06-3, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-3 (ML15296A005), requesting the applicant to provide additional information on verifying the fuel day tank capacity of the EDGs and specifically, the verification of the as-built day tank capacity.

In its response to RAI 234-8284, Question 14.03.06-3 (ML16020A513), the applicant revised ITAAC Item 10 in DCD Tier 1 Section 2.6.2 and Table 2.6.2-3, to verify that inspection will be performed to verify that each as-built fuel oil day tank's capacity bounds the analysis. The staff finds this acceptable and the issue resolved since EDG fuel day tank capacity is verified to provide fuel oil for at least 60 minutes plus a minimum additional margin of 10 percent at EDG rated load by analyses and inspection of the as-built day tank capacity. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-3. Therefore, RAI 234-8284, Question 14.03.06-3, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-3 (ML15296A005), requesting the applicant to provide additional information on verifying the lube oil makeup tank capacity of the EDG specifically verification that the as-built storage tank capacity bounds the analysis.

In its response to RAI 234-8284, Question 14.03.06-3 (ML16020A513), the applicant revised ITAAC Item 12 in DCD Tier 1 Section 2.6.2 and Table 2.6.2-3 to include inspection to verify that each as-built lube oil makeup tank capacity bounds the analysis. The staff finds this acceptable and the issue resolved since the lube oil makeup tank capacity is verified by inspection to bound the analysis. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-3. Therefore, RAI 234-8284, Question 14.03.06-3, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-4 (ML15296A005), requesting the applicant to provide additional information on why an ITAAC is not needed to confirm that the Class 1E dc power cables are sized to carry the required load currents and to provide the minimum design basis voltage at load terminals.

In its response to RAI 234-8284, Question 14.03.06-4 (ML16020A513), the applicant added ITAAC Item 15 to DCD Tier 1, Section 2.6.3.1 and Table 2.6.3-3. This new ITAAC item confirms by inspection and analysis that the Class 1E dc power system cables are sized to carry the required load currents and to provide minimum design basis voltage at the load terminals, considering derating due to ambient temperature, cable grouping, and other derating effects as applicable. The staff finds this response acceptable and the issue resolved since there is verification that the Class 1E dc power system cables are sized to meet their intended function. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-4. Therefore, RAI 234-8284, Question 14.03.06-4, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-4 (ML15296A005), requesting the applicant to provide additional information on why an ITAAC is not needed to confirm that the Class 1E batteries have enough capacity to carry the worst case load profile assuming the chargers are unavailable.

In its response to RAI 234-8284, Question 14.03.06-4 (ML16020A513), the applicant stated that the design commitment and ITAAC in DCD Tier 1, Table 2.6.3-3, Item 6, verifies that each Class

1E battery is sized to supply its design basis event (DBE) loads, at the end of installed life, for pertinent required hours without recharging. The staff issued follow-up RAI 455-8553, Question 14.03.06-9 (ML16096A307), requesting the applicant to state whether the DBE load profile is the worst case load profile for the Class 1E batteries, considering that the SBO load profile could be of a longer duration. In its response to RAI 455-8553, Question 14.03.06-9 (ML16181A333), the applicant stated that the worst case load profile for the Class 1E batteries is the DBE load profile, which bounds the SBO load profile. The staff finds these responses acceptable, and the issue resolved since verification exists in DCD Tier 1, Table 2.6.3-3, "DC Power System ITAAC," Item 6, that the Class 1E batteries are sized based on the worst case load profile.

The applicant provided ITAAC to verify 1) the adequate sizing of electrical system equipment, its ability to respond, and its ability to power the loads, and 2) the initiation of Class 1E equipment necessary to mitigate postulated events for which the equipment is credited. The staff reviewed the DCD Tier 1, Section 2.6 and DCD Tier 2, Section 14.3.2.6 information to ascertain whether the above stated requirements are met. The staff finds that the subject ITAAC verify that electrical systems have the capacity and capability to supply the safety-related electrical loads by both inspections and tests. Because the ITAAC verify the capacity and capability of the as-built systems, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.4 Electrical Protection Features

ITAAC are required to verify the adequacy of the electrical circuit protection design to ensure that the electrical power system is protected against potential electrical faults. Operating experience and NRC Electrical Distribution System Functional Inspections (EDSFIs) found inadequacies in the short circuit rating of certain electrical equipment and breaker and protective device coordination. ITAAC are required to analyze the as-built electrical system equipment for its ability to withstand and clear electrical faults. Further, ITAAC are included to analyze the protection coordination to verify its ability to limit the loss of equipment due to postulated faults. Similarly, emergency power (i.e., EDGs) protective trips (and bypasses if applicable) are to be verified by ITAAC.

The staff reviewed the Tier 1 and Tier 2 information in the APR1400 DCD to verify that the applicant had included ITAAC for the above stated requirements. The applicant has provided ITAAC for the electrical protection features including attributes such as analyzing the ability of the as-built electrical system equipment to withstand and clear electrical faults and to possess protection feature coordination. These ITAAC items are identified as follow:

Table 14.3-8 Electrical Protection Features ITAAC

Table	Item Number
2.6.1-3	18
2.6.1-3	11
2.6.1-3	12

Table	Item Number
2.6.1-3	15
2.6.1-3	20
2.6.2-3	20
2.6.3-3	12
2.6.3-3	16
2.6.4-3	10
2.6.4-3	11
2.6.5-1	5
2.6.7-1	1
2.6.7-1	2
2.6.7-1	3
2.6.7-1	4
2.6.7-1	5
2.6.7-1	6

The DCD Tier 1 Table 2.6.1-3, “AC Electric Power Distribution System ITAAC,” Item 10 provides ITAAC on independence between the trains of the Class 1E equipment, as well as between Class 1E and non-Class 1E equipment for the ac systems.

The staff issued RAI 234-8284, Question 14.03.06-4 (ML15296A005), requesting the applicant to provide additional information regarding how the qualification of the isolation devices between Class 1E and non-Class 1E equipment is verified considering the isolation devices provide independence between the Class 1E dc system and the non-Class 1E dc loads.

In its response to RAI 234-8284, Question 14.03.06-4 (ML16020A513), the applicant revised DCD Tier 1, Table 2.6.3-3, to add ITAAC Item 16 to confirm by inspection and analysis that the Class 1E protective devices (circuit breakers/fuses) in the dc power system are rated to supply their required loads and withstand fault currents for the time required to clear the fault from the power source. The staff finds this response acceptable and the issue resolved since the added ITAAC provides verification of the protective devices in the dc power system. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-4. Therefore, RAI 234-8284, Question 14.03.06-4, was resolved and closed.

The staff issued RAI 234-8284, Question 14.03.06-7 (ML15296A005), requesting the applicant to provide additional information on whether DCD Tier 1, Section 2.6.7, “Lightning Protection

and Grounding System,” Table 2.6.7-1, “Grounding and Lightning Protection System ITAAC,” Item 4, on equipment grounding includes the ground bus of switchgear, load centers, motor control centers (MCCs), and switchboards.

In its response to RAI 234-8284, Question 14.03.06-7 (ML16020A513), the applicant revised DCD Tier 1 Section 2.6.7, Table 2.6.7-1 and DCD Tier 2, Section 8.3.1.1.8, “Grounding and Lightning Protection Criteria,” to include the ground bus of switchgear, load centers, and MCCs. The staff finds the response acceptable and the issue resolved since the ITAAC for equipment grounding includes the grounding busbar. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-7. Therefore, RAI 234-8284, Question 14.03.06-7, was resolved and closed.

The staff finds the applicant has included ITAAC in the APR1400 electrical design for analyzing the as-built electrical system equipment to withstand and clear an electrical fault and to maintain protection coordination. The staff determined that the information in DCD Tier 1 Section 2.6, which addresses electrical protection features, has been prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the adequacy of the electrical circuit protection included in the design. Furthermore, the applicant has addressed protection features related to grounding. Therefore, the staff finds that the subject ITAAC verify that the as-built equipment will be able to withstand and clear an electrical fault and to maintain protection coordination by both inspections and tests. Because the ITAAC verify the electrical protection features, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.5 Displays, Controls, and Alarms

To ensure that the electrical power system is available when required, ITAAC are required to verify the existence of monitoring and controls for the electrical equipment. The minimum set of displays, alarms, and controls is based on the emergency procedure guidelines. In some cases, additional displays, alarms, and controls may be specified based on special considerations in the design and/or operating experience. The applicant included ITAAC to inspect, retrieve the information (displays and alarms), and control the electrical power system in the main control room (MCR) and/or at locations provided for remote shutdown. Section 14.3.6.4.1.8, “Alternate AC Power Source,” discusses the controls associated with the AAC source. Detection of undervoltage conditions along with the starting and loading of EDGs were included in ITAAC by the applicant, under Items 15 and 17 of DCD Tier 1 Table 2.6.2-3.

The staff identified the following ITAAC regarding displays, controls, and alarms:

Table 14.3-9 Displays, Controls and Alarms ITAAC

Table	Item Number
2.6.1-3	3a
2.6.1-3	3b
2.6.1-3	3c

Table	Item Number
2.6.1-3	3d
2.6.1-3	7b
2.6.2-3	6a
2.6.2-3	6b
2.6.2-3	6c
2.6.2-3	6d
2.6.3-3	11a
2.6.3-3	11b
2.6.4-3	3a
2.6.4-3	3b
2.6.6-1	11

The staff finds the applicant has included ITAAC in the APR1400 electrical design for verifying the existence of monitoring and controls for the electrical equipment. The staff determined that the information in DCD Tier 1 Section 2.6, which addresses displays, controls, and alarms, has been prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the existence of monitoring and controls. The staff finds that the subject ITAAC verify the existence of monitoring and controls for the electrical equipment by both inspections and tests. Because the ITAAC verify the existence of monitoring and controls for the electrical equipment, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

In addition to the Class 1E systems addressed above, other aspects of the electrical design that are deemed to be important to safety and the design commitments (Tier 1) were reviewed by the staff for ITAAC compliance. These electrical systems are discussed in the remaining sections below.

14.3.6.4.1.6 Offsite Power

To ensure that the requirements of GDC 17 for the adequacy and independence of the preferred offsite power sources within the standard design scope are met, an ITAAC should verify the capacity and capability of the offsite sources to feed the Class 1E divisions, and the independence of those sources. ITAAC should be included to inspect the direct connection of the offsite sources to at least one Class 1E division, and to inspect for the independence/separation of the offsite sources, and offsite sources and onsite power sources. ITAAC should include appropriate lightning protection and grounding features associated with

the offsite power system. In addition, the design description should include COL interface requirements for the portions of the offsite power outside of the standard design scope.

The staff reviewed the DCD Tier 1 Chapter 2.6 “Electrical system,” and DCD Tier 1 Chapter 3, “Interface Requirements,” and Tier 2, Section 14.3.2.6 information in the DCD for ITAAC to verify the above requirements. Specifically, DCD Tier 1, Table 2.6.1-3, addresses the ac electric power distribution system ITAAC, including ITAAC to verify the capacity and capability for the offsite power sources to provide power to the Class 1E onsite system.

The staff identified the following ITAAC regarding offsite power:

Table 14.3-10 Offsite Power ITAAC

Table	Item Number
2.6.1-3	1
2.6.1-3	5
2.6.1-3	6
2.6.1-3	7a
2.6.1-3	7b
2.6.1-3	8
2.6.1-3	18a
2.6.1-3	18b
2.6.1-3	19
2.6.1-3	23
2.6.1-3	24
2.6.1-3	25

The staff finds the applicant has included ITAAC in the APR1400 electrical design for verifying the adequacy and independence of the preferred offsite sources. The staff determined that the information in DCD Tier 1, Section 2.6, which addresses offsite power, has been prepared in accordance with the guidance in SRP Section 14.3.6, “Electrical Systems – Inspections, Tests, Analyses, and Acceptance Criteria,” and RG 1.206, which states that the applicant should develop ITAAC to verify capacity and capability of the offsite sources to supply power to the Class 1E divisions and the independence of those sources. The staff finds that the applicant provided ITAAC to verify: 1) the direct connection of the offsite sources to the Class 1E divisions, 2) the capacity and capability of the offsite sources to supply power to the Class 1E divisions, and 3) the independence and separation of offsite sources. Therefore, the staff finds that the subject ITAAC verify capacity and capability of the offsite sources to supply power to

the Class 1E divisions and the independence of those sources by both inspections and tests. Because the ITAAC verify the capacity and capability of the offsite sources to supply power to the Class 1E divisions and the independence of those sources, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.7 Containment Electrical Penetrations

The ITAAC for containment electrical penetrations (both Class 1E and non-Class 1E circuits) verify that the containment electrical penetrations do not fail due to electrical faults and potentially breach the containment. The ITAAC should verify that all electrical containment penetrations are protected against postulated fault currents, i.e., currents greater than the continuous current rating. The applicant in DCD Tier 2, Section 14.3.2.6, has committed to have ITAAC to verify that the containment penetrations are protected against postulated fault currents greater than their continuous current rating. DCD Tier 1 Table 2.6.5-1, "Containment Electrical Penetration Assemblies ITAAC," Items 1, 2, 3, 4, 5, and 6 capture the applicant's containment electrical penetration assemblies ITAAC.

The staff issued RAI 234-8284, Question 14.03.06-5 (ML15296A005), requesting the applicant to provide additional information regarding why an ITAAC was not necessary to confirm that separate electrical penetrations are provided for medium voltage circuits, low voltage circuits, control power circuits, and instrumentation signal circuits.

In its response to RAI 234-8284, Question 14.03.06-5 (ML16020A513), the applicant responded by revising DCD Tier 1, Section 2.6.5.1, "Design Description," and Table 2.6.5-1, to include separation of penetrations per voltage level as a new ITAAC Item 6. The staff finds this acceptable and this issue resolved since there is verification of separate electrical penetrations for the different circuits. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-5. Therefore, RAI 234-8284, Question 14.03.06-5, was resolved and closed.

The staff determined that the information in DCD Tier 1, Section 2.6.5, "Containment Electrical Penetration Assemblies," which addressed containment electrical penetrations, was prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify that all containment electrical penetrations are protected against postulated currents greater than their continuous current rating. The staff finds that the applicant has adequately addressed this item and the information submitted is acceptable. Furthermore, the ITAAC for containment electrical penetrations verify that the containment electrical penetrations do not fail due to electrical faults and potentially breach the containment. Therefore, the staff finds that the subject ITAAC verify that all containment electrical penetrations are protected against postulated currents greater than their continuous current rating by both inspections and tests. Because the ITAAC verify that all containment electrical penetrations are protected against postulated currents greater than their continuous current rating, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.8 Alternate AC Power Source

The ITAAC for AAC power source are required to verify through inspection and testing the availability of the AAC power source for SBO events, and the AAC power sources and its auxiliaries are independent from other ac sources. The applicant in DCD Tier 2 Section 14.3.2.6, has committed to have ITAAC to verify through inspection and testing the AAC power source and its auxiliaries provide reasonable assurance of the availability of the AAC power sources for SBO events as well as its independence from other ac sources. DCD Tier 1 Table 2.6.6-1, "Alternate AC Source ITAAC," Items 1, 2, 3, 4, 5, 6, 7, 8a, 8b, 9, 10, 11, and 12, capture the applicant's commitment.

The staff issued RAI 234-8284, Question 14.03.06-6 (ML15296A005), requesting the applicant to provide additional information regarding the AAC source, specifically why ITAAC are not necessary: (1) to confirm that the AAC source is capable of providing power at the set voltage and frequency to the Class 1E bus after receiving a start signal and (2) to confirm that controls exist in the MCR and remote shutdown room (RSR) to start, stop and synchronize the AAC power source.

In its response to RAI 234-8284, Question 14.03.06-6 (ML16020A513), the applicant revised DCD Tier 1 Section 2.6.6.1, "Design Description," and Table 2.6.6-1 and DCD Tier 2 Table 14.3.4-2, "PRA and Severe Accident Analysis Key Design Features," to add verification that: (1) the AAC is started, brought up to the required voltage and frequency, and (2) all controls required by the design exist in the MCR and RSR to start and stop the AAC gas turbine generator (GTG) and to synchronize the AAC GTG to its respective Class 1E bus. Furthermore, the applicant revised DCD Tier 1 Table 2.6.6-1, Item 2, to verify the AAC source is sized with sufficient capacity to accommodate SBO or LOOP conditions, tests will be performed and a report exists to verify that the AAC is capable of supplying rated power at proper voltage and frequency. The staff finds the response acceptable, the issue resolved since verification is provided to show that the AAC source can be brought up to the required voltage and frequency as well as controls in the MCR and RSR exist to start, stop and synchronize the AAC source to its respective Class 1E buses. The staff confirmed that the DCD was revised as committed in the response to RAI 234-8284, Question 14.03.06-6. Therefore, RAI 234-8284, Question 14.03.06-6, was resolved and closed.

The DCD Tier 1 Table 2.6.6-1, captures the applicant's commitment regarding the inspection of the as-built circuit breakers in series (i.e. one Class 1E circuit breaker at the Class 1E bus and the other non-Class 1E AAC bus) between each AAC power source and the emergency Class 1E power supply systems. The staff finds that the applicant has addressed separation of the non-1E AAC system and the Class 1E electrical system. The staff reviewed the alternate lighting information in DCD Tier 1, Section 2.6.8, and determined it was prepared in accordance with the guidance in SRP Section SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the functional arrangement of electrical power systems provided to support non-safety systems to the extent that those systems perform a significant safety function. Therefore, the staff finds that the applicant has adequately verified the functional arrangement of electrical power systems provided to support non-safety systems to the extent that those systems perform a significant safety function and the information submitted is acceptable.

The staff determined that the information in DCD Tier 1 Section 2.6.6, "Alternate AC Source," has been prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206,

which states that the applicant should develop ITAAC to verify through inspection and testing the AAC power source (GTG) and its auxiliaries to ensure the availability of the AC power source for SBO events as well as its independence from other ac sources. Therefore, the staff finds that the subject ITAAC verify that AAC power source (GTG) and its auxiliaries to ensure the availability of the AC power source for SBO events as well as its independence from other ac sources by both inspections and tests. Because the ITAAC verify that AAC power source (GTG) and its auxiliaries to ensure the availability of the AC power source for SBO events as well as its independence from other ac sources, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.9 Lighting

The ITAAC for lighting are required for verifying the continuity of power sources for plant lighting systems to ensure that portions of the plant lighting remain available during accident events, partial loss of power, and SBO conditions. The applicant in Section 14.3.2.6 of the DCD Tier 2 has committed to have ITAAC to verify the continuity of power sources for plant lighting systems to provide reasonable assurance that a portion of the plant lighting remains available during accident scenarios and power failures. DCD Tier 1 Table 2.6.8-1, "Lighting Systems ITAAC," Items 1, 2, 3, 4, and 5 capture the applicant's commitment.

The staff issued RAI 234-8284, Question 14.03.06-8 (ML15296A005), requesting the applicant to provide additional information regarding why an ITAAC is not necessary to confirm that supports for the emergency lighting fixtures in Class 1E equipment areas can withstand seismic design basis loads.

In its response to RAI 234-8284, Question 14.03.06-8 (ML16020A513), the applicant stated that the lighting system equipment, which includes normal, emergency ac and emergency dc lighting fixtures, located in safety-related areas are classified as seismic Category II. In addition, the applicant stated that because verification of seismic Category II equipment is not included in DCD Tier 1, Chapter 2, "Design Description and ITAAC," the ITAAC for verification of structural integrity of the lighting system equipment located in safety-related areas is not included. DCD Tier 2, Section 3.2.1, "Seismic Classification," defines seismic Category II SSCs and states that seismic Category II SSCs meet augmented quality assurance requirements as described in DCD Tier 2, Section 17.5, "Quality Assurance Program Description – Design Certification." The staff finds this response acceptable and the issue resolved since the lighting fixtures located in areas with Class 1E equipment are classified as seismic Category II and verification of the seismic Category II equipment is not included in DCD Tier 1.

The staff determined that the information in DCD Tier 1 Section 2.6.8, "Lighting Systems" has been prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the continuity of power sources for plant lighting systems to ensure that portions of the plant lighting remain available during accident scenarios and power failures. Therefore, the staff finds that the subject ITAAC verify that continuity of power sources for plant lighting systems to ensure that portions of the plant lighting remain available during accident scenarios and power failures by both inspections and tests. Because the ITAAC verify that continuity of power sources for plant lighting systems to ensure that portions of the plant lighting remain available during accident scenarios and power failures, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as

discussed in Chapters 8 and 9 of this report. Therefore, the staff finds the ITAAC are necessary, sufficient, and meet the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.10 Electrical Power for Non-Safety Plant Systems

The ITAAC are required to ensure that electrical power is provided to support the non-safety plant systems, including the functional arrangement of electrical power systems to the extent that those systems perform a significant safety function. The applicant in DCD Tier 2 Section 14.3.2.6 has committed to have ITAAC to verify the functional arrangement of electrical power systems provided to support non-safety systems to the extent that those systems perform a significant safety function.

The staff identified the following ITAAC regarding electrical power for non-safety plant systems:

Table 14.3-11 Electrical Power for Non-Safety Systems ITAAC

Table	Item Number
2.6.1-3	1

The staff issued RAI 234-8284, Question 14.03.06-1 (ML15296A005), requesting the applicant to provide additional information on the DCD Tier 2 Section 14.3.2.6, "ITAAC for Electrical Systems," Part j, discussion of electrical power for non-safety plant systems and whether this includes testing of the main generator system.

In its response to RAI 234-8284, Question 14.03.06-1 (ML16020A513), the applicant stated that testing of the main generator is included in the initial test program as part of the unit main power system test, as described in DCD Tier 2, Section 14.2.12.1.110, "Unit Main Power System Test." Since the initial test program of the unit main power system, as discussed in DCD Tier 2, Section 14.2.12.1.110, demonstrates: (1) the ability of the main generator to generate designed voltage and (2) that the unit main power system is capable of supplying power to designated loads, the staff considers the issue resolved.

The staff reviewed the electrical systems and equipment in DCD Tier 1, Section 2.6, and determined that it was prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the functional arrangement of other electrical systems and equipment that are not part of the Class 1E system, but are included to improve the reliability of the individual Class 1E systems. Therefore, the staff finds that the subject ITAAC verifies electrical power for non-safety plant systems by both inspections and tests. Because the ITAAC verifies electrical power for non-safety plant systems, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC is necessary, sufficient, and meets the requirements of 10 CFR 52.47(b)(1).

14.3.6.4.1.11 Physical separation and independence

Design descriptions in the APR1400 DCD also address electrical equipment that are not part of the Class 1E system, but are included to improve the reliability of the individual Class 1E systems. Also, brief design descriptions are included for the non-Class 1E portions of the electrical system that power the balance of plant loads and these generally focus on the aspects

needed to support the Class 1E portion. The applicant has provided description of these non-Class 1E systems that power the balance of the plant loads and are included to improve the reliability of the individual Class 1E divisions. Appendix A to RG 1.206, (pages C.II.1-A-19-C.II.1-A-22) lists ITAAC for ac distribution equipment in items A through P. Similarly, SRP Section 14.3, Appendix C.II, lists electrical systems review checklist that should be included in the Tier 1 information. The equipment and systems identified in the ITAAC in the DCD do not include several of the ac distribution equipment that are identified by the RG 1.206 and SRP review checklists.

The staff identified the following ITAAC regarding physical separation and independence of non-Class 1E portions of the electrical system:

Table 14.3-12 Physical Separation and Independence ITAAC

Table	Item Number
2.6.1-3	1

DCD Tier 1, Figure 2.6.1-1 depicts, in part, the non-Class 1E and Class 1E AC electrical power system.

The staff reviewed the electrical systems and equipment in DCD Tier 1, Section 2.6, and determined that it was prepared in accordance with the guidance in SRP 14.3, SRP 14.3.6, and RG 1.206, which states that the applicant should develop ITAAC to verify the functional arrangement of other electrical systems and equipment that are not part of the Class 1E system, but are included to improve the reliability of the individual Class 1E systems. The staff finds that the subject ITAAC verifies the functional arrangement of other electrical systems and equipment that are not part of the Class 1E system by both inspections and tests. Because the ITAAC verifies the functional arrangement of other electrical systems and equipment that are not part of the Class 1E system, the staff finds that the as-built systems will meet the requirements of GDC 17 and 18, as discussed in Chapter 8 of this report. Therefore, the staff finds the ITAAC is necessary, sufficient, and meets the requirements of 10 CFR 52.47(b)(1).

14.3.6.5 Combined License Information Items

The DCD Tier 2, Section 14.3.2.6 contains no COL information items.

14.3.6.6 Conclusion

The staff has reviewed all the relevant ITAAC information that is applicable to the electrical power system design and evaluated its compliance with 10 CFR 52.47(b)(1), 10 CFR 50.49, 10 CFR 50.63, GDC 17, and GDC 18, and its conformance with relevant NRC guidance in SRP Section 14.3. On the basis of the information provided in the DCD, the general description of ITAAC for electrical review areas found in DCD Tier 1, Sections 2.6.1 through 2.6.8 and DCD Tier 2, Chapter 14, Section 14.3.2.6, the staff finds that the APR1400 Tier 1 has provided sufficient information to satisfy the guidance in SRP Section 14.3. Therefore, the staff concludes that the ITAAC provides reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, then a facility referencing the certified design can be constructed and operated in compliance with the DC and applicable regulations.

DCD Tier 1 Section 2.6.9, "Communication Systems," and Table 2.6.9-1, "Communication Systems ITAAC," are evaluated in Sections 9.5.2 and 14.3.12 of this SER.

14.3.7 Plant Systems – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.7.1 Introduction

The DCD Tier 2, Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," discusses the selection criteria and methods used to develop the DCD Tier 1 information and the ITAAC. DCD Tier 1 chapters include the portion of the design-related information contained in a generic DCD that is approved and certified by the DC rule, 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The design descriptions, interface requirements, and site parameters are derived from DCD Tier 2 information.

The staff's evaluation addresses ITAAC related to most of the fluid systems that are not part of the core reactor systems. The specific areas addressed in this section include:

- New and spent fuel handling systems; power generation systems; air systems; cooling water systems; radioactive waste systems; and heating, ventilation and air conditioning (HVAC) systems; and
- Issues which affect multiple structures, systems, and components (SSCs), such as equipment qualification and protection from fires, floods and wind-borne missiles.

The staff reviewed the ITAAC with respect to plant systems described in the DCD in accordance with NUREG-0800, SRP for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition", Sections 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria," and 14.3.7, "Plant Systems – Inspections, Tests, Analyses, and Acceptance Criteria." The staff reviewed the proposed ITAAC to determine whether these ITAAC are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC is built and will operate in accordance with the DC, the Atomic Energy Act of 1954, as amended, and the NRC's regulations. In addition, the staff reviewed the justification that compliance with the interface requirements is verifiable through ITAAC, and also reviewed the method that the applicant will use for verification of the interface requirements.

The scope of the review in this subsection is the plant systems ITAAC included in the DCD Tier 1 and listed in Table 14.3-13, "Cross References for the Staff's Evaluation of Plant Systems ITAAC," of this SER, that are significantly related to normal operation, transients, and accidents. The detailed evaluation of each plant system's proposed ITAAC is in the SER section identified in Table 14.3-13. For systems that did not contain any proposed ITAAC, the staff verified that no ITAAC were required.

14.3.7.2 Summary of Application

DCD Tier 1: The applicant provided design descriptions for plant systems in DCD Tier 1 Section 2.7, "Plant Systems." DCD Tier 1, Chapter 1, "Introduction," provides definitions, general provisions, and a legend for figures, acronyms, and abbreviations.

Table 14.3-13 Cross References for the Staff's Evaluation of Plant Systems ITAAC

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
2.7.1.1	Turbine Generator	2.7.1.1-1	10.2	10.2
2.7.1.2	Main Steam System	2.7.1.2-4	10.3	10.3
2.7.1.3	Turbine Bypass System	No entry for this system		
2.7.1.4	Condensate and Feedwater System	2.7.1.4-4	10.4.7	10.4.7
2.7.1.5	Auxiliary Feedwater System	2.7.1.5-4	10.4.9	10.4.9
2.7.1.6	Condenser Vacuum System	No entry for this system		
2.7.1.7	Circulating Water System	No entry for this system		
2.7.1.8	Steam Generator Blowdown System	2.7.1.8-3	10.4.8	10.4.8
2.7.1.9	Auxiliary Steam System	2.7.1.9-1	10.4.10	10.4.10
2.7.2.1	Essential Service Water System	2.7.2.1-4	9.2.1	9.2.1
2.7.2.2	Component Cooling Water System	2.7.2.2-4	9.2.2	9.2.2
2.7.2.3	Essential Chilled Water System	2.7.2.3-4	9.2.7	9.2.7
2.7.2.4	Plant Chilled Water System	2.7.2.4-1	9.2.7	9.2.7
2.7.2.5	Equipment and Floor Drainage System	2.7.2.5-4	9.3.3	9.3.3

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
2.7.2.6	Process and Post-Accident Sampling System	2.7.2.6-4	9.3.2	9.3.2
2.7.2.7	Turbine Generator Building Closed Cooling Water System	No entry for this system		
2.7.2.8	Turbine Generator Building Open Cooling Water System	No entry for this system		
2.7.3.1	Control Room HVAC System	2.7.3.1-3	9.4.1	9.4.1
2.7.3.2	Fuel Handling Area HVAC System	2.7.3.2-3	9.4.2	9.4.2
2.7.3.3	Auxiliary Building Clean Area HVAC System	2.7.3.3-3	9.4.3	9.4.3
2.7.3.4	Turbine Generator Building HVAC System	No entry for this system		
2.7.3.5	Engineered Safety Features Ventilation System	2.7.3.5-3	9.4.5	9.4.5
2.7.3.6	Reactor Containment Building HVAC System and Reactor Containment Building Purge System	2.7.3.6-1	9.4.6	9.4.6
2.7.3.7	Compound Building HVAC System	No entry for this system		

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
2.7.4.1	New Fuel Storage	2.7.4.1-1	9.1.1 and 9.1.2	9.1.1 and 9.1.2
2.7.4.2	Spent Fuel Storage	2.7.4.2-1	9.1.1 and 9.1.2	9.1.1 and 9.1.2
2.7.4.3	Spent Fuel Pool Cooling and Cleanup System	2.7.4.3-4	9.1.3	9.1.3
2.7.4.4	Light Load Handling System	2.7.4.4-2	9.1.4	9.1.4
2.7.4.5	Overhead Heavy Load Handling System	2.7.4.5-1	9.1.5	9.1.5
2.7.5.1	Compressed Air and Gas Systems	2.7.5.1-1	9.3.1	9.3.1
2.7.5.2	Fire Protection System	2.7.5.2-3	9.5.1	9.5.1
2.7.5.3	Domestic Water and Sanitary Systems	No entry for this system		
2.7.6.1	Liquid Waste Management System	2.7.6.1-2	11.2	11.2
2.7.6.2	Gaseous Waste Management System	2.7.6.2-4	11.3	11.3
2.7.6.3	Solid Waste Management System	2.7.6.3-2	11.4	11.4
2.7.6.4	Process and Effluent Radiation Monitoring and Sampling System	2.7.6.4-3	11.5	11.5
2.7.6.5	Area Radiation Monitoring System	2.7.6.5-3	14.3.8	14.3.8

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
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System design descriptions include relevant information for the ITAAC, including key design features, seismic and American Society of Mechanical Engineers (ASME) code classifications used in design and construction, system operation, alarms, displays and controls logic for system actuation, interlocks, Class 1E power sources and divisions, equipment to be qualified for harsh environment, interface requirements, and numeric performance values. The design description contains tables and figures that are referenced in the Design Commitment column of the ITAAC tables listed above.

The applicant organized its Tier 1 information in a manner similar to that used for the evolutionary designs as described in SRP Section 14.3 and Regulatory Guide (RG) 1.206, Section C.II.1-1, "Design Descriptions and ITAAC Format and Content." The ITAAC tabular format and content for the plant systems follows the NRC recommended format described and presented in RG 1.206, Table C.II.1-1, "Sample ITAAC Format." The ITAAC are presented in a three-column table that includes the proposed commitment to be verified (column 1), method by which the licensee will verify (column 2), and specific acceptance criteria for the inspections, tests, or analyses (column 3) that, if met, demonstrate the licensee has met the design requirements/commitment in column 1.

DCD Tier 2: The DCD Tier 2, Section 14.3 provides a general description of the APR1400 ITAAC including its relationship to other DCD Tier 1 information, the selection criteria, and content.

The applicant specified that the ITAAC for plant systems were prepared in accordance with the guidance in RG 1.206, Section C.II.1; NUREG-0800, SRP Section 14.3; and NUREG-0800 SRP Section 14.3.7.

ITAAC: The applicant provided ITAAC for plant systems in DCD Tier 1 sections as listed above in Table 14.3-13.

TS: There are no TS for this area of review.

14.3.7.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Sections 14.3 and 14.3.7 of NUREG-0800. Review interfaces with other SRP sections are also identified in this SRP section.

The applicable regulatory requirements are as follows:

- Title 10 CFR 52.47(b)(1), "Contents of applications; technical information," as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC is built and will operate in accordance with the

DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations.

14.3.7.4 Technical Evaluation

The staff performed its review of the system and non-system based ITAAC in accordance with the SRP Section 14.3 sections described above and SRP Section 14.3.7, particularly the applicable review procedures identified in each SRP section, as well as the guidance provided by RG 1.206, Section C.II.1. The staff review examined the ITAAC to ensure that they can be inspected by the organization holding the combined license and closed out by the staff. The review examined the phrasing and format of the ITAAC to determine if they were consistent (i.e., the Commitment Wording; the Inspection, Test, or Analysis; and the Acceptance Criteria are parallel and in agreement). In addition, the staff determined that the DCD Tier 1 ITAAC items were derived from the DCD Tier 2 information.

14.3.7.4.1 ITAAC Development Criteria

The RG 1.206, Section C.II.1.2.7, "ITAAC for Plant Systems," describes the ITAAC development for plant systems and identifies the aspects that need to be verified through ITAAC, which are related to: new and spent fuel handling systems; power generation systems; air systems; cooling water systems; radioactive waste systems and HVAC systems; as well as issues which affect multiple SSCs, such as equipment qualification and protection from fires, floods and wind-borne missiles.

Since the features for ITAAC development criteria listed in DCD Tier 2, Section 14.3.2.7, "ITAAC for Plant Systems," are identical to those listed in RG 1.206, Section C.II.1.2.7, "ITAAC for Plant Systems," for an active plant, the staff concludes that the applicant adequately identified the general aspects to be verified through ITAAC in DCD Tier 2, Section 14.3.2.7, including the ITAAC to verify the top-level design features.

14.3.7.4.2 Design Descriptions and Figures

The staff reviewed the APR1400 DCD design description and figures for the plant systems in Tier 1 using the guidance provided in SRP Section 14.3, including Appendix C, "Detailed Review Guidance, Fluid Systems Review Checklist," and SRP Section 14.3.7.

14.3.7.4.3 Standard and System Specific ITAAC Entries

The staff reviewed the APR1400 DCD Tier 1 ITAAC entries in Section 2.7, "Plant Systems," using the guidance provided for standard and system specific ITAAC entries contained in SRP Sections 14.3 and 14.3.7.

14.3.7.4.4 Plant Systems Tier 1 Section 2.7

In performing the evaluation of the ITAAC items, the staff considered the safety function significance of each item with regard to its adequacy and consistent with DCD Tier 2, Section 14.2, "Initial Plant Test Program."

In addition, the staff used the SRP sections identified in SRP Section 14.3.7 that have a potential impact on the plant systems ITAAC sections. These included the following SRP sections that provide information related to SRP Section 14.3.7:

- SRP Section 14.3 – general guidance information on ITAAC
- SRP Section 14.3.2 – information regarding the ability of SSCs to withstand various natural phenomena
- SRP Section 14.3.3 – information for piping design
- SRP Section 14.3.5 – information for instrumentation and controls
- SRP Section 14.3.6 – information for electrical systems and components

The staff assessed the plant systems ITAAC items for the following DCD Tier 2 sections related to HVAC systems in accordance with the applicable procedures and guidance provided in SRP Sections 14.3 and 14.3.7:

- Section 9.4.1, “Control Room HVAC System”
- Section 9.4.2, “Fuel Handling Area HVAC System”
- Section 9.4.3, “Auxiliary Building Clean Area HVAC System”
- Section 9.4.4, “Turbine Generator Building HVAC System” (No ITAAC for 9.4.4)
- Section 9.4.5, “Engineered Safety Features Ventilation System”
- Section 9.4.6, “Reactor Containment Building HVAC System and Purge System”
- Section 9.4.7, “Compound Building HVAC System” (No ITAAC for 9.4.7)

The staff’s specific evaluation results of the above DCD Tier 2 sections relating to the adequacy of the ITAAC listed in Table 14.3-13 are presented in the individual technical evaluation of each of the above sections in this SER.

14.3.7.4.5 Interface Requirements

Interface requirements are defined for: (a) systems that are entirely outside the scope of the design and (b) the out-of-scope portions of those systems that are only partially within the scope of the standard design. Except for the Essential Service Water System and the Ultimate Heat Sink, the applicant has included the plant systems’ designs within the complete scope of the standard design. The staff’s review of the interface requirements for these two systems are in sections 14.3.1 and 9.2 of this SER.

14.3.7.5 Combined License Information Items

The DCD Tier 2 Section 14.3.2.7 contains one COL item pertaining to plant systems. The staff agrees that it is the COL applicant’s responsibility to provide ITAAC for the site-specific portions of these systems. Therefore, the staff finds COL 14.3(1) acceptable. The staff concluded that no additional COL items were needed.

Table 14.3-14 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 14.3(1)	The COL applicant is to provide the ITAAC for the site-specific portion of the plant systems specified in DCD Tier 2, Subsection 14.3.3.	14.3

14.3.7.6 Conclusion

Based on the review in this SER Section, as well as those SER Sections discussed therein, staff finds that if the ITAAC for the systems identified in Table 14.3.7-1 are performed and the acceptance criteria met, there is reasonable assurance the APR1400 standard design nuclear power plant will be built and operated in accordance with the design.

14.3.8 Radiation Protection– Inspections, Tests, Analyses, and Acceptance Criteria

14.3.8.1 Introduction

SRP Section 14.3.8, “Radiation Protection - Inspections, Tests, Analyses, and Acceptance Criteria,” addresses the review of ITAAC for radiation protection for the APR1400. The staff reviewed the proposed ITAAC to determine whether a plant that incorporates the DC can be built and operated in accordance with the DC and NRC regulations.

The scope of the radiation protection Tier 1 and ITAAC review includes:

- Radiation shielding provided by structures and components
- Radiation monitoring systems
- Ventilation systems (as they relate to radiation protection design features)
- Design features and processes for radiation protection

Tier 2, Chapter 11, “Radioactive Waste Management,” of the DCD provides information on effluent releases, public dose, the design of radioactive waste management systems, radioactive waste, and process and effluent monitors. Tier 2, Chapter 12, “Radiation Protection,” of the DCD provides information on the radiation protection design features of the APR1400, in-plant radiation sources, and information on occupational radiation exposure. Details on compliance with radiation protection regulations (including 10 CFR Part 20, “Standards for Protection Against Radiation,” and applicable portions of 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants”) are discussed in the Chapter 11 and 12 SER sections, which review those DCD Tier 2 chapters and will therefore not be discussed in detail in this section. The purpose of this SER Section is to document the staff’s review of the radiation protection design features provided in Tier 1 of the DCD, including ITAAC, and to determine if the appropriate Tier 1 information and ITAAC are included in the DCD.

14.3.8.2 Summary of Application

DCD Tier 1: The applicant provided design descriptions for radiation protection in DCD Tier 1, Section 2.8, “Radiation Protection.” Other sections of Tier 1 that include information related to radiation protection include Section 2.4.7, “Leakage Detection System”; Section 2.7.3, “HVAC

Systems”; Section 2.7.6.4, “Process and Effluent Radiation Monitoring and Sampling System”; and Section 2.7.6.5, “Area Radiation Monitoring System.”

DCD Tier 2: DCD Tier 2, Section 14.3, “Inspection, Tests, Analyses, and Acceptance Criteria,” provides a general description of the APR1400 ITAAC including its relationship to other DCD Tier 1 information, the selection criteria, and content. DCD Tier 2, Chapter 11, provides design information for the radioactive waste management systems and process and effluent monitors, as well as information on normal expected effluent releases to the public during normal operations. DCD Tier 2, Chapter 12, provides radiation protection design information, including design-related aspects supporting the APR1400 as low as is reasonably achievable (ALARA) and radiation protection programs, information related to in-plant radiation sources, and worker dose assessment. Chapter 12 also includes COL information items on the ALARA and radiation protection programs, which are to be addressed by the COL applicant. In accordance with SRP 14.3.8, Tier 1 includes significant Tier 2 radiation protection design information.

ITAAC: The staff reviewed the radiation protection ITAAC in Tier 1, Section 2.8, as well as ITAAC relevant to radiation protection in Tier 1, Sections 2.2.1, 2.4.7, 2.7.2.5, 2.7.3, 2.7.4.2, 2.7.4.3, 2.7.4.4, 2.7.6.1, 2.7.6.4, 2.7.6.5, 2.8, and 2.11.4. The specific ITAAC items reviewed in these sections are discussed in the SER below.

Technical Specifications (TS): There are no TS for this area of review.

14.3.8.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are specified in Sections 14.3.8 and 12.0 of NUREG-0800. Review interfaces with other SRP sections also can be found in NUREG-0800, Section 14.3.8.

The applicable regulatory requirements are as follows:

1. Title 10 CFR Part 50, Appendix A, GDC 19, “Control Room,” as it relates to the requirement, in part, that adequate radiation protection be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 0.05 Sieverts (5 rem) whole body, or its equivalent to any part of the body, for the duration of the accident.
2. Title 10 CFR Part 50, Appendix A, GDC 61, “Fuel Storage and Handling and Radioactivity Control,” as it relates to the requirement that occupational radiation protection aspects of fuel storage, fuel handling, radioactive waste, and other systems that may contain radioactivity, be designed such that they ensure adequate safety during normal and postulated accident conditions, with suitable shielding and appropriate containment and filtering systems.
3. Title 10 CFR Part 50, Appendix A, GDC 63, “Monitoring Fuel and Waste Storage,” as it relates to the requirement, in part, that appropriate systems be provided for the fuel storage and radioactive waste systems and associated handling areas to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels.

4. Title 10 CFR Part 50, Appendix A, GDC 64, "Monitoring Radioactivity Releases," as it relates to the requirement that the containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs be monitored for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.
5. Title 10 CFR 20.1101, "Radiation protection programs," as it relates to the requirement that the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA.
6. Title 10 CFR 20.1201, "Occupational dose limits for adults," as it relates to the requirement, in part, that with the exception of planned special exposures that the annual dose limit for adults is equal to a total effective dose equivalent of 5 rems, or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems.
7. Title 10 CFR 20.1406, "Minimization of contamination," Subpart B, as it relates to applicants for standard design approvals describing in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.
8. Title 10 CFR 20.1501, "General," as it relates to the requirement, in part, that licensees make surveys that are reasonable under the circumstances to evaluate, the magnitude and extent of radiation levels, the concentrations or quantities of radioactive material, and the potential radiological hazards.
9. Title 10 CFR 20.1701, "Use of process or other engineering controls," as it relates to the requirement that the applicant shall use, to the extent practical, process or other engineering controls to control the concentration of radioactive material in air.
10. Title 10 CFR 50.34(f)(2)(xvii), "Contents of applications; technical information," as it relates to the requirement, in part, that instrumentation be provided, that can measure, record and readout in the main control room containment radiation intensity (high level).
11. Title 10 CFR 50.48 "Fire protection," as it relates to fire induced radiological hazards to the public and radiation workers.
12. 10 CFR 52.47(b)(1), "Contents of applications; technical information," as it relates to the requirement that the APR1400 application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC is built and will operate in accordance with the

DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations.

SRP Section 14.3.8 refers to SRP Section 14.3 for guidance on the content and format of ITAAC. Relevant portions of SRP 14.3 include:

1. SRP Section 14.3, Appendix A, "Information on Prior Design Certification Reviews," IV.1.A, "Definitions."
2. SRP Section 14.3, Appendix A, IV.2, "General Provisions."
3. SRP Section 14.3, Appendix A, IV.3, "Legend for Figures and Acronyms and Abbreviations."
4. SRP Section 14.3, Appendix A, IV.4.B, "ITAAC," Defines three column format and explains ITAAC terminology.
5. SRP Section 14.3, Appendix C, "Fluid Systems Review Checklist," II.C, "Style Guidelines for ITAAC."
6. SRP Section 14.3, Appendix C, "Instrumentation and Control Systems Review Checklist," III, "Reviewer Check Lists."
7. SRP Section 14.3, Appendix D, "ITAAC Entries."

14.3.8.4 Technical Evaluation

The applicant provided design-basis information, including associated tables and figures, in accordance with the selection criteria and methodology for developing DCD Tier 1 information, as described in DCD Tier 2, Section 14.3. The applicant organized the DCD Tier 1 information in the systems, structures, and topical areas format shown in the DCD Tier 1, Table of Contents. The staff reviewed the DCD Tier 1 information and ITAAC provided by the applicant in accordance with SRP Section 14.3.8.

14.3.8.4.1 Radiation Shielding

SRP Section 14.3.8 indicates that the criteria in Tier 1 should ensure that the radiation shielding design (as provided by the plant structures or by permanent or temporary shielding included in the design) is adequate so that the maximum radiation levels in plant areas are commensurate with the areas' access requirements (and the requirements of 10 CFR Part 20). SRP Section 14.3.8 also specifies that the review should ensure that Tier 1 clearly describes the SSCs that provide a significant radiation protection function, including the key performance characteristics and safety functions of SSCs based on their safety significance. Therefore, the staff reviewed Tier 1 of the APR1400 DCD to ensure that important radiation shield barriers were included in Tier 1 of the DCD. Barriers relied upon to attenuate radiation from potential very high radiation areas and vital areas that may require access during accident conditions are considered by the staff to be examples of significant radiation barriers, which should be included in Tier 1. However, the initial application provided no ITAAC to verify the plant's shielding materials or thicknesses. Instead, the applicant provided a proposed ITAAC indicating that

radiation levels specified for various plant areas will be met, based on a future report generated when the plant has been built (Tier 1, Table 2.8-2, item 1). This ITAAC was unverifiable because the radiation zones for specific rooms were not provided or referenced in Tier 1 or the ITAAC. In Tier 2, Section 12.3, the applicant already provides minimum shielding thicknesses based on an analysis of radiation sources in the plant. It is more appropriate if the radiation shielding ITAAC verified that the shielding material and thicknesses meet the criteria in Tier 2, Section 12.3. Therefore, Tier 1, Table 2.8-2, item 1, was unacceptable.

The staff issued RAI 116-8054, Question 14.03.08-1 (ML15208A511) requesting that the applicant modify Tier 1, Table 2.8-2, Item 1, to provide an ITAAC to verify the shield barrier thickness. The staff also requested that this ITAAC verify that appropriate shielding material is used, that shielding thicknesses are verifiable in the ITAAC, and that any doors relied on for radiation attenuation are listed in the ITAAC.

In its response to RAI 116-8054, Question 14.03.08-1 (ML16036A078), the applicant proposed revising the acceptance criteria to Tier 1, Table 2.8-2, Item 1; however, the revisions did not include any specific shielding information. In a clarification call with the applicant, the staff explained that they were expecting the applicant to provide specific radiation shielding information, including the composition of the shielding materials and the thicknesses, for important shields in Tier 1. The staff noted that Tier 1, Section 2.2, Table 2.2.1-1, already provided some structural thicknesses, but the applicant indicated that these thicknesses were not provided for the purposes of radiation protection. Therefore, the applicant agreed to revise the response to Question 14.03.08-1, to provide shielding information for important radiation shields in Tier 1, and to provide the basis for the shields selected to be included in Tier 1.

In its response to RAI 116-8054, Question 14.03.08-1, the applicant also proposed adding a new ITAAC to Tier 1, Table 2.8-2. The purpose of the proposed ITAAC was to ensure that the Compound Building truck bay doors provide adequate radiation shielding during waste loading and unloading operations. It is necessary to ensure appropriate shielding for the doors in order to ensure that doses to the public will be kept ALARA and to ensure that the requirements of 10 CFR 20.1301 (particularly 10 CFR 20.1301(e)) are met. In its response to RAI 14-7858, Question 12.03-4 (ML15201A377), the applicant previously indicated that the COL applicant will provide the material composition and shielding properties of these doors (COL 12.3(1)). It is not appropriate for a DCD applicant to provide an ITAAC for a site specific design feature which is to be provided by the COL applicant. Therefore, in the clarification call, the applicant indicated that they would revise the response to Question 14.03.08-1 to remove the proposed ITAAC for the truck bay doors from Table 2.8-2 and would instead modify COL item 12.3(1) to indicate that the COL applicant is to provide an ITAAC for these doors (see the discussion related to Revision 2 below).

In Revision 1 of its response to RAI 116-8054, Question 14.03.08-1 (ML17006A392), the applicant proposed to update DCD Tier 1 Table 2.2.1-1a, to provide additional information about significant radiation shields such as several missing important radiation shield walls and a large number of floor thicknesses for the Auxiliary Building. In addition, the applicant proposed to add Table 2.2.1-1a to Tier 1 to provide the minimum required shielding thicknesses for significant radiation shield walls in the Compound Building and outdoor tanks containing radioactive material (i.e. the boric acid storage tank and holdup tank). The shielding thicknesses added included most of the significant radiation shielding barriers in the plant. However, some of the aspects of radiation shielding were still under review as part of the Chapter 12 radiation

protection review, and some of the shielding barriers had been revised and a few barriers had been added to Chapter 12. Therefore, some of the Tier 1 information regarding radiation shielding thicknesses in Revision 1 were inadequate.

In Revision 2 of its response to RAI 116-8054, Question 14.03.08-1 (ML17248A371), the applicant removed ITAAC item 4 in Tier 1 Table 2.8-2, related to the shielding design of the Compound Building truck bay door, because the design of the truck bay door is to be provided by the COL applicant, as specified in Tier 2, Section 12.3, COL 12.3(3). As part of the response, the applicant also revised COL 12.3(3) to specify that the COL applicant is to provide an ITAAC for the radiation shielding for the shield doors that are to be provided by the COL applicant, including the truck bay door. The staff finds these revisions to be acceptable.

In Revision 2 of its response, the applicant also proposed to update the shielding thicknesses in Tier 1 Table 2.2.1-1a, because many of the minimum shield thicknesses for the Compound Building had been revised in Chapter 12 RAI responses. This response makes the Tier 1 information consistent with Tier 2, which is acceptable.

However, as part of the proposed Tier 1 update, to Section 2.8.2, the applicant specified that Table 2.2.1-1 and Table 2.2.1-1a provides radiation shielding thicknesses for the Auxiliary Building and Compound Building, but the text added to Section 2.8.2 did not mention the Reactor Containment Building shielding, which was also provided in Table 2.2.1-1. Finally, some of the important shielding thicknesses necessary to ensure appropriate radiation shielding for vital area access routes, provided in the applicant's response to RAI 544-8756, Question 12.03-55, Revision 1 (ML17248A233) were not included in Tier 1, in this response.

In Revision 3 of its response to RAI 116-8054, Question 14.03.08-1 (ML17257A546), the applicant proposed to update Tier 1, Section 2.8.2 to clarify that Table 2.2.1-1 provides radiation shielding wall and floor thicknesses for the Reactor Containment Building and Auxiliary Building and that Table 2.2.1-1a provides radiation shielding wall and floor minimum thicknesses for the Compound Building. In its response, the applicant also included important shielding thicknesses, including shield barriers associated with vital area access routes, which had previously been missing from Tier 1, Table 2.2.1-1. However, in Revision 3 of its response, the applicant also revised several shield barrier thicknesses and parameters in Tier 1, Table 2.2.1-1. In reviewing these changes, staff identified that the revised shielding thicknesses provided for walls associated with Rooms 068-A10A and 068-A07A and floor slabs for Rooms 100-A13A and 100A-13B were less than the minimum required thicknesses specified for these rooms in DCD Tier 2, Table 12.3-4.

In Revision 4 of its response to RAI 116-8054, Question 14.03.08-1 (ML17268A038), the applicant proposed to correct the thicknesses for Rooms 068-A10A, 100-A13A, and 100-A13B, to make the thicknesses the same, or greater than the minimum thicknesses in Tier 2, which had previously been evaluated by the staff and found to be acceptable. For Room 068-07A, the applicant added new information to Tier 2, Table 12.3-4, to provide separate shielding information for the labyrinth wall and the west wall within column line from AA to AD and between column lines 25 to 26. The applicant specified that the appropriate shielding thicknesses for the labyrinth design was considered in the radiation zoning analysis. The staff also found that the zoning was appropriate with the west wall thickness specified. Therefore, these thicknesses are acceptable. The Tier 1 information was found to be consistent with the Tier 2 information. As a result, the staff found the response to be acceptable. Based on a

review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 116-8054, Question 14.03.08-1 was resolved and closed.

In addition, the applicant provided Tier 1, Table 2.8-2, item 3 to verify that the shielding design is adequate to ensure that operators can take actions to mitigate and recover from design basis accidents and that doses will not exceed the 5 rem limit provided in GDC 19, during design basis accidents. The staff found this shielding ITAAC acceptable to verify that the post-accident dose to operators meets the applicable regulations.

14.3.8.4.2 Radiation Protection Features Associated with Fuel Handling and Storage

The majority of occupational radiation exposure typically occurs during refueling outages, with exposure to plant personnel from the movement of irradiated fuel and in-core components being a potentially significant contributor to this dose. Furthermore, the plant should be designed with appropriate radiation protection design features during potential accident conditions, in accordance with 10 CFR Part 50, Appendix A, GDC 61. Therefore, the staff reviewed Tier 1 information and ITAAC related to spent fuel handling and storage, to ensure that significant radiation protection design features were included in Tier 1 of the DCD. The design includes the refueling machine, spent fuel handling machine, and spent fuel transfer machine to handle spent fuel. However, it was unclear to the staff if the control element assembly change platform and elevator could be used to transfer spent fuel assemblies, and the staff could find no information in the DCD (including Tier 1) clearly specifying what equipment would be used to handle fuel.

The staff issued RAI 23-7929, Question 12.02-6 (ML15174A324), requesting that the applicant describe all areas where fuel will be handled or stored and update Tier 1 to clarify where fuel will be handled and stored, so that the staff can adequately review fuel storage and handling areas in both Tier 1 and Tier 2.

In its response to RAI 23-7929, Question 12.02-6 (ML15223B087), the applicant updated Tier 1, Table 2.7.4.4-1 to specify that the only equipment or locations used to handle or store fuel (other than the new fuel racks, spent fuel racks, reactor core, and upender (for transferring between the spent fuel pool (SFP) and the core)) are the refueling machine, spent fuel handling machine, new fuel elevator, and fuel handling hoist of overhead crane, and that no other equipment, locations, or areas will be used to do so at APR1400 plants. New fuel is not a significant radiological concern prior to activation, and transferring fuel on the upender occurs at the bottom of the refueling pool and refueling canal and inside the fuel transfer tube, so there would be sufficient water shielding in these areas during transfer. For these reasons, no specific ITAAC for radiation protection purposes is needed for this equipment, other than ITAAC for the structural shielding barriers for the fuel transfer tube, which is provided in DCD Tier 1, Table 2.2.1-1. The staff's evaluation of RAI 23-7929, Question 12.02-6, can be found in Section 12.2 of this SER.

However, spent fuel assemblies and other in-core components being transferred by the refueling machine and spent fuel machine could be a significant source of radiation exposure to plant personnel. In reviewing ITAAC associated with fuel handling features, the staff could not find an ITAAC to verify that there would be interlocks provided on the refueling machine or spent fuel machine to ensure that it cannot be raised to a height that would result in operators being exposed to a dose rate exceeding 2.5 mrem/hour during fuel movement, in accordance with

ANSI/ANS-57.1-1992, "Design Requirements for Light Water Reactor Fuel Handling Systems," which is referenced by the applicant. In addition, RG 8.38, "Control of Access to High and Very High Radiation Areas in Nuclear Power Plants," specifies that control measures should be implemented to ensure that activated materials are not raised above or brought near the surface of the pool. The staff issued RAI 116-8054, Question 14.03.08-3 (ML15208A511), requesting the applicant to provide this information.

In its response to RAI 116-8054, Question 14.03.08-3 (ML15244B378), the applicant indicated that ITAAC item 8 of Table 2.7.4.4-2 specifies that the refueling machine and spent fuel handling machine are provided with mechanical stops that restrict the withdrawal of the fuel assemblies. However, this ITAAC does not specify an acceptable lift height or dose rate to an operator from a raised fuel assembly. The ITAAC should ensure that the dose to an operator from raised fuel assemblies and control elements will not exceed 2.5 mrem/hour in accordance with ANSI/ANS-57.1-1992. Therefore, RAI 116-8054, Question 14.03.08-3, was closed and the staff issued RAI 310-8355, Question 14.03.08-12 (ML15320A348), requesting that the applicant provide this information.

In its response to RAI 310-8355, Question 14.03.08-12 (ML16285A531), the applicant proposed providing information in Tier 1 Section 2.7.4.4 and ITAAC in Tier 1 Table 2.7.4.4-2. The information specified that the refueling machine, spent fuel handling machine, and control element assembly change platform include mechanical stops that restrict withdrawal of the spent fuel assemblies or control element assemblies above a minimum safe water cover depth of nine feet (2.7 meters). The applicant indicated that nine feet of water shielding ensures that an operator on the refueling platform is exposed to less than 2.5 mrem/hour, when at the lower limit of the normal operating water level, in accordance with ANSI/ANS-57.1-1992. The applicant proposed that the ITAAC acceptance criteria would be that the equipment provides at least nine feet of water cover depth. In staff's view, the proposed Tier 1 information and ITAAC wording would be acceptable if nine feet of water was all that was necessary to meet the 2.5 mrem/hour dose criteria. However, in its response to RAI 396-8463, Question 12.03-50 (ML16083A547), the applicant indicated that in addition to the nine feet of water, additional shielding from the fuel handling equipment was also needed to reduce the dose to operators to less than 2.5 mrem/hour. In Revision 1 of RAI 396-8463, Question 12.03-50 (ML16232A504), the applicant provided information demonstrating that the 2.5 mrem/hour dose criteria would be met if the shielding properties provided by the refueling machine, grapple, mast, and hoist box were considered. In its revised response to RAI 310-8355, Question 14.03.08-12 (ML16285A531), the applicant proposed to update the information in Tier 1 Section 2.7.4.4, to specify that the minimum nine feet of water coverage, plus the shielding provided by the refueling equipment, ensures that an operator on the refueling platform is not exposed to the radiation dose limit of 2.5 mrem/hour when the pool is at the lower limit of the normal operating water level. This is consistent with ANSI/ANS-57.1-1992 and is therefore acceptable. The staff verified that the proposed changes have been incorporated into the DCD. The DCD also updated ITAAC item 8 in Table 2.7.4.4-2 to be consistent with the information in the text of Tier 1, Section 2.7.4.4, which is appropriate and acceptable. Therefore, RAI 396-8463, Question 14.03.08-12, was resolved and closed. More information on the review of the response to RAI 396-8463, Question 12.03-50, can be found in Chapter 12 of this SER.

Also, the staff could find no information in Tier 1 to verify that there will be no piping penetrations in the SFP lower than 10 feet (3.1 meters) above the top of fuel assemblies seated in the pool or to ensure that the failure of the gates connecting the SFP to the transfer canal and

spent fuel cask loading pit will result in the coolant inventory from being drained to levels lower than 10 feet (3.1 meters) above the tops of fuel assemblies in accordance with RG 1.13, "Spent Fuel Storage Facility Design Basis." In addition, the staff could not identify any information in Tier 2 demonstrating that a failure of a single gate would not result in draining the pool below 10 feet above the top of the assemblies. Therefore, the staff could not verify that the APR1400 application contained the appropriate Tier 1 information to verify compliance with GDC 61. As a result, the staff issued RAI 116-8054, Question 14.03.08-2 (ML15208A511), requesting the applicant to provide this information.

In its response to RAI 116-8054, Question 14.03.08-2 (ML15303A426), the applicant indicated that the information requested was already provided in its responses to RAI 98-8051, Question 09.01.02-8 (ML15299A481) and RAI 79-7990, Question 09.01.02-7 (ML15301A236). The applicant's response to RAI 98-8051, Question 09.01.02-8, provided a detailed analysis of the SFP water level in the event of a failure of the gates to the cask loading pit and fuel transfer canal. The staff reviewed this response, which calculated the water level in the SFP after a failure where water had transferred to the fuel transfer canal and cask loading pit individually. The response showed that the water level in the SFP remained well above 10 feet above the top of the fuel assemblies stored in the pool. RG 1.13 specifies that the water level should remain more than 10 feet above the top of the fuel assemblies during such an event. The 10 feet of water provides sufficient water coverage for shielding purposes during an accident and is therefore acceptable, from a radiation protection perspective. However, while acceptable from a radiation protection perspective, additional review is performed in Chapter 9, "Auxiliary Systems," of this SER to determine the acceptability of the design for safety-system operation and maintaining appropriate SFP cooling.

In its response to RAI 79-7990, Question 09.01.02-7 (ML15301A236), the applicant provided Tier 1 information for a failure of a gate and Tier 1 information for the locations of piping penetrations. Specifically, in the applicant's response to RAI 79-7990, Question 09.01.02-7, the applicant proposed modifying the design description in Tier 1, Section 2.7.4.2, to indicate that the SFP has no openings, gates, drains, or connections below the top of the stored fuel; that the gates were Seismic Category I and designed to minimize leakage; and that the water level in the SFP remains 3 meters (10 feet) above the top of the fuel assemblies in the event of a single gate failure. The design description of Tier 1, Section 2.7.4.2, also specifies that all piping penetrations are located approximately 3 meters above the top of the irradiated fuel assemblies seated in the storage racks, and all piping extending down into the SFP will have siphon breaker holes installed on the piping inside the SFP at or above the 10 foot (3 meter) level. While the information on siphon breaks not allowing leakage below the lowest piping penetrations is consistent with RG 1.13 and is acceptable, RG 1.13 specifies that there should be no piping penetrations below the minimum water level of 3 meters.

Therefore, RAI 116-8054, Question 14.03.08-2, was closed and the staff issued RAI 449-8533, Question 14.03.08-15 (ML16082A354), requesting that the applicant specify that all piping penetrations are located "at least" 10 feet (3 meters) above the top of the fuel assemblies, instead of "approximately" 10 feet (3 meters) above the fuel assemblies. In its response to RAI 449-8533, Question 14.03.08-15 (ML16183A362), the applicant made the suggested changes to Tier 1, Section 2.7.4.2, indicating that all piping penetrations in the SFP will be at least 10 feet (3 meters) or more above the top of the stored fuel assemblies.

Tier 1, Table 2.7.4.2-1, ITAAC item 1, covers all of the information in the design description section of Tier 1, Section 2.7.4.2. Since there is Tier 1 information and an ITAAC to ensure that all piping penetrations in the SFP will be at least 10 feet (3 meters) or more above the top of the stored fuel assemblies, the staff determined that the proposed Tier 1 design description and ITAAC for penetrations in the SFP and potential drain down events from a gate failure are acceptable from a radiation protection perspective. Chapter 9 of this SER discusses the acceptability of these issues as they relate to adequate cooling of the SFP and appropriate safety system operation. The staff confirmed that DCD Tier 2, was revised as committed in the response to RAI 449-8533, Question 14.03.08-15. Therefore, RAI 449-8533, Question 14.03.08-15, was resolved and closed.

14.3.8.4.3 Radiation Monitoring

The staff reviewed ITAAC Table 2.7.6.4-1 associated with process and effluent radiation monitors in Tier 1, Section 2.7.6.4, and ITAAC Table 2.7.6.5-1 associated with the area radiation monitors identified in Tier 1, Section 2.7.6.5. The main purpose of reviewing the process and effluent monitors as part of this section is to review the appropriateness of the ITAAC for the main control room monitors. Therefore, while some aspects of the process and effluent monitor Tier 1 information, including ITAAC, are discussed in this section of the SER, other aspects of the process and effluent monitor Tier 1 information, including ITAAC, are reviewed in more detail in Chapter 11, "Radioactive Waste Management," of this SER.

All area, process, and effluent radiation monitors provided in Tier 1 provide local displays and alarms, as well as displays and alarms in the MCR.

The staff noted that Tier 1, Section 2.4.7-1 discusses relying on a containment airborne particulate monitor to detect reactor coolant leakage in containment. Table 2.4.7-1, ITAAC item 1.e, contains an ITAAC associated with this. However, it was unclear from reviewing the ITAAC which monitor was being relied on to detect reactor coolant system leakage. The staff issued RAI 116-8054, Question 14.03.08-8 (ML15208A511) requesting this information.

In its response to RAI 116-8054, Question 14.03.08-8 (ML15303A426), the applicant proposed adding Table 2.4.7-2 to Tier 1 of the DCD, which identifies the equipment being relied on for reactor coolant system leakage detection, including radiation monitors PR-RE-039A and PR-RE-040B. The applicant also proposed referencing this Table in Tier 1 Section 2.4.7 and ITAAC Table 2.4.7-1. The radiation monitors identified are consistent with the monitors described in Tier 2, Chapter 11 and are therefore acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 116-8054, Question 14.03.08-8. Therefore, RAI 116-8054, Question 14.03.08-8, was resolved and closed.

As a result of other issues with the radiation monitoring ITAAC and Tier 1 information identified by the staff, the staff issued RAI 116-8054, Question 14.03.08-4 (ML15208A511), associated with area radiation monitoring, and Question 14.03.08-5, associated with process and effluent monitors. Both Question 14.03.08-4 and Question 14.03.08-5 contain several subparts, with different topics (the specific questions asked can be found in ML15208A511).

The next several pages discuss the RAI responses and staff evaluation of the most significant aspects of Questions 14.03.08-4 and 14.03.08-5, in sequential order. The evaluations of Questions 14.03.08-4 and 14.03.08-5 resulted in follow-up RAI 368-8470, Question 14.03.08-14

(ML16019A273), which also contains several subparts. The responses and evaluation of Question 14.03.08-14 make up the remainder of this section and are discussed following the evaluation of the Question 14.03.08-4 and Question 14.03.08-5 responses.

In its response to RAI 116-8054, Question 14.03.08-4 (ML15303A426), the applicant made numerous changes to the plant area radiation monitoring system in both Tier 1 and Tier 2. The changes to Tier 2 included mostly editorial changes, except for deleting proposed monitors for a potential interim radwaste storage facility, which will not be included as part of the DCD (COL item 11.4(7)), deleting the instrument calibration facility radiation monitor, and clarifying that there are two Truck Bay Area monitors (C-RE-288 and C-RE-289). The evaluation of these changes is found in the following three paragraphs.

Regarding the proposed removal of radiation monitors for a potential interim radwaste storage facility, it would be inappropriate for the application to contain information and ITAAC for radiation monitors that are not within the scope of the DCD. Therefore, the removal of the interim radwaste storage facility monitors from the design is acceptable.

Regarding the proposed deletion of the instrument calibration facility, the instrument calibration facility is a potential very high radiation area, when the instrument calibrator is unshielded. In addition, the instrument calibration facility was an area where changes in plant conditions can cause significant increases in personnel exposure rate, which according to ANSI/ANS-HPSSC-6.8.1-1981, "Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Nuclear Reactors," as referenced in the staff's SRP and Section 12.3-12.4 of the DCD, should have a radiation monitor and alarm both inside and outside of the instrument calibration room. Therefore, the staff issued Part 1 of RAI 368-8470, Question 14.03.08-14 (ML16019A273), requesting that the applicant justify the removal of this monitor.

Regarding the proposed clarification that there are two truck bay monitors, it is acceptable to clarify that there are two area monitors in the truck bay area because this provides additional radiation dose rate information for an additional area of the truck bay. However, the DCD Section 11.5, "Process and Effluent Radiation Monitoring and Sampling Systems," figures, which shows the locations of radiation monitors throughout the plant, only still shows one truck bay monitor. Therefore, the staff issued Part 2 of RAI 368-8470, Question 14.03.08-14 (ML16019A273), requesting that the applicant identify the location of the other radiation truck bay radiation monitor.

The staff had also identified several inconsistencies between the Tier 1 and Tier 2 radiation monitor information and asked the applicant, in Question 14.03.08-4, to clarify or revise the DCD, as appropriate. For example, there were monitors with inconsistent tag numbers and monitors that were labeled as safety related in Tier 2 and non-safety related in Tier 1. There was also information missing for some monitors listed in Tier 1. In its response to RAI 116-8054, Question 14.03.08-4 (ML15303A426), the applicant changed Tier 1 information, including correcting monitor tag numbers, correcting the classification of monitors, and making other corrections.

In addition, there was no ITAAC or information in Tier 1 to ensure that the containment upper operating area monitors will be positioned to view a large fraction of the containment free air volume, as discussed in NUREG-0737, "Clarification of TMI Action Plan Requirements." So in Question 14.03.08-4 the staff asked the applicant to provide this information. Therefore, in the

response to Question 14.03.08-4, the applicant proposed to add a proposed ITAAC to Tier 1, Table 2.7.6.5-3, to ensure that the containment upper operating area monitors are located in an unimpeded location. However, the proposed ITAAC on the location of the upper operating area monitors did not provide enough information to ensure that the monitors will actually be able to view a large fraction of the containment volume, consistent with NUREG-0737. Therefore, the staff issued Part 3 of RAI 368-8470, Question 14.03.08-14 (ML16019A273), requesting that the applicant provide more information in this area.

In addition, the containment operating area monitors (including the two lower operating area monitors and two upper operating monitors), SFP area monitors, and main control room air intake monitors provide engineered safety features (ESF). The ESF functions initiated by these monitors are initiating containment purge isolation, fuel handling area emergency ventilation, and main control room emergency ventilation. While there are ITAAC to confirm that these monitors send initiation signals to the ESF group control cabinet, there did not appear to be an ITAAC to confirm that the ESF function will actually initiate when high radiation is detected. It was also unclear if sufficient overlap testing is being included in the ITAAC consistent with IEEE 338-1987, "Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems," which is referenced in RG 1.118, "Periodic Testing of Electric Power and Protection Systems." In its response to Part 4 of RAI 116-8054, Question 14.03.08-4 (ML15303A426), the applicant pointed to several different ITAAC which they indicated provided overlap testing of the ESF function of the safety-related monitors. While IEEE 338-1987 specifies that testing from sensor (monitor) to actuation (specified ESF function) is the preferred method of testing, it is also acceptable to perform individual overlap tests when whole scale testing is not practicable. However, the ITAAC that the applicant referenced only appeared to be testing individual pieces of the circuitry between the radiation monitors and actuation of the components. There did not appear to be sufficient overlap testing. In addition, ITAAC items 4 and 5 in Table 2.7.6.4-3 and ITAAC items 3 and 6 in Table 2.7.6.5-3 specified that the radiation monitors would be tested with an "integral activated check source". It was unclear what this term means to staff. During a pre-application audit, the applicant indicated that the monitors would be tested with a radiation calibration check source. Therefore, the staff issued Part 4 of RAI 368-8470, Question 14.03.08-14 (ML16019A273), requesting that the applicant address these issues.

In its response to RAI 116-8054, Question 14.03.08-5 (ML15303A426), the applicant proposed updating Tier 1, Table 2.7.6.4-1, to include the safety-class information and range for the process and effluent radiation monitors and sampling system components. The information provided was consistent with the information in Tier 2 of the application, except for a few minor errors, which were later corrected in the response to RAI 368-8470, Question 14.03.08-14. Therefore, the changes with those additional corrections provided in the applicant's response to RAI 368-8470, Question 14.03.08-14, are acceptable.

In its response to RAI 116-8054, Question 14.03.08-5 (ML15303A426), the applicant also provided information justifying why it was acceptable for the main control room air intake monitors to only monitor for noble gasses when many other designs also include particulate and iodine monitors in the main control room intakes. The main control room air intake monitors initiate main control room emergency filtration and close the air intake damper with the higher radiation level (the higher of the two intakes), when radiation levels above the pre-determined set point are detected. This is necessary to ensure that the dose to control room operators does not exceed 5 rem during an accident in accordance with GDC 19. Specifically, the

applicant provided the results of an analysis that showed that noble gas releases during all design basis accidents would be significant. Moreover, in many accidents, it was the only significant type of radioactive material released. Therefore, it is acceptable to use noble gas monitors alone for the main control room intake monitors.

Finally, in Part 4 of RAI 116-8054, Question 14.03.08-5, the staff had requested that the applicant demonstrate how the main control room air intake monitors were tested with sufficient overlap testing, as was similarly asked in RAI 116-8054, Question 14.03.08-4, for the area radiation monitors. In its response to Part 4 of RAI 116-8054, Question 14.03.08-5 (ML15303A426), the applicant duplicated the information provided in its response to RAI 116-8054, Question 14.03.08-4, claiming that sufficient overlap testing was provided. As discussed above, the staff found this response to be unacceptable. Therefore, in Part 6a of RAI 368-8470, Question 14.03.08-14 (ML16019A273), the staff requested that the applicant provide additional information on the testing and functioning of the main control room intake monitors and emergency ventilation system. The staff issued Part 6b of Question 14.03.08-14 requesting the applicant to provide additional information on ITAAC 9 in Table 2.7.3.1-3, which indicated that the air intake damper with the higher radiation level would close while the intake with the lower intake would remain open, in order to provide the cleanest air possible to the control room. Specifically, the staff asked the applicant to explain what would prevent the dampers from continually swapping between open and closed, because as a damper closes, the airborne radiation levels in the intakes would likely decrease significantly because there is no longer a suction drawing air into the intake. If this were to occur, the dose rates in the control room could be significantly higher than if the higher intake remained closed, because the intake with higher radiation levels could be open for a large portion of an accident.

For the reasons described above, the responses to RAI 116-8054, Questions 14.03.08-4 and 14.03.08-5 were unacceptable and closed and the staff issued RAI 368-8470, Question 14.03.08-14 (ML16019A273) as a follow-up RAI. Question 14.03.08-14 included Parts 6a and 6b discussed above. The topic of each question is repeated below, as well as the applicant's response to each item, in sequential order. The applicant submitted an original response (ML16113A303) and three revisions to the response to Question 14.03.08-14 (Revision 1 at ML17191B027, Revision 2 at ML17242A326, and Revision 3 at ML17257A542). All items resolved in earlier revisions were carried forward through Revision 3.

Part 1 of Question 14.03.08-14

Part 1 of RAI 368-8470, Question 14.03.08-14 (ML16019A273) requested that the applicant provide additional information regarding why the instrument calibration facility radiation monitor was being removed from the design in the response to Question 14.03.08-4.

Response and Evaluation to Part 1 of Question 14.03.08-14

In the original response to Part 1 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant indicated that they would retain the monitor in the instrument calibration facility and associated information in both Tier 1 and Tier 2.

However, in Revision 1 of the response to Question 14.03.08-14 (ML17191B027), the applicant revised the response to Part 1, again removed the instrument calibration facility from the design. This is because the applicant deleted information from the DCD specifying that high activity

instrument calibration will be conducted at the plant site. Instead, in the response to RAI 235-8275, Question 12.03-34 (ML17102B266) and RAI 376-8496, Question 12.03-49 (ML17095B053), the applicant specified that the use of the room will be determined by the COL applicant. The COL applicant is also to provide all necessary access controls and any other design features or operational procedures for the room to meet all applicable requirements. This is satisfactory because it is acceptable for these types of calibration activities (using high activity sources that meet the 10 CFR Part 36 definition of an irradiator) to be performed offsite by a separate licensee. As a result, it is acceptable to remove the instrument calibration facility monitor from the design. Therefore, the response to Part 1 of RAI 368-8470, Question 14.03.08-14 is acceptable. Please see the SER discussion of Questions 12.03-34 and 12.03-49 for more information on this topic.

Part 2 of Question 14.03.08-14

Part 2 of RAI 368-8470, Question 14.03.08-14 requested that the applicant update DCD Figure 11.5-2T to show truck bay monitor RE-288 or justify why it did not need to be shown in the figure.

Response and Evaluation to Part 2 of Question 14.03.08-14

In the original response to Part 2 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant included the missing truck bay area radiation monitor (RE-288) on DCD Tier 2, Figure 11.5-2T. The monitor is located in the opposite truck bay of monitor RE-289. This location would provide the radiation levels in the other truck bay and is therefore in accordance with ANSI/ANS-HPSSC-6.8.1-1981 and was found to be acceptable. Therefore, the response to Part 2 of RAI 368-8470, Question 14.03.08-14 was found to be acceptable.

Part 3 of Question 14.03.08-14

Part 3 of RAI 368-8470, Question 14.03.08-14 requested that the applicant provide additional information on the locations of containment high range radiation monitors and requested that the applicant provide additional information on how it will be ensured that the monitors will meet 10 CFR 50.34(f)(xvii) and the guidance of NUREG-0737.

Response and Evaluation to Part 3 of Question 14.03.08-14

In the original response to Part 3 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant provided additional information on the locations of the containment operating area monitors. The response indicates that the two upper operating area radiation monitors (RE-233A and RE-234B) were located on opposite sides of containment just below the containment polar crane support girder (near El. 230'). However, in response to RAI 376-8496, Question 12.03-49 (see ML16123A127 for Revision 0 and ML16211A098 for Revision 1 of the response), the applicant proposed updating DCD Tier 2, Figure 11.5-2A, which shows monitor RE-233A at elevation 200'. Therefore, the responses were inconsistent and the staff requested that the applicant correct the discrepancy. In addition, if monitor RE-233A is at the 200' elevation, than it would appear that the pressurizer compartment wall, which extends up to elevation 200', could block part of the view of containment for monitor RE-233A. Therefore, it was unclear why the location of the monitor at 200' elevation is acceptable.

In the revised response to Question 14.03.08-14 (ML17191B027), the applicant provided additional information related to the response to Part 3. The applicant specified that the two upper containment radiation monitors are 180 degrees apart from each other. Monitor RE-234B is located just below the containment polar crane rail support girder near elevation 230' and has an unobstructed view of containment. Monitor RE-233A was initially located at elevation 228' at the reference plant, but was moved for ease and safety when the monitor needed to be accessed. The new location is the pressurizer compartment concrete wall at elevation 200'. While a portion of the monitor's view is blocked by the pressurizer compartment, it still provides observation of a large fraction of the containment free air volume. Staff reviewed the locations of the monitors on the associated figures and found the description to be accurate. Therefore, the placement of the monitors is consistent with the requirements of 10 CFR 50.34(f)(xvii) and is acceptable. The applicant also proposed to include an ITAAC in Tier 1, Table 2.7.6.5-3 to ensure the monitors are placed to meet this criteria. The staff reviewed this proposed ITAAC and found it to be acceptable. Therefore, the response to Part 3 of RAI 368-8470, Question 14.03.08-14 is acceptable.

Part 4 of Question 14.03.08-14

Part 4 of RAI 368-8470, Question 14.03.08-14 requested that the applicant provide additional information on ITAAC testing for radiation monitors with ESF functions.

Response and Evaluation to Part 4 of Question 14.03.08-14

In the original response to Part 4 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant revised various ITAAC to ensure that the entire loop of the radiation monitor channels from radiation detector to actuation of the ESF function is tested. However, there did not appear to be complete testing of the monitor indications in the main control room. In addition, the applicant indicated that they would not include testing the functionality of the radiation monitors with a physical radiation calibration source as part of the ITAAC because of the high levels of radioactivity required to reach the setpoints on some of the monitors. Staff agrees that testing the monitors with high activity sources could be an unnecessary radiation hazard and could be inconsistent with ALARA, as required by 10 CFR 20.1101(b). However, the lower end of each radiation monitor's range could be tested with a radiation check source, without resulting in a radiological hazard to workers. In addition, most radiation monitors have a built in radiation check source. Therefore, at least the lower end of the radiation monitors range should be tested with an actual radiation check source to ensure radiation monitor functionality. As a result, the original response to Part 4 of RAI 368-8470, Question 14.03.08-14 was unacceptable.

In the revised response to Question 14.03.08-14 (ML17191B027), the applicant provided additional information regarding the response to Part 4. In the revised response, the applicant included new and revised ITAAC in Tier 1, Table 2.7.6.4-3, for the process and effluent radiation monitors and Table 2.7.6.5-1 for area monitors. The new ITAAC were to ensure that each monitor channel of the process, effluent, and radiation monitors are tested using a radiation check source (as opposed to a simulated signal), to ensure that the channel responds to radiation. However, some of the new and revised ITAAC lacked clarity. In Revision 2 of the response to RAI 368-8470, Question 14.03.08-14 (ML17242A326), the applicant revised some of the ITAAC wording for radiation monitors to add clarity regarding the intent of the ITAAC.

The staff found these changes to be acceptable. Therefore, the staff finds the response to RAI 368-8470, Question 14.03.08-14, Part 4 to be acceptable.

Part 5 of Question 14.03.08-14

Part 5 of RAI 368-8470, Question 14.03.08-14 requested the applicant to make several editorial corrections and minor clarifications.

Response and Evaluation to Part 5 of Question 14.03.08-14

In the original response to Part 5 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant made various minor corrections and edits to Tier 1 information, which are acceptable.

Part 6 of Question 14.03.08-14

Part 6 of RAI 368-8470, Question 14.03.08-14 requested a) that the applicant provide additional information on the overlap testing for the main control room air intake monitors and; b) to provide additional information regarding the operation of the main control room intake dampers and associated ITAAC.

Response and Evaluation to Part 6 of Question 14.03.08-14

In the original response to Part 6 of RAI 368-8470, Question 14.03.08-14 (ML16113A303), the applicant indicated that upon detection of high radiation in either one (or both) of the outside air intakes, the outside air intake isolation dampers in the outside air intake with the largest radiation level closes automatically. Then, after a preset time, the closed dampers will re-open and the radiation level in both intakes will be analyzed again, with the intake with the higher radiation level again closing. This process will repeat for the duration of the accident. The applicant proposed revising ITAAC in DCD Tier 1, Section 2.7.3.1-3, to adequately test this function (see the revised item 9 in Table 2.7.3.1-3). Specifically, the acceptance criteria of 9.b states that the as-built outside air intake isolation dampers are automatically reset and reopened at an interval after they are initially closed upon receipt of a simulated high radiation signal. The applicant also proposed adding COL 9.4(2) to specify that the COL applicant is to provide the interval of reopening the closed outside air intake isolation dampers by considering the durability of the isolation dampers and the site-specific meteorological data.

It was unclear to staff if the occasional re-opening of the main control room dampers was appropriately considered in the Chapter 15 and Section 6.4 main control room dose analysis and in the main control room filter loading source term provided in the response to RAI 207-8247, Question 12.02-16 (ML15343A410), proposed DCD Table 12.2-24, Sheets 13 and 14.

In Revision 1 (ML17191B027) and Revision 2 (ML17242A326) of the response to RAI 368-8470, Question 14.03.08-14, the applicant provided additional information regarding the response to Part 6. In these revisions, the applicant provided additional information regarding the main control room intake dampers and the adequacy of the calculations for MCR dose and filter loading. The applicant indicated that the Chapter 15 analysis modeling of the MCR ventilation system accounts for the additional outside air intake for the intermittent periods when both dampers are open. Specifically, the applicant indicated that the total time to open

the closed damper, detect the radiation level, process the signal, and re-close the intake damper would take approximately 45 seconds and that the interval between re-assessment would be 1 hour. Assuming the opening time would be 60 seconds (instead of 45 seconds) would increase the intake by approximately 8.3%. However, RG 1.194 allows for a reduction factor of 10 for intakes with an auto-select function. KHNP used a reduction factor of 8 in their calculations. This 20% conservatism more than accounts for the 8.3% increase during the period when both dampers are open.

The applicant also proposed to update DCD Tier 2 Chapter 15 to provide information on re-opening the closed intake dampers, including specifying that the interval time of 1 hour is assumed between re-opening the closed intake dampers. In addition, the applicant also proposed to provide COL information items stating that the COL applicant will provide the interval of re-opening the closed dampers based on site specific meteorology and other information (See COLs 9.4(5), 15.0(2), and 15.0(3), in the response). Specifically, the COL applicant has to re-evaluate the following radiological consequence analyses for the main control room: 1) the interval time for reopening the intake dampers exceeds the 1 hour time assumed; 2) the time period for re-opening and closing the dampers exceeds 60 seconds; or 3) if there are any other aspects of the design of the dampers that are non-conservative compared to what is described in DCD Section 15.0.3.5.

Finally, in the response, the applicant proposed to update Tier 1, Table 2.7.3.1-3, ITAAC 9.b, to clarify that the ITAAC will test that the closed outside air intake dampers are automatically opened after an interval and then the intake dampers with the higher radiation level are closed. The staff finds this ITAAC to be acceptable because using the intake with the lower radiation level is expected to decrease the dose to operators within the MCR and helps to ensure that doses are maintained in accordance with GDC 19.

In summary, the staff finds the justification and the proposed DCD revisions consistent with the intent of RG 1.194. In addition, the proposed COL items 9.4(5), 15.0(2), and 15.0(3) assures that the COL applicant will be required to address any non-conservatisms in the site specific damper design, based on site meteorology, etc. The staff finds the COL items to be acceptable. In Revision 3 of the response to RAI 368-8470, Question 14.03.08-14 (ML17257A542), the applicant proposed to revise DCD Section 15.0.3.5 to revise the reference of COL 9.4(5) to COL 9.4(2). This is an editorial correction because the COL numbers in Section 9.4 of the DCD had been revised by the applicant. COL 9.4(2) is the correct number. Therefore, this change was acceptable. Therefore, the staff finds the response to RAI 368-8470, Question 14.03.08-14, Part 6 to be acceptable, regarding the control room dampers and potential impacts on MCR dose and filter loading.

Additional information on the MCR air intake radiation monitors and dampers are also found in Chapters 12 and 15 of this SER.

Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore RAI 368-8470, Question 14.03.08-14 was resolved and closed.

14.3.8.4.4 Ventilation Systems

The staff reviewed the radiation protection aspects of the APR1400 ventilation system ITAAC, as they apply to this section. Item 2 in Tier 1, Table 2.8-2, is provided to verify that airflow within

radiological controlled areas is from areas of low airborne contamination to areas of higher airborne contamination. The staff finds this ITAAC acceptable to confirm that airborne contamination in the plant is minimized to the extent practicable. However, the wording of this ITAAC was unclear. The staff issued RAI 116-8054, Question 14.03.08-11 (ML15208A511), requesting the applicant to clarify.

In its response to RAI 116-8054, Question 14.03.08-11 (ML16034A204), the applicant modified item 2 in Tier 1, Table 2.8-2, to revise and clarify the acceptance criteria for the ITAAC. The wording is now clear that the acceptance criteria is met if airflow is from areas of lower potential airborne contamination to areas of higher potential airborne contamination. This is consistent with the design described in Section 12.3 of the DCD and also consistent with the criteria in SRP 12.3-12.4, and is therefore acceptable. The applicant also stipulated in the ITAAC that the concentrations of airborne radionuclides shall not exceed the concentrations provided in 10 CFR Part 20, Appendix B. This proposed ITAAC and acceptance criteria is acceptable. The staff confirmed that the DCD Tier 2 was revised as committed in the response to RAI 116-8054, Question 14.03.08-11. Therefore, RAI 116-8054, Question 14.03.08-11, was resolved and closed.

In addition, the staff reviewed other Tier 1 information associated with ITAAC for ventilation systems in Tier 1 Section 2.7.3, and in these sections the staff reviewed filter configurations and layout in ventilation systems to ensure that these systems properly filter and control the release of radioactive material, from a radiation protection perspective. The staff finds the information acceptable, except that the applicant did not appear to provide an ITAAC assuring that the total leakage rate from ducting in the ESF systems is less than the value assumed in the post-accident dose consequence design basis, as described in RG 1.52, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants." The staff issued RAI 116-8054, Question 14.03.08-6 (ML15208A511), requesting this information.

In its response to RAI 116-8054, Question 14.03.08-6 (ML15280A260), the applicant specified that, in accordance with RGs 1.52 and 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Plants," the air cleaning unit (ACU) housing and ductwork are tested to provide reasonable assurance that the leakage rate from ductwork and ACU housing is less than the allowable leakage rate as defined in Sections HA-4500 and SA-4500 of ASME AG-1-2009, with addenda, "Code on Nuclear Air and Gas Treatment." In addition, the applicant specified that ductwork and ACU housing leak tests are performed in accordance with Section TA-4300 of ASME AG-1-2009 with addenda. Finally, the applicant proposed adding ductwork and ACU housing leak testing to DCD Tier 2 for the containment purge system, fuel handling area heating, ventilation, and air conditioning (HVAC) system, compound building HVAC system, and the auxiliary building controlled area HVAC system.

However, while the applicant's response indicated that the ductwork and ACU housing leak testing will occur in accordance with TA-4300 of ASME AG-1-2009 with addenda, the proposed DCD updates do not specify which version of ASME AG-1 is being referenced. Therefore, the staff closed RAI 116-8054, Question 14.03.08-6 and issued RAI 329-8424, Question 14.03.08-13 (ML15343A330), requesting that the applicant specify which version of ASME AG-1 is being referenced in the DCD. In addition, DCD, Revision 0, Chapter 15 specified that unfiltered inleakage to the MCR and technical support center from the ventilation systems

during design basis accidents is assumed to be 8.50 cubic meters (300.2 cubic foot) per minute. In the response to RAI 108-7973, Question 15.00.03-2, the applicant changed the maximum total system inleakage in the emergency mode to 170 cubic meters per hour (100 cfm). If leakage exceeds this value, it is outside the accident dose analysis performed in Chapter 15. If this occurred, it is unclear if the dose limit of 5 rem for control room operators in GDC 19 would be met. In Question 14.03.08-13, the staff also requested that the applicant include an ITAAC to ensure that the inleakage to the MCR and technical support center does not exceed 8.50 cubic meters per minute.

In its response to RAI 329-8424, Question 14.03.08-13 (see ML16028A460 for Revision 0 and ML18170A057 for Revision 1, which made corrections to information related to MCR unfiltered inleakage), the applicant proposed updating the DCD additions to specify that the 2009 version of ASME AG-1-2009, with Addenda, is being referenced. This is consistent with RG 1.52 and is, therefore, acceptable. In addition, the applicant proposed updating DCD Tier 2, Section 14.2.12.1.95 to specify that one of the acceptance criteria for the control room HVAC system is that the total unfiltered inleakage rate is less than 170 cubic meters per hour (100 cfm) in the emergency mode. This is consistent with the information in Chapter 15 and is, therefore, acceptable. Finally, in the response, the applicant also indicated that DCD Tier 1 Subsection 2.7.3.1.1, item 11, already provides the ITAAC for control room envelope leakage. While Subsection 2.7.3.1.1, item 11, is just the design description that states that unfiltered leakage is within performance value limits the staff verified that ITAAC Table 2.7.3.1-3, item 11 provided an ITAAC to verify that the main control room unfiltered inleakage is less than the specified value. Therefore, no new ITAAC was needed and the applicant's response is acceptable. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 329-8424, Question 14.03.08-13 was resolved and closed.

Other aspects of the ventilation system ITAAC review, including other system design related ITAAC are discussed in Section 9.4 of this SER.

14.3.8.4.5 Minimization of Contamination

The staff could not identify any design features associated with minimizing contamination in the Tier 1 ITAAC. The staff issued RAI 116-8054, Question 14.03.08-7 (ML15208A511), requesting the applicant to provide this information. In its response to RAI 116-8054, Question 14.03.08-7 (ML16093A011), the applicant proposed providing ITAAC in the DCD for significant 10 CFR 20.1406 related design features, including an ITAAC to ensure that the steam generator blowdown radiation monitor alarms in the MCR on high radioactive contamination and isolates the blowdown valves (ITAAC Table 2.7.6.4-3, item 8); an ITAAC for the leak detection design and alarms for the holdup tank, boric acid storage tank, and reactor makeup water tank, which are outside tanks potentially containing radioactive material (ITAAC Table 2.7.2.5-4, item 9); ITAAC for the leak detection design for the floor drain tanks, equipment waste tanks, and monitor tanks (ITAAC Table 2.7.6.1-2, items 7, 8, and 9); and an ITAAC for SFP liner leaks (ITAAC Table 2.7.4.3-4, item 13). In its revised response to RAI 116-8054, Question 14.03.08-7 (ML16211A413), the applicant modified these proposed ITAAC to make the acceptance criteria clearer and more easily verifiable. For example, the ITAAC for the leak detection design now includes acceptance criteria to verify that an alarm functions in the MCR, as the result of a signal test, to notify operators of leakage from the tanks and for indoor radwaste tanks, to ensure an alarm also functions in the radwaste control room. The staff finds that the proposed

ITAAC for 10 CFR 20.1406 related design features are acceptable, because they adequately test some of the more significant 10 CFR 20.1406 related design features in the plant. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 116-8054, Question 14.03.08-7. Therefore, RAI 116-8054, Question 14.03.08-7, was resolved and closed.

14.3.8.4.6 Radiation Protection Equipment Qualification ITAAC

Tier 1 provides ITAAC ensuring that certain equipment that is located in environmentally harsh conditions are capable of withstanding the conditions for which they are located. However, the staff identified that even though several containment radiation monitors are safety-related and located within an environmentally harsh environment (including radiological harsh environment), as identified in DCD Tier 2, Section 3.11, these monitors did not have an ITAAC ensuring that they can withstand the environment in which they are located. The staff issued RAI 116-8054, Question 14.03.08-9 (ML15208A511), requesting that the applicant provide justification for why certain equipment included an ITAAC associated with the environmentally harsh condition for which they are located and others did not.

In its response to RAI 116-8054, Question 14.03.08-9 (ML16050A536), the applicant acknowledged that some of the equipment located in a harsh environment did not have an associated ITAAC. The applicant included an example of the type of ITAAC that will be added for the missing equipment. In the example, the applicant showed a proposed update to Tier 1, Section 2.7.6.5, on area radiation monitoring, which would include Tier 1 information to ensure that the containment operating area and upper operating area radiation monitors were identified as being Class 1E equipment, located in a harsh environment. In addition, the applicant proposed adding an ITAAC to Tier 1, Table 2.7.6.5-3, to ensure, in part, that these monitors are capable of withstanding the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function. The staff finds this proposed ITAAC to be acceptable because it ensures that the safety-related area radiation monitors will be qualified for the harsh environmental conditions in which they are located. However, while the response provided an acceptable example of how Tier 1 and ITAAC would be updated, the response did not provide any updates for the equipment located in a harsh environment that was missing from Tier 1. The applicant indicated in the response that this additional information would be included in a future revision to the response.

In its revised response to RAI 116-8054, Question 14.03.08-9 (ML16211A397), the applicant indicated that it completed its review of other systems which contained equipment located in a harsh environment, for which ITAAC were not included in the DCD, Revision 0. The applicant indicated that the other systems and components missing ITAAC were relevant components in the Containment Hydrogen Control System and the Fuel Handling Area HVAC System. Therefore, the applicant proposed including similar ITAAC to those provided in Section 2.7.6.5 for applicable components in these systems, in ITAAC Tables 2.7.6.5-3 and 2.11.4-3. Therefore, these proposed ITAAC are acceptable. The staff did not identify any other systems or components identified as being located in a harsh environment in Tier 2, which did not include an ITAAC in Tier 1. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 116-8054, Question 14.03.08-9. Therefore, RAI 116-8054, Question 14.03.08-9, was resolved and closed.

14.3.8.4.7 Other Design Features

The APR1400 design credits a decontamination factor of 100 for the pre-holdup ion exchanger for the removal of Cesium and Rubidium. This decontamination factor far exceeds the value of 2 specified in NUREG-0017 and ANSI/ANS 18.1-1999, which are referenced in Chapter 12 of the SRP. This large decontamination factor is relied on to lower the activity in the holdup tank and boric acid storage tank, which are located outdoors. Therefore, having an ion exchanger that can achieve this decontamination factor for the life of the facility is an important design feature to limit the doses from these tanks and to ensure doses to members of the public remain within limits. In a June 15, 2016 meeting, the applicant agreed to include information in Tier 1, specifying that the decontamination factor of 100 will be maintained for the pre-holdup ion exchanger for the life of the facility. The staff issued RAI 308-8339, Question 12.02-19 (ML16272A470), which, in part, requested the applicant to address this issue. In the response to RAI 308-8339, Question 12.02-19 (ML16272A470), the applicant proposed to update DCD Tier 1, Section 2.4.6 to specify that the pre-holdup ion exchanger is used to limit radionuclide inventories stored in the holdup tank and that the pre-holdup ion exchanger has a minimum cesium decontamination factor of 100. Staff finds that this response is acceptable and adequately addresses the issue. The staff confirmed that this was incorporated into the DCD. Therefore, RAI 308-8339, Question 12.02-19, was resolved and closed. The full evaluation of RAI 308-8339, Question 12.02-19 is provided in Chapter 12 of the SER.

14.3.8.5 Combined License Information Items

There are no COL items associated with Section 14.3.2.8 of the APR1400 DCD. The proposed COL 9.4(2) and COL 12.3(1), are related to this section. COL 9.4(2) and COL 12.3(1) are discussed in Chapters 12 and 9 of this SER, as appropriate.

14.3.8.6 Conclusion

The applicant provided DCD Tier 1 and ITAAC for radiation protection SSCs, which it credited for demonstrating that a plant incorporating the APR1400 DC will be built and operated in accordance with 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 52. The staff concludes, as explained above, that the radiation protection Tier 1 information and ITAAC discussed in this SER section meet the applicable acceptance criteria in SRP Section 14.3.8, the requirements of 10 CFR 52.47(b)(1), and applicable radiation protection regulations in 10 CFR Part 20, 10 CFR Part 50, and 10 CFR Part 52. In addition, if the inspections, tests, and analyses are performed and the acceptance criteria met, then a facility referencing the APR1400 certified design has been constructed, and will be operated, in compliance with the DC, the Atomic Energy Act of 1954, as amended, and applicable NRC regulations.

14.3.9 Human Factors Engineering – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.9.1 Introduction

This SER section addresses inspections, tests, analyses, and acceptance criteria (ITAAC) related to the human factors aspects of the nuclear power plant design for the main control room (MCR), the remote shutdown facility, the local control stations, the technical support center, and the emergency operations facility.

14.3.9.2 Summary of Application

DCD Tier 1: The applicant has provided commitments for human factors engineering (HFE) in Tier 1 Section 2.9, "Human Factors Engineering." Tier 1 Section 1, "Introduction," provided definitions, general provisions, and a legend for figures, acronyms, and abbreviations.

DCD Tier 2: Tier 2 Section 14.3, "Inspections, Tests, Analysis, and Acceptance Criteria," provides a general description of the APR1400 ITAAC, including its relationship to other Tier 1 information, and the selection criteria and processes used to develop the Tier 1 content.

ITAAC: The applicant has provided ITAAC for HFE in Tier 1 Section 2.9, Table 2.9-1, "Human Factor Engineering ITAAC."

TS: There are no TS for this area of review.

14.3.9.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Section 14.3 and 14.3.9 of NUREG-0800. Review interfaces with other SRP sections are also identified in this SRP section.

The applicable regulatory requirements are as follows:

- 10 CFR 52.47(b)(1), "Contents of applications; technical information," as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will be operated in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

14.3.9.4 Technical Evaluation

ITAAC and Tier 1 Design Description

The staff and industry conducted a series of public meetings as part of an effort to develop a set of standardized ITAAC that will be incorporated into regulatory guidance and will be applied as a basis for future applications under 10 CFR Part 52. The public meeting summary dated February 6, 2015 (ML15036A211) states:

This was the 7th meeting in a series of public meetings between NRC staff and stakeholders held with regard to improvements and standardization of inspections, tests, analyses, and acceptance criteria (ITAAC). The goal of this effort is to develop a set of standardized ITAAC that will be incorporated into regulatory guidance, and will be applied as a basis for future applications under Part 52...The first subject area discussed was Human Factors Engineering. Both industry and staff agreed that the proposed standardized ITAAC were acceptable. These ITAAC will be incorporated into the list of standardized ITAAC.

An attachment to the meeting summary (ML15015A226) lists two standardized ITAAC for HFE. The applicant proposed two HFE ITAAC based on these draft standardized ITAAC. Because the SRP has not been updated to reflect these ITAAC, the applicant's use of standardized ITAAC in this application is being reviewed as an alternative method.

The staff reviewed DCD Tier 1, Section 2.9, "Human Factors Engineering," and Table 2.9-1, "Human Factor Engineering ITAAC." Table 2.9-1 lists two ITAAC for HFE. The applicant's HFE ITAAC are generally consistent with the format and content of the standardized HFE ITAAC; however, the staff found that the acceptance criteria stated for Item 1 in Table 2.9-1 was not consistent with the standardized HFE ITAAC. To resolve the inconsistency, the staff issued RAI 349-8440, Question 14.03.09-1 (ML16039A351), asking the applicant to either revise the acceptance criteria to make it consistent with the standardized ITAAC acceptance criteria or provide the basis for the acceptance criteria provided in the DCD. In its response to RAI 349-8440, Question 14.03.09-1 (ML16081A305), the applicant confirmed that it would revise the acceptance criteria wording for Item 1 of the DCD Tier 1, Table 2.9-1. In its response, the applicant also provided a proposed markup of the revised Item 1 in Table 2.9-1. The staff reviewed the applicant's response to RAI 349-8440, Question 14.03.09-1 and found it acceptable because the revised acceptance criteria for Item 1 in DCD Tier 1, Table 2.9-1 is consistent with the standardized ITAAC acceptance criteria. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 349-8440, Question 14.03.09-1 was resolved and closed.

When the staff determined the standardized HFE ITAAC were acceptable, the staff assumed the HFE implementation plans (IPs) submitted by a DC applicant with an application containing the standardized ITAAC would be designated as Tier 2*. A discussion of how conclusions on the acceptability of Tier 1 and ITAAC are related to the staff's review of an applicant's HFE program, and why the staff's conclusions on the acceptability of the standard ITAAC relied in part on the NRC being able to review and approve changes to information in the approved HFE implementation plans prior to those changes being made, is found below in the subsection titled, "Background Information on the HFE Review and Tier 2*." Based on the assumption that the HFE implementation plans would be designated as Tier 2*, and based on the review of the applicable sections of the DCD in conjunction with the applicant's responses to RAI 349-8440 Question 14.03.09-1, the staff determined that:

1. The ITAAC table includes Item 1 describing completion of the integrated system validation (ISV) test that demonstrates the control room design incorporates HFE principles that minimize the potential for operator error. As discussed in SER Section 18, "Human Factors Engineering," the staff has reviewed, and found acceptable, the applicant's design process for the control room human-system interfaces. The ISV test is a performance-based assessment of the design based on the realistic operation of a sample of the control room human-system interfaces within a simulator-driven MCR. Pass/fail criteria for the ISV test are identified in Technical Report APR1400-E-I-NR-14008, "Human Factors Verification and Validation Implementation Plan" (V&V IP), and Technical Report APR1400-E-I-NR-14010, "Human Factors Verification and Validation Scenarios," which were provided with the DC application. These criteria provide for a clear, measureable set of acceptance criteria for the ISV test.

2. The ITAAC table includes Item 2 describing an inspection that verifies the as-built plant is built and operates in conformance to the certified HFE program and the standard DC. The inspection to be performed will verify the as-built control room human-system interfaces conform to the validated design.
3. Tier 1 HFE-related information is consistent with Tier 2, Chapter 18 information. The HFE design elements addressed in Chapter 18 were appropriately summarized in Tier 1 so there is a clear statement of the objectives accomplished by each element.

However, during the review, the staff received new information indicating that the applicant did not intend to use Tier 2*. As a result of this new information, the staff re-evaluated the acceptability of the standard HFE ITAAC for the application. The results of the reevaluation are discussed below in the subsection titled, "*Reevaluation of the Applicant's ITAAC and Resolution.*"

Background Information on the HFE Review and Tier 2*

SER Section 18.0, "Overview," explains that the staff uses the guidance in NUREG-0711, "Human Factors Engineering Program Review Model," to determine whether the applicant has met the requirement of 10 CFR 50.34(f)(2)(iii) to provide, for Commission review, a control room design that reflects state-of-the-art human factors principles. Figure 1-1, "Elements of the HFE program's review model," of NUREG-0711 illustrates the HFE design process, which consists of 12 HFE program elements. The 12 HFE program elements are organized into the following phases: planning and analysis, design, verification and validation, and implementation and operation.

As discussed in SER Section 18.0, "Overview," the applicant addressed the 12 HFE program elements by providing three COL items and nine IPs in lieu of a control room design for review and approval. The COL items address the HFE elements established by operational programs. SER Section 18.8, "Procedure Development," and Section 13.5; SER Section 18.9, "Training Program Development," and Section 13.2; and SER Section 18.12, "Human Performance Monitoring," document the staff's evaluation of the three COL items and the staff's conclusions that they are acceptable because these elements are addressed by operational programs that are established and implemented by a COL holder. Operational programs are subject to NRC inspection prior to operation of the facility.

The HFE IPs are technical reports that contain the procedures and describe the methods for completing a particular HFE program element, and they are incorporated by reference in DCD Tier 2 as shown in Table 1.6-2, "List of Technical Reports." The applicant's IPs describe the means by which nine of the HFE program elements will be completed. As shown in Figure 4-2, "APR1400 HFE Program Milestones," of the Human Factors Engineering Program Plan (HFE PP), which is one of the nine IPs, the IPs have been provided with the DC application. Figure 4-2 also shows that the COL holder is to complete the activities in the implementation plans and document the results in results summary reports.

The applicant's HFE IPs contain design acceptance criteria (DAC) because they contain the procedures for completing the control room design that reflects state-of-the-art human factors principles, and the staff has relied, in part, on the information in the implementation plans to

make a safety determination for the DC. SECY-92-053, "Use of Design Acceptance Criteria During 10 CFR Part 52 Design Certification Reviews," describes DAC and states:

The DAC are a set of prescribed limits, parameters, procedures, and attributes upon which the NRC relies, in a limited number of technical areas, in making a final safety determination to support a DC. The DAC are to be objective (measurable, testable, or subject to analysis using pre-approved methods), and must be verified as a part of the ITAAC performed to demonstrate that the as-built facility conforms to the certified design. That is, the acceptance criteria for DAC become the acceptance criteria for ITAAC, which are part of the DC.

The ITAAC in DCD Tier 1, Table 2.9-1 for the ISV verifies satisfactory completion of the DAC. The ISV employs a sampling strategy such that a sample of the control room human-system interfaces are tested during the ISV. If the activities are performed in accordance with each of the approved HFE IPs, then the staff has reasonable assurance that the control room design incorporates human factors principles. The ITAAC for the ISV test that samples that design is sufficient to verify the design has incorporated HFE principles and thus minimizes the potential for operator error because the human system interfaces (HSIs) sampled during the test are from the design that has been developed in accordance with an acceptable human factors design process.

As documented in the "Conclusions" sections of SER Section 18, the staff has reviewed the implementation plans using the relevant review criteria in NUREG-0711, Revision 3; concluded the IPs conform to these review criteria; and thus found the applicant's HFE program complies with HFE-related requirements. Therefore, the staff has reasonable assurance that the ISV test that samples the design resulting from the applicant's HFE program, if implemented in accordance with the DC, is sufficient to verify the design has incorporated HFE principles and minimizes the potential for operator error.

Consistent with SRP Section 14.3, Appendix A, IPs previously approved by the staff have been designated as Tier 2* because they contained the DAC the staff used to make its safety finding during the DC. The staff's rationale for designating the IPs as Tier 2* was that the staff made its conclusions to support a finding based on the information in the IPs, and thus the NRC's approval prior to making changes to the IPs is necessary to ensure proposed changes made after DC do not invalidate the safety finding made during DC.

As discussed in SRP Section 14.3, "Tier 2 information can be changed by a combined license (COL) applicant or licensee under a '50.59-like' process, provided the change does not impact Tier 1. The entire change process is set forth in the DC rules (Appendices A - D to 10 CFR Part 52)." The staff has not relied on the "50.59-like" process for Tier 2 information to adequately control changes to the implementation plans submitted by previous DC applicants because the "50.59-like" process uses criteria that do not apply to the HFE IPs.

Reevaluation of the Applicant's ITAAC and Resolution

The applicant designated the HFE implementation plans as Tier 2 documents, and the staff had planned to designate them as Tier 2* consistent with the guidance in SRP Section 14.3, Appendix A. However, shortly after the ACRS subcommittee meeting on June 21, 2017, SECY-17-0075, "Planned Improvements in Design Certification Tiered Information

Designations,” dated July 24, 2017 (ML16196A321), was issued. SECY-17-0075 explains that Tier 2* information must be demonstrated to have the same safety significance as Tier 1, and Tier 2* should be applied only when the subject matter reflects a demonstrated need for the additional flexibility provided by the Tier 2* change control process.

The applicant has not designated any portion of the application as Tier 2*. Given the IPs would not be Tier 2* and were designated as Tier 2 in the application, the staff could not rely on the “50.59-like” process to ensure the staff would be able to review and approve changes to the HFE IPs to ensure that no changes would invalidate the safety finding for the applicant’s HFE program made during DC. The staff considered whether the IPs had the same safety significance as Tier 1. Because the IPs contain the procedures and attributes the staff has relied on during DC to make a finding on the applicant’s HFE program, they contain DAC. SECY-92-053 says the DAC are to be objective (measurable, testable, or subject to analysis using pre-approved methods) and must be verified as a part of the ITAAC performed to demonstrate that the as-built facility conforms to the certified design. ITAAC are part of Tier 1.

The staff considered whether the ITAAC in the application were sufficient to verify whether the activities described in the IPs were completed in accordance with the approved IPs (i.e., whether they were sufficient to verify the DAC). Because the ISV test is a performance-based test, it is an effective means of verifying the control room design incorporates HFE principles that minimize the potential for operator error (i.e., the design commitment in the ITAAC Item 1). However, the ISV employs a sampling strategy such that a sample of the control room human-system interfaces are tested during ISV. As discussed in SER Section 18, the staff has reviewed the applicant’s HFE program (i.e., the three COL items together with the nine IPs) and found it conforms to the review criteria in NUREG-0711. If the activities are performed in accordance with each of the approved IPs, then the staff has reasonable assurance that control room design incorporates human factors principles. The ITAAC for the ISV test that samples that design is sufficient to verify the design has incorporated HFE principles and minimizes the potential for operator error because the human system interfaces (HSIs) sampled during the test are from the design that has been developed in accordance with an acceptable human factors design process. Additionally, the applicant’s IPs contain criteria for documenting in the results summary reports (ReSRs) the results of completing the activities in each of the IPs. The ReSRs would be available for the staff to audit if it was determined necessary to do so.

An ITAAC to verify the ISV test would be sufficient to verify the design commitment if there is assurance that the sampled HSIs are representative of the control room design as a whole. To provide this assurance, the IPs need to be subject to appropriate regulatory controls, but a 50.59-like process does not provide such controls for the IPs. Thus, the staff initially determined it was necessary for additional ITAAC to be added to verify the completion of each of the IPs, similar to the ITAAC that were provided for other applications (e.g., AP1000 and Economic Simplified Boiling Water Reactor). The staff thought adding additional ITAAC in Tier 1 for verification of each IP would provide a basis for designating the information in the IPs as Tier 1 because the IPs would contain the DAC that would be the acceptance criteria for the ITAAC.

Additionally, the staff observed that technical report “Human Factors Verification and Validation Scenarios” (the Scenarios Document) was not incorporated by reference in Tier 2, in Table 1.6-2. The staff relied on the information in the Scenarios Document to make conclusions to support the safety finding. Therefore, the staff thought portions of the Scenarios Document

should be identified as Tier 1 information because those portions contain the specific set of scenarios used to perform the ISV test and the acceptance criteria for each of the events in the scenarios. As such, it contains the DAC for the ITAAC provided to verify the acceptance criteria for the scenarios is satisfied. Therefore the staff issued RAI 553-9084, Question 18-134 (ML17249A979) requesting the applicant provide an ITAAC to verify the completion of each IP. Additionally, the staff provided a list of the specific sections of the IPs and the Scenarios Document that needed to be designated as Tier 1 because those sections contain information the staff relied on to make the safety finding during the DC (i.e., the DAC), and that information would be verified by the additional ITAAC that the staff requested be added as well as the standardized HFE ITAAC for the ISV.

On October 16, 2017, the staff conducted a public meeting with the applicant to discuss RAI 553-9084, Question 18-134 (ML17277B794). At the meeting, the applicant stated that the staff already determined that the standardized ITAAC for HFE were sufficient and acceptable for HFE, therefore the applicant did not think it was necessary to provide additional ITAAC. The applicant also stated that sufficient regulatory processes and controls existed for the IPs, such as the “50.59-like” process. The staff explained its concern that the “50.59-like” criteria could not be relied on to provide adequate control of changes to the implementation plans following DC.

Given these concerns, the applicant and the staff discussed whether other options existed to sufficiently control the information in the implementation plans. Specifically, Regulatory Guide (RG) 1.206, Section C.IV.3.3.2, “Tier 2 Information,” states: “An applicant or licensee may depart from Tier 2 information, without prior NRC approval, if the proposed departure does not involve a change to, or departure from, Tier 1....” Similar statements are included in the DC rules in the appendices to Part 52 (e.g., Appendix D to Part 52, “Design Certification Rule for the AP1000,” Section VIII.B.5(a), which states: “An applicant or licensee who references this appendix may depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information...”).

The applicant and the staff discussed the scope and type of information that could be added to DCD Tier 1 to constrain changes to the Tier 2 IPs and Scenarios Document such that the staff could review significant changes to ensure they would not invalidate the safety findings in the SER. The staff explained that at a minimum, DCD Tier 1 needed to include additional text to specify that the implementation plans conform to the review criteria in NUREG-0711, Revision 3, which is the criteria the staff used to determine the applicant’s HFE program is acceptable as documented in SER Section 18.

In its response to RAI 553-9084, Question 18-134 (ML17317A397), the applicant provided a proposed revision to DCD Tier 1, Section 2.9, which stated the following:

The HSI system is designed in accordance with the HFE program to provide reasonable assurance that the HFE design is properly developed and effectively implemented to conform to NUREG-0711, Rev. 3. The HFE program objectives for the design are that the design is human-centered, it incorporates HFE principals and methods, and is developed according to a systematic top-down integrated approach in accordance with applicable requirements and performance of the HFE program element implementation plans and results summary reports to support ITAAC closure.

Design ITAAC is applied to the human factors verification and validation (HF V&V) for the APR1400. The HFE program is in effect at least from the start of the design cycle through completion of initial plant startup test program to conform to NUREG-0711, Rev. 3. The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC. Design ITAAC will be closed in accordance with applicable regulatory guidance. Any changes and departures will be governed by applicable regulatory guidance and that included with the design certification rulemaking.

The staff reviewed the applicant's response and considered whether the additional text in DCD Tier 1 would provide sufficient controls to constrain changes to the implementation plans that would affect the conclusions in the SER. The staff determined that the proposed revision was not sufficient because it did not clearly state that the implementation plans were complete and conformed to the review criteria in NUREG-0711, Revision 3. If DCD Tier 1 contained a statement that the IPs are complete and conform to the review criteria in NUREG-0711, Revision 3, then any changes made to the IPs would not need to be reviewed and approved by the staff prior to being implemented as long as the IPs continued to conform to those review criteria.

At a public meeting held on March 14, 2018 (ML18073A255), the staff discussed this with the applicant. Additionally, the staff discussed the following items as additional changes that would need to be made to DCD Tier 1, Section 2.9.

- Not all of the review criteria in NUREG-0711 are applicable to the IPs submitted with this DC application. Some review criteria are identified in NUREG-0711 as being applicable only to boiling water reactors, and thus these review criteria are not applicable to this design because the APR1400 is a pressurized water reactor. Other review criteria are identified as being applicable to reviews of modifications to control rooms at operating plants, and thus these review criteria are not applicable to this application for the development of a new control room design. The appendices of the HFE IPs include a list of the review criteria in NUREG-0711 and the sections of the IPs that conform to those criteria. The staff reviewed these appendices and found they identify the review criteria for boiling water reactors and modifications as not being applicable in all cases except for one instance in the HFE PP. The HFE PP appendix lists one of the modification criteria as being applicable. The staff stated that the applicant should evaluate why this one review criteria is treated differently than the other review criteria for plant modifications and remove it from the HFE PP, if necessary. The staff explained that the HFE IPs should be consistent with NUREG-0711 such that if a COL questions which review criteria in NUREG-0711 are applicable when evaluating changes to the HFE IPs, the information in the application is consistent with the guidance in NUREG-0711.
- Additionally, the staff reviewed all of the applicable review criteria in NUREG-0711 to determine whether they were prescriptive enough to constrain changes to the IPs. The staff found that the majority of the review criteria are sufficiently prescriptive. For example, Review Criterion 5.4(1) in NUREG-0711 provides a list of tasks that should be included in an applicant's task analysis. In order to

conform to this review criterion a required by the statement in DCD Tier 1, the tasks included in the scope of the task analysis, which is discussed in APR1400-E-I-NR-14004, "Task Analysis Implementation Plan," need to contain, at a minimum, the tasks listed in this criterion. Therefore, changes to the scope of task analysis described in the HFE IP can be made as long as the change does not result in the IP no longer conforming to the review criterion.

However, the staff determined some of the review criteria related to ISV testing are not prescriptive enough to adequately control changes to the implementation plans. For example, Review Criterion 11.4.3.5.1(5) states: "The applicant should identify the workload measures obtained for each scenario." In this case, the V&V IP, Section 4.5.5.1, "Types of Performance Measures Used," identifies the method for measuring workload. As discussed in SER Section 18.10.4.3, "Integrated System Validation," for the staff's evaluation of Review Criterion 11.4.3.5.1(5), the staff has reviewed the method for measuring workload during ISV testing and found it is acceptable. However, if another tool for measuring workload is selected instead of the measure in the approved IP, then it is possible that the measure might not be acceptable because it might not be valid, reliable and sensitive. In this case, the IP would continue to conform to the review criterion because the wording in the criterion says the workload measure(s) should be identified and does not prescribe what they should be.

Therefore the staff provided a list of the specific information in the V&V IP that the staff used to make its conclusions, and for which the review criteria are not sufficiently prescriptive, that should be added either in DCD Tier 1 Section 2.9 or in the ITAAC for the ISV test. The applicant stated that all of the information could be added to DCD Tier 1, Section 2.9; however, the applicant stated that the means for measuring workload and situation awareness were proprietary and that it was not desirable to include this information in Tier 1. The staff stated that the applicant could instead state that measures of workload and situation awareness will be valid, reliable, and sensitive. Therefore the specific methods for measuring workload and situation awareness can be changed so long as those methods are valid, reliable and sensitive.

- The Scenarios Document was included with the DC application, and is an extension of the V&V IP. The staff has made some findings on the information in the document. However, unlike all of the other HFE technical reports, it was not incorporated by reference in the DCD. The staff stated it should be incorporated by reference as part of DCD Tier 2 because it is an extension of the V&V IP, and it contains information the staff has relied on to make conclusions to support the safety finding. The staff said the Scenarios Document did not need to be Tier 1 as originally requested in RAI 553-9084, Question 18-134, because the addition of a statement in DCD Tier 1, Section 2.9 that the IPs conform to the review criteria of NUREG-0711, Revision 3, would be sufficient to constrain changes to the scenarios. Specifically, changes to the scenarios in the Scenarios Document will not require prior staff review and approval so long as the scenarios continue to conform to the review criteria in NUREG-0711, Revision 3. The staff's experience conducting inspection of the Westinghouse AP1000 ISV shows that flexibility with the number of scenarios and scenario events is desirable when

DAC has been used because the scenarios may need to be changed as more detailed plant information becomes available. The applicant stated it would include the V&V Scenarios Document in Table 1.6-2.

- The staff also identified some editorial changes that could be made for clarity (e.g., changing “HFE principals” to “HFE principles.”)

In its revised response to RAI 553-9084, Question 18-134 (ML18115A330), the staff reviewed the applicant’s response and determined it was acceptable because the applicant revised the application to address each of the topics discussed at the public meeting on March 14, 2018. Specifically, the applicant proposed the following revisions:

- Addition of a statement in DCD Tier 1, Section 2.9 that the IPs are complete and conform to the review criteria of NUREG-0711, Revision 3.
- Deletion of the review criterion applicable to plant modifications in the appendix of the HFE PP.
- Addition of information from the V&V IP the staff requested to be added because the review criteria in NUREG-0711 are not prescriptive enough to control changes to these sections of the IP. The information continues to be included in the V&V IP, which is Tier 2; however, any changes to the information in the V&V IP that is also included in DCD Tier 1, Section 2.9, requires the NRC’s approval prior to implementing changes.
- Addition to DCD Tier 2, Table 1.6-2, of the Scenarios Document.

The staff finds the proposed revisions to DCD Tier 1, Section 2.9 are sufficient to control changes to the IPs such that any changes are comparable to what would have otherwise been afforded by using Tier 2*. They impose a constraint on the IPs because changes cannot occur that would cause the IP to no longer conform to the NUREG-0711 review criteria or would change the ISV test information in Tier 1, and any changes to Tier 1 require the NRC’s approval prior to changing. The Tier 1 information also states that the design will be developed in accordance with requirements and performance of the IPs and the ReSRs to support ITAAC closure.

Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 553-9084, Question 18-134 was resolved and closed.

ITAAC Closure and COL Information Items

In reviewing DCD Section 14.3.2.9, “ITAAC for Human Factors Engineering,” the staff noted a statement in this section that the ITAAC applied to HFE will be closed in accordance with Section 8.3.1 of NEI 08-01, “Industry Guidelines for the ITAAC Closure Process Under 10 CFR 52,” Revision 4 (Reference 32). Upon further review, the staff found that the cited Section 8.3.1 did not exist in NEI 08-01 and also that the DCD did not reflect the current revision of this Nuclear Energy Institute (NEI) document that has been approved for use by the staff, as documented in RG 1.215, Rev. 2. The staff also found that the description of COL item 14.3(4) provided in DCD Section 14.3.6, “Combined License Information,” and that described in

DCD Section 14.3.2.9, "ITAAC for Human Factors Engineering," were not consistent. Specifically, DCD Section 14.3.2.9 said, "The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC (COL 14.3(4))," but COL item 14.3(4) only said, "The COL applicant is to provide a design ITAAC." The ITAAC had already been provided in DCD Tier 1, Table 2.9-1. To resolve these two issues, the staff issued RAI 512-8665, Questions 14.03.09-2, and 14.03.09-3 (ML16217A494), respectively.

In its response to RAI 512-8665, Question 14.03.09-2 (ML16314E535), the applicant provided proposed revisions to DCD Section 14.3.2.9. The staff reviewed the proposed changes and concluded that the applicant adequately addressed RAI 512-8665, Question 14.03.09-2 because the applicant proposed to revise DCD Section 14.3.2.9 to refer to Section 10.1, "Design Acceptance Criteria," of NEI 08-01, Revision 5 – Corrected and change Reference 32 to NEI 08-01, Revision 5 – Corrected. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 512-8665, Question 14.03.09-2 was resolved and closed.

In its response to RAI 512-8665, Question 14.03.09-3 (ML16314E535), the applicant provided a proposed revision to DCD Section 14.3.6, COL item 14.3(4), which now states, "The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC as addressed in Subsection 14.3.2.9." The staff reviewed the proposed change and concluded that the applicant adequately addressed RAI 512-8665, Question 14.03.09-3 because the applicant proposed to revise the description of COL item 14.3(4) to align with the information in DCD Section 14.3.2.9. The COL information item is acceptable because providing an ITAAC closure schedule for implementing the V&V ITAAC is consistent with guidance in RG 1.206, Section C.III.5.1, "Detailed Design Information and the Combined License Application," which explains the staff's need for a schedule as follows:

The COL applicant should identify those design areas where detailed information cannot be provided and should supply the NRC with a schedule for completion of detailed engineering, procurement, fabrication, installation, and testing information. The applicant should similarly do this in a manner to support timely NRC inspection of DAC information. The path to successfully satisfying the DAC and completing the associated ITAAC may include review of information or procedures that occur early in the construction, fabrication, or development processes that may necessitate early involvement by NRC inspectors and staff.

The applicant also provided conforming changes to DCD Tier 2 Table 1.8-2, "Combined License Information Items." The staff also observed that the applicant changed the numbering of the COL items listed in DCD Section 14.3.6 and Table 1.8-2 such that COL item 14.3(4) in Revision 0 of the DCD is COL item 14.3(2) in Revision 1 of the DCD. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 512-8665, Question 14.03.09-3 was resolved and closed.

At a public meeting held on March 14, 2018 (ML18073A255), the staff discussed clarifying the V&V IP to reflect activities needing to be performed before ITAAC closure. The HFE PP includes Figure 4-2, "APR1400 HFE Program Milestones," and the applicant's response to RAI 553-9084, Question 18-134 (ML17317A397), includes the same figure. The figure shows that the IPs were submitted with the DC application, and the COL holder needs to complete the ReSRs as discussed in the IPs. The figure shows that the results of completing the HFE

activities, as described in the IPs, are inputs to the design, and the ISV test validates the design. Because an ITAAC has been provided for the ISV, but the activities in other HFE IPs need to be completed before the ISV test occurs as shown in the figure, the staff stated that the applicant should consider adding the figure to the V&V IP to help clarify the meaning of the statement the applicant proposed to be added to DCD Tier 1, Section 2.9, which states: “The HFE program objectives for the design are that the design...is developed... in accordance with applicable requirements and performance of the HFE program element implementation plans and results summary reports to support ITAAC closure.” The staff thought this would be helpful to a COL holder because the figure shows the HFE activities that need to occur before the ISV test and thus before ITAAC closure.

In the applicant’s revised response to RAI 553-9084, Question 18-134 (ML18082A926), the applicant revised the V&V IP by adding Figure 3-1, “ITAAC Closure Schedule,” which shows the activities that precede the ISV and ITAAC closure, and that the results of those activities are inputs to the design that is validated by the ISV test. The staff finds this acceptable. Based on the review of the V&V IP, the staff has confirmed incorporation of the changes described above; therefore, RAI 553-9084, Question 18-134 was resolved and closed.

During the APR1400 Subcommittee Meeting of the Advisory Committee on Reactor Safeguards (ACRS) held on June 21, 2017, to discuss Chapter 18 of the DCD, the ACRS questioned why there are no COL items for the HFE elements that have an associated IP. Specifically, the ACRS questioned how the COL applicant will know that it is the COL applicant’s responsibility to complete the activities described in the HFE IPs. Following the ACRS meeting, the staff considered this question and reevaluated the application.

As stated above, the applicant included nine IPs and three COL items in the DC application to address the 12 HFE program elements. The applicant’s IPs describe the means by which nine of the HFE program elements will be completed. The results of completing the activities in the IPs are inputs to the design that is validated during the ISV test. The ISV test must be completed before the ITAAC for the ISV can be closed; however, the activities described in the IPs are not required to be complete prior to issuance of a COL. Therefore, COL items are not necessary for the HFE program elements for which the DC applicant has provided an implementation plan. Additionally, because Figure 4-2, “APR1400 HFE Program Milestones,” of the HFE PP shows that the IPs are completed as part of during C and that the ReSRs need to be completed following DC and prior to conducting the ISV test and closing the ITAAC, the staff finds the application sufficiently describes what a COL applicant needs to do.

14.3.9.5 Combined License Information Items

The DCD Tier 2 Section 14.3.2.9 contains one COL item pertaining human factors engineering. The staff’s review of this item is discussed in Section 14.3.9.4 of this report. The staff concluded that no additional COL items were needed.

Table 14.3-15 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 14.3(2)	The COL applicant is to provide a design ITAAC closure schedule for implementing the V&V design ITAAC as addressed in DCD Tier 2, Subsection 14.3.2.9.	14.3

14.3.9.6 Conclusion

The staff concludes that DCD Tier 1 Section 2.9 satisfactorily summarizes the top-level design process objectives that will be used to develop the HFE design and is consistent with DCD Tier 2, Chapter 18 “Human Factors Engineering.” Therefore the Tier 1 information associated with DCD Section 14.3.9 “Human Factors Engineering - Inspections, Tests, Analyses, and Acceptance Criteria” is acceptable.

Furthermore, the staff concludes that the ITAAC in Tier 1 Section 2.9 adequately verify the DCD Tier 1 HFE design. Therefore, within the review scope of this section, the staff concludes that the APR1400 ITAAC in Tier 1 Section 2.9, are necessary and sufficient to provide reasonable assurance that, if the Inspections, Tests, and Analyses are performed and the Acceptance Criteria are met, a facility that incorporates the certified APR1400 design has been constructed and will be operated in conformity with the applicable portions of the DC, the AEA, and the NRC’s rules and regulations.

14.3.10 Emergency Planning– Inspections, Tests, Analyses, and Acceptance Criteria

The staff’s evaluation of the design-related Emergency Planning ITAAC contained in DCD Tier 1, Section 2.10, Table 2.10-1, “Emergency Planning ITAAC,” and Tier 2 Section 14.3.2.10, “ITAAC for Emergency Planning,” are evaluated in Section 13.3.4.9, “ITAAC,” of this SER.

14.3.11 Containment Systems – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.11.1 Introduction

Design Control Document (DCD) Tier 2, Section 14.3, “Inspections, Tests, Analysis, and Acceptance Criteria,” (ITAAC) discusses the selection criteria and methods used to develop the DCD Tier 1 information and the ITAAC. DCD Tier 1 includes the portion of the design-related information that, if acceptable, would be approved, certified, and incorporated by reference into a new DC rule for the APR1400 design. The design descriptions, interface requirements, and site parameters are derived from DCD Tier 2 information.

This Section 14.3.11 evaluation addresses ITAAC related to the containment and associated systems. The scope of “containment systems” encompasses containment design and associated issues, which include containment isolation provisions, containment leakage testing, hydrogen generation and control, containment heat removal, and subcompartment analysis.

The staff reviewed the ITAAC with respect to containment systems described in the DCD in accordance with NUREG-0800, Sections 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria,” and 14.3.11, “Containment Systems – Inspections, Tests, Analyses, and Acceptance

Criteria.” The staff reviewed the proposed ITAAC to determine whether they are necessary and sufficient to provide reasonable assurance that, if the ITAAC are successfully completed, a facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the Commission's rules and regulations. In addition, the staff reviewed whether interface requirements are necessary for containment systems.

The scope of the review of the containment systems ITAAC includes the DCD Tier 1 sections given in Table 14.3-16, “Cross References for the Staff’s Evaluation of Containment Systems ITAAC,” of this report, that are significantly related to normal operation, transients, and accidents. The evaluation of each containment system’s ITAAC is documented in the section of this SER referenced below in Table 14.3-16.

14.3.11.2 Summary of Application

DCD Tier 1: The applicant provided design descriptions for containment systems in DCD Tier 1 Section 2.11, “Containment Systems.” DCD Tier 1, Chapter 1, “Introduction,” provides definitions, general provisions, and a legend for figures, acronyms, and abbreviations.

Table 14.3-16 Cross References for the Staff’s Evaluation of Containment Systems ITAAC

DCD Tier 1 Section	Title	ITAAC Table	SER Section	SER Section for 52.47(b)(1) Finding
2.11.1	Containment Structure	2.11.1-2	6.2.1	6.2.1
2.11.2	Containment Spray System	2.11.2-4	6.2.2	6.2.2
2.11.3	Containment Isolation System	2.11.3-2	14.3.11.4.5	14.3.11.4.5
2.11.4	Containment Hydrogen Control System	2.11.4-3	14.3.11.4.6	14.3.11.4.6

System design descriptions include relevant information for the ITAAC, such as key design features; seismic and ASME code classifications used in design and construction; system operation; alarms, displays, and controls; logic for system actuation; interlocks; class 1E power sources and divisions; equipment to be qualified for harsh environment; interface requirements; and numeric performance values. The design description contains tables and figures that are referenced in the Design Commitment column of the ITAAC tables listed above.

The applicant organized its Tier 1 information in a manner similar to that used for the evolutionary designs as described in SRP Section 14.3 and RG 1.206 Section C.II.1. The ITAAC tabular format and content for the containment systems follows the NRC recommended format described and presented in RG 1.206, Table C.II.1-1, “Sample ITAAC Format.” The ITAAC are presented in a three-column table that includes the proposed commitment to be verified (column 1), the method by which the licensee will verify (column 2), and specific

acceptance criteria for the inspections, tests, or analyses (column 3) that, if met, demonstrate the licensee has met the design commitment in column 1.

DCD Tier 2: The DCD Tier 2, Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria,” provides a general description of the APR1400 ITAAC including its relationship to other DCD Tier 1 information, and the bases, processes, and selection criteria used to develop Tier 1 information.

The applicant specified that the ITAAC for containment systems were prepared in accordance with the guidance in RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria”; NUREG-0800 SRP Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria”; and NUREG-0800 SRP Section 14.3.11 “Containment Systems – Inspections, Tests Analyses, and Acceptance Criteria.”

ITAAC: The applicant provided ITAAC for containment systems in DCD Tier 1 sections as listed above in Table 14.3-16.

TS: There are no TS for this area of review.

14.3.11.3 Regulatory Basis

The relevant requirements of the Commission regulations for this area of review, and the associated acceptance criteria, are given in Section 14.3 and 14.3.11 of NUREG-0800. Review interfaces with other SRP sections are also identified in this SRP section.

The applicable regulatory requirements are as follows:

- 10 CFR 52.47(b)(1), “Contents of applications; technical information,” as it relates to the requirement that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the DC has been constructed and will be operated in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC rules and regulations.

14.3.11.4 Technical Evaluation

The staff performed its review of the system and non-system based ITAAC in accordance with the SRP Section 14.3 and SRP Section 14.3.11, particularly the applicable review procedures identified in each SRP Section III, as well as the guidance provided by RG 1.206, Section C.II.1, “Inspections, Tests, Analyses, and Acceptance Criteria.” The staff examined the ITAAC to ensure that they can be inspected by the organization holding the combined license and closed out by the staff. The review examined the phrasing and format of the ITAAC to determine if they were consistent (i.e., the Design Commitment; the Inspection, Test, or Analysis; and the Acceptance Criteria are parallel and in agreement). In addition, the staff determined that the DCD Tier 1 ITAAC items were derived from the DCD Tier 2 information.

14.3.11.4.1 ITAAC Development Criteria

The RG 1.206 Section C.II.1.2.11, "ITAAC for Containment Systems," describes the ITAAC development for containment systems and identifies the aspects to be verified through ITAAC. These are related to the containment design and associated issues, such as containment isolation provisions, containment leakage testing, hydrogen generation and control, containment heat removal, and sub-compartment analysis.

Since the features for ITAAC development criteria listed in DCD Tier 2 Section 14.3.2.11 are identical to those listed in RG 1.206 Section C.II.1.2.11 for an active plant, the staff concludes that the applicant adequately identified the general aspects to be verified through ITAAC in DCD Tier 2 Section 14.3.2.11, including the ITAAC to verify the top-level design features.

14.3.11.4.2 Containment Systems Tier 1 Section 2.11

In performing the evaluation of the ITAAC items, and determining whether the ITAAC appropriately verify the top-level design features, the staff considered the safety function significance of each item in light of the results of the containment safety analyses, such as loss-of-coolant-accident, main-steam-line-break, main-feed-line-break, and subcompartment analyses. Specifically, DCD Tier 2, Table 14.3.4-1, "Design Basis Accident Analysis Key Design Features," DCD Tier 2, Table 14.3.4-2, "PRA and Severe Accident Analysis Key Design Features," and DCD Tier 2, Table 14.3.4-6, "Radiological Analysis Key Design Features," were reviewed to confirm that the table entries are complete with respect to the safety analyses in DCD Tier 2, Chapter 6, "Engineered Safety Features," and DCD Tier 2, Chapter 15, "Transient and Accident Analyses," and consistent with DCD Tier 2, Section 14.2, "Initial Plant Test Program."

In addition, the staff used the SRP sections identified in SRP Section 14.3.11 that have a potential impact on the containment systems ITAAC sections. These included the following SRP sections that provide information related to SRP Section 14.3.11: SRP Section 14.3 (general guidance on ITAAC), SRP Section 14.3.2 (structures, systems, and components' (SSCs') ability to withstand various natural phenomena), SRP Section 14.3.3 (piping design), SRP Section 14.3.5 (instrumentation and controls), SRP Section 14.3.6 (electrical systems and components), and SRP Chapter 19 (SSCs' design features and functions that should be addressed based on severe accident, PRA, and shutdown safety evaluations).

The staff assessed the containment systems ITAAC items for the following DCD Tier 2 sections in accordance with the applicable procedures and guidance provided in SRP Sections 14.3 and 14.3.11:

- Section 6.2.1, "Containment Functional Design"
- Section 6.2.2, "Containment Heat Removal System"
- Section 6.2.4, "Containment Isolation System"
- Section 6.2.5, "Containment Hydrogen Control System"

The staff's specific evaluation of the above sections relating to the adequacy of their ITAAC items are presented in the sections of this report identified above in Table 14.3-16. The staff considers the ITAAC to be adequately addressed and acceptable.

14.3.11.4.3 Containment Function Design ITAAC, Table 2.11.1-2

The primary functions of the RCB are to protect the safety-related SSCs located within it and to prevent the release of radiation and contamination during normal plant operations and accidents. The containment encloses the reactor system and is the final barrier against the release of significant amounts of radioactive fission products in the event of an accident. Containment structure must also maintain functional integrity in the long term following a postulated accident. The design and sizing of containment systems are largely based on the pressure and temperature conditions that result from release of the reactor coolant in the event of LOCA.

The information associated with this evaluation is provided in DCD Tier 2, Section 6.2.1.1, "Containment Structure," and DCD Tier 1, Section 2.11.1, "Containment Structure."

The ITAAC associated with the evaluation of DCD Tier 2, Section 6.2.1 are provided in DCD Tier 1, Table 2.11.1-2, "Containment Structure ITAAC." The staff's detailed review of Containment Function Design Tier 1 information is contained in Section 6.2.1 of this SER.

14.3.11.4.4 Containment Heat Removal System ITAAC, Table 2.11.2-4

The containment heat removal system credited in the APR1400 DCD is the containment spray system (CSS). The CSS is a safety-related system which acts to reduce containment pressure and temperature following a main steam line break or a loss-of-coolant accident (LOCA). The CSS consists of two divisions, each with a pump, heat exchanger, spray header and associated piping and valves capable of delivering 100 percent of the required flow.

The information associated with this evaluation is provided in DCD Tier 2, Section 6.2.2, "Containment Heat Removal System," and DCD Tier 1, Section 2.11.2, "Containment Spray System."

The ITAAC associated with the evaluation of DCD Tier 2, Section 6.2.2 are provided in DCD Tier 1, Table 2.11.2-4, "Containment Spray System ITAAC." The staff's detailed review of the CSS Tier 1 information is contained in Section 6.2.2 of this SER.

14.3.11.4.5 Containment Isolation System ITAAC, Table 2.11.3-2

The containment isolation system (CIS) is a safety-related system which allows the normal or emergency passage of fluids through the containment boundary while preserving the ability of the boundary to prevent or limit the escape of fission products from postulated accidents. The CIS includes the system and components (piping, valves, and actuation logic) that establish and preserve the containment boundary integrity.

The information associated with this evaluation is provided in DCD Tier 2, Section 6.2.4, "Containment Isolation System," and DCD Tier 1, Section 2.11.3, "Containment Isolation System."

The ITAAC associated with the evaluation of DCD Tier 2, Section 6.2.4 are provided in DCD Tier 1, Table 2.11.3-2, "Containment Isolation System ITAAC." The staff's detailed review of the CIS is contained in Section 6.2.4 of this SER, but the review of the ITAAC in Tier 1 Section 2.11.3 follows.

DCD Tier 1, Section 2.11.3, "Containment Isolation System," describes the design, functional requirements, and location of all the components in the CIS and provides ITAAC confirming the design and location of all components. DCD Tier 1 Table 2.11.3-1, "Containment Isolation System Components List," also provides the design and functional requirements of all components in the CIS with the configuration as shown in Figure 2.11.3-1, "Containment Isolation Valves Functional Arrangement." The ITAAC associated with the design commitments are provided in DCD Tier 1 Table 2.11.3-2, "Containment Isolation System ITAAC."

The staff has reviewed Table 2.11.3-1 and Table 2.11.3-2 regarding the design commitments and ITAAC. ITAAC Table 2.11.3-2, Item 1 verifies functional arrangement of the CIS components. Items 2, 3, and 4 verify ASME Section III requirements of ASME Code components and piping, pressure boundary welds and pressure boundary integrity at their design pressure. Item 5 verifies seismic Category I requirements of the CIS. Items 6 to 11 verify component environmental qualification, Class 1E power source, separation and electrical isolation, controls and indications, and valve closure times. After reviewing these ITAAC items, the staff determined, with one exception discussed below, that the ITAAC would be necessary and sufficient to verify that a facility incorporating the APR1400 design has been constructed and will be operated in accordance with the applicable portions of the certified design, the NRC's rules and regulations, and the AEA.

However, the staff's review of the Containment Isolation System ITAAC, Table 2.11.3-2 revealed that no ITAAC were provided to confirm that the as-built piping distances from containment to containment isolation valve outside containment will not exceed those listed in DCD Tier 2 Table 6.2.4.1, "List of Containment Penetrations and System Isolation Positions." The staff also indicated that the associated penetration numbers should be included in DCD Tier 1, Table 2.11.3-1, "Containment Isolation System Component List." Therefore, the staff issued RAI 357-8344, Question 06.02.04-11 to address the issue (ML15006A045). In the response (ML16182A591), the applicant stated that General Design Criteria (GDC) 55, 56, and 57 require that isolation valves located outside of containment should be located as close to containment as practical. The APR1400 design has incorporated this design concept into the location of the containment isolation valves, and acceptable containment isolation valve location is assured through the overall design and piping analysis program. According to the applicant, the length of pipe between containment and the isolation valve indicated in DCD Tier 2, Table 6.2.4-1 does not necessarily represent a bounding condition for each piping line listed. Therefore, the applicant stated that including verification of as-built piping distances as a prescriptive ITAAC item is not meaningful nor practical for a subjective criteria such as locating isolation valves as close as practical to containment and the graded approach for piping analysis that has been implemented for the APR1400. In a revised response (ML17171A364), the length of pipe from containment to outer isolation valves in DCD Tier 2, Table 6.2.4-1 markups was included. The applicant provided an example from an operational plant as a reference which was subject to change during the detailed design phase. As discussed in Section 6.2.4 of this report, the staff finds these values of length in Table 6.2.4-1 acceptable for conformance with the requirements of GDC 55, 56 and 57. But in the response to RAI 357-8344, Question 06.02.04-11, the applicant did not provide ITAAC to ensure that the outer isolation valves in the as-built structure are located as close to the containment as

practical. In an email (ML18073A391), the NRC notified the applicant that an ITAAC needs to be provided to ensure the requirements of GDC 55, 56, and 57 are met. In a revised response to RAI 357-8344 Question 06.02.04-11 (ML18089A578), the applicant proposed an additional ITAAC to be added to DCD Tier 1 Table 2.11.3-2. The staff's review found the proposed ITAAC sufficient to ensure that the isolation valves in the as-built structure are as close to the containment as practical, thereby meeting the requirements of GCDs 55, 56, and 57.

Containment penetration numbers were added to DCD Tier 1, Revision 1, Table 2.11.3-1 in the response to RAI 357-8344 Question 06.02.04-11, Revision 0. The applicant indicated that some incorrect information in DCD Tier 1, Table 2.11.3-1 regarding valves FW-V132, IA-V0020, PS-V0032, PS-V0258 and WI-V0015 will be corrected, and missing manual valves VQ-V2014, V016 AND V2024 will be added as indicated in the attachment associated with this response. The staff reviewed the proposed markup changes to DCD Tier 1, Table 2.11.3-1 and finds them acceptable.

Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 357-8344, Question 06.02.04-11 was resolved and closed.

The staff finds that the proposed ITAAC in Table 2.11.3-2 of DCD Tier 1 satisfy 10 CFR 52.47(b)(1) because they are necessary and sufficient to provide reasonable assurance that, if met, the containment isolation system has been constructed and will be operated in conformity with the applicable portions of the certified design, the NRC's rule and regulations, and the AEA. The ITAAC ensure the containment isolation system conforms to the design as described in the DCD Tier 2 Section 14.3.2.11 by verifying locations and classifications for components and the necessary controls and alarms for monitoring system operation. This conclusion is based on the inclusion of comprehensive inspections, tests, and analyses that verify the acceptability of the containment structure.

14.3.11.4.6 Containment Hydrogen Control System ITAAC, Table 2.11.4-3

The Containment Hydrogen Control System (CHCS) mitigates the consequences of postulated accidents by mixing, monitoring, preventing, or removing combustible gas concentrations that may be released into the containment atmosphere in the event of a significant beyond-design-basis accident.

The information associated with this evaluation is provided in DCD Tier 2, Section 6.2.5, "Hydrogen Control System," and DCD Tier 1, Section 2.11.4, "Containment Hydrogen Control System."

DCD Tier 1, Section 2.11.4, "Containment Hydrogen Control System," describes the function and location of all the components in the CHCS and provides ITAAC confirming the existence and location of all components. The staff requested that additional design information for the Containment Hydrogen Monitoring System (CHMS) be added to the ITAAC in Section 2.11.4 as indicated in RAI 155-8167, Question 06.02.05-5 (ML15235A001). In its response to RAI 155-8167, Question 06.02.05-5, (ML15322A028), the applicant committed to adding to the ITAAC additional design information concerning the number and locations of the passive autocatalytic recombiners (PARs) and the hydrogen igniters (HIs), and range information for the hydrogen monitors (ML15322A028). The staffs finds this response acceptable. The staff confirmed that APR1400 contains this update. RAI 155-8167, Question 06.02.05-5 was resolved and closed.

The staff also requested in RAI 155-8167, Question 06.02.05-4, dated August 18, 2015, the PAR and HI locations be provided in DCD Tier 1 and PAR recombination rates be added to DCD Tier 1 ITAAC Table 2.11.4-3, and Tier 2 (ML15235A001). In its response to RAI 155-8167, Question 06.02.05-4, the applicant provided the recombination rates for the three sizes of PARs (ML15322A028). The staff has reviewed this response and found the recombination rates acceptable, as they form the basis of the combustible gas control in containment analysis. However, staff needed this information to be provided in both DCD Tier 1 and Tier 2 for completing its review. Therefore, the staff closed RAI 155-8167, Question 06.02.05-4 as unresolved and issued a follow-up RAI 541-8724, Question 06.02.05-12 requesting this information be added to the DCD.

In its response to RAI 541-8724, Question 06.02.05-12, the applicant provided PAR and HI locations in the containment and markups for DCD Tier 1 Table 2.11.4-1 (ML17363A255). The staff reviewed this information and determined that it provided an adequate basis for locating PARs and HIs in the containment. The applicant provided PAR recombination rates and markups for DCD Tier 2 Table 6.2.5-3 giving this information. The applicant provided markups for DCD Tier 1 Table 2.11.4-3 providing an acceptance criterion for PAR and HI capacities that would verify that the hydrogen depletion rates for the installed PARs and HIs will maintain containment hydrogen concentration, both locally and globally, of less than or equal to 10 percent by volume, or that DDT or detonation is avoided in order to maintain containment integrity. For hydrogen igniters, the acceptance criterion requires that the surface temperature exceeds 1,700 °F. Based on the review of the DCD, the staff has confirmed incorporation of the changes described above; therefore, RAI 541-8724, Question 06.02.05-12 was resolved and closed.

DCD Tier 1 Table 2.11.4-1 identifies PARs and HIs of the CHCS and the containment temperature element of the CHMS as seismic Category I, for which DCD Tier 1 ITAAC Table 2.11.4-3 lists a design commitment with an acceptance criterion to ensure that they are located in a seismic Category I structure. (The temperature measurement is for monitoring hydrogen concentration in the containment as described in DCD Tier 2 Section 6.2.5.2.2.) The staff finds this acceptable because this ITAAC would ensure that the CHCS and CHMS would function after a seismic event consistent with SRP Section 6.2.5 and RG 1.7.

DCD Tier 1 ITAAC Table 2.11.4-3 lists a design commitment requiring that electrical power to HIs be supplied from the Class 1E division. On loss of offsite power and failure of the emergency diesel generator to start or run, the HIs have the alternate power supply from the alternate alternating current (AAC) generator. Also, HIs are powered by battery back-up. Tests will be performed on the as-built HIs to confirm that they are powered from Class 1E division, the emergency diesel generator, the AAC generator, and DC battery. The staff finds this ITAAC acceptable because it ensures that HIs are powered from reliable, diverse power sources consistent with SRP Section 6.2.5 and RG 1.7.

DCD Tier 1 ITAAC Table 2.11.4-3, provides a design commitment requiring that the Containment Temperature Element, CM-TE-031A, be qualified for a harsh environment so that it is capable of withstanding the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. The ITAAC verifies this design commitment through type tests, analyses or a combination of type tests and analyses of the SSC, with an inspection to verify that the as-built SSC is bounded by the tested or analyzed conditions. As stated in DCD Tier 2

Section 6.2.5.2.2, "Containment Hydrogen Monitoring System," the temperature measurement from the Containment Temperature Element is used to calculate containment hydrogen concentration. The staff informed the applicant that the containment and IRWST hydrogen concentration instruments should be included in the list of equipment to be verified by ITAAC that they are qualified for a harsh environment. In response to RAI 558-9456 Question 14.03.01-1 (ML18137A480) the applicant proposed to add the instruments identified in Table 2.11.4-2 to the design commitment and acceptance criteria of ITAAC 6 in Table 2.11.4-3. Since Table 2.11.4-2 identifies the containment and IRWST hydrogen concentration instruments, the staff finds this response acceptable. Based on a review of the DCD, the staff confirmed incorporation of the changes described above; therefore RAI 558-9456 Question 14.03.01-1 was resolved and closed. The staff finds that the design commitment and ITAAC provided are consistent with SRP Section 6.2.5 and RG 1, and therefore, are acceptable.

DCD Tier 2 Section 6.2.5.2.1 states the following: "Because the PAR is self-actuated and does not need a power supply, operator action for the PAR is not needed. The HIs are actuated by manual actuation in the MCR or RSR on indication that the hydrogen concentration exceeds a predetermined setpoint of volume percent or an indication of the beyond DBA." Consistent with this DCD Tier 1 ITAAC Table 2.11.4-3 lists design commitments for controls, displays, and alarms existing in the MCR and RSR for which inspections will be performed to confirm. The staff finds these ITAAC acceptable because they ensure the availability of controls, displays, and alarms for monitoring hydrogen concentration in the containment from the MCR and RSR consistent with SRP Section 6.2.5 and RG 1.7.

In its response to RAI 546-8782, Question 14.03.03-6, on incorporation of standardized ITAAC guidance regarding equipment qualification for nonmetallic parts in safety-related mechanical equipment, the applicant added item 7 to DCD Tier 1 ITAAC Table 2.11.4-3 (ML17227A608). DCD changes in response to this RAI are reviewed and found acceptable in Section 14.3.3.4.3 of this report.

The staff review found that the applicant's proposed ITAAC for the CHCS in Table 2.11.4-3 in Tier 1 of the DCD, are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the CHCS has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations. Therefore, the staff finds that the APR1400 CHCS meets the requirements of 10 CFR 52.47(b)(1).

14.3.11.4.7 Interface Requirements

Interface requirements are defined for: (a) systems that are entirely outside the scope of the design, and (b) the out-of-scope portions of those systems that are only partially within the scope of the standard design. The applicant has included the containment systems' designs within the complete scope of the standard design, thus precluding the necessity of having interface requirements for these systems. The staff has accepted that interface requirements are not needed for containment systems.

14.3.11.5 Combined License Information Items

There are no COL Information Items associated with the APR1400 Containment Systems ITAAC.

14.3.11.6 Conclusion

In general, the staff concludes that the applicant has adequately identified the containment systems which need to have ITAAC requirements. The review of the ITAAC in Tier 1 Tables 2.11.1-2 (Containment Functional Design) and 2.11.2-4 (Containment Heat Removal System) are in Sections 6.2.1 and 6.2.2 of this report, respectively. The review completed in this section of the SER supports the 10 CFR 52.47(b)(1) findings made in those sections of the SER. For the review of the ITAAC in Tier 1 Table 2.11.3-2 (Containment Isolation System) and Table 2.11.4-3 (Containment Hydrogen Control System), the staff finds, based on the above review, that these ITAAC satisfy 10 CFR 52.47(b)(1).

14.3.12 Physical Security Hardware – Inspections, Tests, Analyses, and Acceptance Criteria

14.3.12.1 Introduction

In APR1400 DCD Tier 2, Chapter 14, Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria [ITAAC],” the applicant described the methods for verifying design commitments for physical security incorporated into the KHNP APR1400 standard design. The DCD Tier 2 describes the engineered physical security systems (PSS), hardware, and features within the scope of the APR1400 standard DC to establish a design standard for multiple security functions. That standard will provide, in part, the detection, assessment, communication, delay, and response functions of the design of a physical protection system that implement a physical security program that will protect against potential acts of radiological sabotage and theft of special nuclear material (SNM).

Specifically, the applicant provided the design descriptions for engineered PSS and credited design features (e.g., structural walls, floors, and ceilings, configurations of nuclear island and structures), descriptions of intended security functions and performance requirements, assumptions for detailed design, and supporting technical bases that a COL applicant will incorporate by reference as part of the design and licensing bases. The APR1400 standard design, along with site-specific design of a physical protection system, physical protection programs, and a security organization that are described by a COL applicant, demonstrates how a COL applicant will meet the performance and prescriptive requirements of 10 CFR Part 73, “Physical Protection of Plants and Materials.”

The design bases, analyses, and assumptions for the design of PSS, including plant layout and building configurations of the APR1400 design, are described in KHNP TeR APR1400 E-A-NR-14002-SGI, “Security Design Features.” The technical report describes evaluations and identifies vital equipment and areas for the APR1400 standard design. The scope of the PSS described in the APR1400 standard design is limited to those related to the nuclear islands and structures within the standard design. DCD Tier 2, Section 13.6, “Physical Security,” identifies COL information items and requires the COL applicant to provide descriptions addressing the design of PSS that are outside the scope of the APR1400 standard

design and provide descriptions of the COL applicant's physical protection programs, respectively.

The APR1400 DCD Tier 1, Section 2.13, "Physical Security Hardware," describes the generic standard physical security ITAAC for the verification of design commitments for vital equipment, vital areas, and PSS. The COL applicant that references the APR1400 standard design, addresses the PSS that are not within the scope of the certified design - beyond the nuclear island and structures - that reference the APR1400 standard design. The COL Information Items COL 14.3(1) and COL 14.3(3), establish actions that the COL applicant will provide the ITAAC for the site-specific portion of the plant systems and describe the ITAAC for the facility's physical security hardware for site-specific PSS credited for performing security functions, based on the COL applicant's final design of a physical protection system and security programs.

14.3.12.2 Summary of Application

The following portions of the APR1400 DCD Tier 1 and Tier 2, and referenced TeRs contain the applicant's design descriptions and physical security ITAAC information related to PSS that meet regulatory requirements:

DCD Tier 1: DCD Tier 1, Section 2.12.1, "Design Description," describes key elements of a physical protection system for the APR1400 standard design that provide detection, delay, and response to protect against the design-basis threat (DBT) for radiological sabotage. Table 2.12-1, "Physical Security Hardware ITAAC [4 sheets]," provides the general design commitments, inspections, tests, and analyses (ITA), and acceptance criteria of PSS included in the scope of the APR1400 standard design. In addition, Section 2.6.9, "Communication Systems," describes plant and plant-to-offsite communications for security-related events and plant security communication systems. Table 2.6.9-1, "Communication Systems ITAAC," includes design commitments for communication systems meeting security functions. Section 2.6.8, "Lighting Systems," describes normal and emergency lighting systems for illuminations inside buildings and plant areas. Table 2.6.8-1, "Plant Lighting Systems Inspections, Tests, Analyses, and Acceptance Criteria," includes verification of design commitments for plant lighting systems.

DCD Tier 2: DCD Tier 2, Section 1.2, "General Plant Description," through Section 1.2.14, "Plant Arrangement Summary," provides descriptions of what is within the scope of the APR1400 standard design. Section 1.8.1, "COL Information Items," identifies COL 1.8(1) and COL 1.8(2) for the COL applicant to address how site-specific interface requirements will be met and how each COL information item is addressed. Tables 1.8-1, "Index of System, Structure, or Component Interface Requirements for APR1400," and 1.8.2, "Combined License Information Items," describe protection systems interfaces, related PSS, and associated ITAAC. COL 14.3(4), specifies that the COL applicant is to provide ITAAC for the facility's physical security hardware addressed in Section 14.3.2.12, "ITAAC for Physical Security Hardware," which describes the PSS that are site specific (i.e., not within the scope of the APR1400 standard design) and how they will meet applicable regulatory requirements of 10 CFR 73.55, "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage," for design, configuration, or installation of PSS.

The applicant described conformance with the U.S. Nuclear Regulatory Commission (NRC) regulatory guides (RGs) in Section 1.9, "Conformance with Regulatory Criteria." Table 1.9-1

identifies conformance to RGs. The applicant's conformance with Division 5, "Materials and Plant Protection," RGs are described in DCD Tier 2, Section 1.9.1, "Conformance with Regulatory Guides." Table 1.9-2, "APR1400 Conformance with the Standard Review Plan," provides specifics for applicability of SRPs (i.e., NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," various dates and revisions) and their conformance. Table 1.9-1, "APR1400 Conformance with Regulatory Guides," identifies guidance, such as RG 5.7, "Entry/Exit Control for Protected Areas, Vital Areas, and Material Access Areas"; RG 5.65, "Vital Area Access Controls, Protection of Physical Security Equipment, and Key and Lock Controls"; and RG 5.79, "Protection of Safeguards Information," for elements of the site-specific physical security program that is addressed by the COL applicant and not applicable for DC. Table 1.9-2 identifies SRP Section 13.6, "Physical Security," and SRP Section 13.6.2, "Physical Security – Design Certification," Revision 1, issued October 2010. The applicant also identified SRP Section 14.3.12, "Physical Security Hardware – ITAAC," Revision 0, issued March 2007, instead of subsequent Revision 1, issued May 2010. The staff issued RAI 197-8176, Question 14.3.12-9 (ML15247A004), requesting that the applicant indicate Revision 1 to SRP Section 14.3.12, which the APR1400 conforms to in preparing the DCD for certification. In its response to RAI 197-8176, Question 14.3.12-9 (ML15315A042), the applicant addressed this issue. The staff finds the applicant's response to indicate the latest revision of SRP 14.3.12 in the revision to the DCD acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-9. Therefore, RAI 197-8176, Question 14.3.12-9, was resolved and closed.

The DCD Tier 2, Section 13.6.2, "Physical Security – Design Certification," states:

[t]his section provides noncategorized, high level, details on the systems, structures and components (SSCs) that make up the Physical Security system. Additional details are provided in the technical report "Physical Security Design Features" (Reference 3) which includes details on the systems, structures, and components (SSCs) that require protection as vital equipment, as defined in 10 CFR 73.2 (Reference 4), as well as details on the installed security features required for physical protection. This report is to be incorporated by reference. Reference 3 is categorized as security safeguards information (SGI) and is withheld from public disclosure pursuant to 10 CFR 73.21 (Reference 6).

The applicant describes PSS incorporated as part of the APR1400 physical standard design. The COL applicant would describe the elements of a physical protection program, such as the organization structure, training, operational programs, plant procedures, target sets, performance assessments, response requirements, design features for physical protection, and Fitness-for-Duty Program, along with an implementation schedule that are outside the scope of the design certification.

The DCD Tier 2, Chapter 14, "Verification Programs," describes the physical security ITAAC for design commitments that will be verified to satisfy the acceptance criteria through inspections, tests, and/or analyses. The following sections discuss the verification of ITAAC within the scope of the APR1400 standard design: Section 14.2, "Initial Plant Test Program"; Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria"; and Section 14.3.2.12, "ITAAC for Physical Security Hardware." Section 14.2 describes the ITAAC abstracts for preparing test procedures for verifying the ITAAC for the APR1400 standard design. In Section 14.3.6, "Combined License Information," the applicant identified COL 14.3(3), which requires the COL

applicant referencing the APR1400 DC to provide site-specific ITAAC for the facility's PSS not addressed in the APR1400 standard design.

Technical Reports: The applicant submitted TeR APR1400-E-A-NR-14002-SGI, "Physical Security Design Features," and TeR APR1400-E-A-NR-14001-SGI, "Physical Security Design Response," which describe the security considerations in the APR1400 standard design. TeR APR1400-E-A-NR-14002-SGI, is incorporated by reference in DCD Tier 2, Operations, Section 13.6, "Physical Security." The applicant did not incorporate by reference, TeR APR1400-E-A-NR-14001-SGI, and therefore does not provide the technical bases for the staff's review and findings for the requested APR1400 standard DC. The information contained in the TeR(s) is Safeguards Information and/or security-related or proprietary information; therefore, it is protected in accordance with 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements," and 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," respectively.

Combined License Information Items: COL 14.3(3), requires the COL applicant referencing the APR1400 standard design to provide ITAAC for the facility's physical security hardware addressed in Section 14.3.2.12, in accordance with RG 1.206, "Combined License Applications for Nuclear Power Plants," as appropriate, and provide a test abstract describing the specific inspections, tests, and analyses for the physical security ITAAC not addressed in the DCD. COL 14.2(5), inadequately identified an action to defer the development of detail descriptions addressing system testing requirements for the APR1400's physical security ITAAC to the COL applicant. The staff issued RAI 197-8176, Question 14.3.12-5 (ML15247A004), requesting the applicant to delete COL 14.2(5). In its response to RAI 197-8176, Question 14.3.12-5 (ML15315A042), the applicant addressed this issue. The staff finds the applicant's response to delete COL item 14.2(5) from the DCD, acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-5. Therefore, RAI 197-8176, Question 14.3.12-5 was resolved and closed. In addition, Revision 1 to DCD Tier 2 Section 14.3 added COL 14.3(4), "the COL applicant is to provide the proposed ITAAC for the facility's physical security hardware not addressed in the DCD in accordance with RG 1.206."

The COL applicant is to revise the nonstandard plant vital areas and vital equipment information in the reference TeR, APR1400-E-A-NR-14002-SGI, and address any site-specific designs or conditions. The site specific information are relied on to identify key design commitments and acceptance requirements that must be verified through ITAAC for site-specific PSS constructed and installed to perform security functions as designed and relied on to implement the security programs.

14.3.12.3 Regulatory Basis

Regulations in 10 CFR 52.47, "Contents of Applications; Technical Information," require that information submitted for a DC must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, as well as procurement specifications and construction and installation specifications by an applicant. The provisions in 10 CFR 52.47(b)(1) require the APR1400 application to contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and will operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended and the Commission's rules and regulations.

The NRC security regulations, 10 CFR Part 73, “Physical Protection of Plants and Materials,” include performance and prescriptive requirements that, when adequately met and implemented, provide protection against acts of radiological sabotage, prevent the theft or diversion of SNM, and protect Safeguards Information.

In accordance with requirements of 10 CFR 73.55(b), the COL applicant must establish and maintain a physical protection system and security organization whose objective will be to provide high assurance that activities involving SNM are not inimical to the common defense and security and do not constitute an unreasonable risk to the public health and safety. A physical protection system (i.e., detection, assessment, communication, and response), with capabilities to detect, assess, interdict, and neutralize, shall be designed to protect against the DBT of radiological sabotage.

Regulations in 10 CFR 73.55(b)(2) establish the performance requirements to protect a nuclear power plant against the DBT for radiological sabotage as described in 10 CFR 73.1(a)(1), “Radiological Sabotage.” The COL applicant must describe how it will meet regulatory requirements, including achieving the high assurance objective for the protection against the DBT of radiological sabotage. The provisions within 10 CFR 73.54, “Protection of Digital Computer and Communication Systems and Networks”; 10 CFR 73.55, “Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors against Radiological Sabotage”; 10 CFR 73.56, “Personnel Access Authorization Requirements for Nuclear Power Plants”; 10 CFR 73.58, “Safety/Security Interface Requirements for Nuclear Power Reactors,” Appendix B, “General Criteria for Security Personnel,” and Appendix C, “Nuclear Power Plant Safeguards Contingency Plans”; establish performance and prescriptive requirements that are applicable to designs of PSS, operational security requirements, management processes, and programs.

The requirements in 10 CFR Part 52, regarding certification of design, limit the application of regulatory requirements that are specific to PSS within the scope of the APR1400 standard design. According to 10 CFR Part 52, Subpart C, “Combined Licenses,” the operational or administrative controls, programs, and processes (e.g., management systems or controls) are addressed by the COL applicant and are not in the scope for certification of the APR1400 standard design.

An applicant may apply the latest revision of the following regulatory guidance documents, and accepted industry codes, standards, or guidance, to meet regulatory requirements on ITAAC:

- (1) RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Revision 3, issued 2007.
- (2) RG 1.206, “Combined License Applications for Nuclear Power Plants (Light-Water Reactor (LWR) Edition),” Revision 0, issued 2007.
- (3) NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,” issued March 2007.
- (4) NUREG-0800, SRP, Section 14.3.12, “Physical Security Hardware—Inspections, Tests, Analyses, and Acceptance Criteria (PS-ITAAC),” Revision 1, issued May 2010.

The NRC guidance, approaches, and examples described above and in other guidance for methods of compliance are not regulatory requirements and are not intended to be the only methods for meeting regulatory requirements. The applicant may use methods or approaches for implementing NRC regulations other than those discussed in agency guidance, provided that such measures satisfy the relevant and applicable NRC regulatory requirements.

14.3.12.4 Technical Evaluation

The staff's technical review consists of determining whether the applicant adequately described physical security ITAAC that provides reasonable assurance that, if the ITA are performed and the acceptance criteria are met, a facility that incorporates the DC has been constructed and operated in conformity with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations. The staff's review determined whether the applicant adequately identified physical security ITAAC and described appropriate ITA needed for verification and the appropriate acceptance criteria capturing the intended security functions, reliability and availability, or performance of selected PSS for ITAAC verification and closure, in accordance with 10 CFR 52.47(b)(1).

The PSS described in the APR1400 standard design (and those specific to a COL application) must be reliable and available to ensure performance and to meet intended security functions. The PSS are required to meet applicable performance and prescriptive requirements of 10 CFR Part 73. Within this context, the applicant addresses PSS that are within the scope of the APR1400 DC. The design and technical bases for PSS within the scope of the APR1400 DCD are described in DCD Tier 2, Section 13.6, and TeR APR1400 E-A-NR-14002-SGI. These documents provide the systems designs and performance requirements supporting the identified ITAAC design commitments for verification.

The staff's review also included the following applicant responses submitted to address the RAIs and resulting revisions to the DCD Tier 1, Tier 2, and referenced technical reports:

- KHNP to the NRC, "Response to RAI 197-8176," issued November 11, 2015 (ML15315A042).
- KHNP to the NRC, "Response to RAI 197-8176," issued November 18, 2015 (ML15322A217).
- KHNP Technical Report APR1400-E-A-NR-14002-SGI (Physical Security Design Features), is incorporated by reference (SGI Report) (ML15280A013).

14.3.12.4.1 Design Commitments, Inspections, Tests, Analyses, and Acceptance Criteria

In DCD Tier 1, Chapter 2.0, "Design Description and ITAAC," Section 2.12, "Physical Security Hardware," the applicant described the specific design commitments for PSS that are within the scope of the APR1400 DC. In DCD Tier 1, Section 1.2.2, "Implementation of ITAAC," the applicant described the arrangement of ITAAC tables applicable to PSS. Consistent with safety-related ITAAC, the first column proposes design requirements or commitments extracted from the design description that must be verified. The second and third columns identify proposed methods of verifications and acceptance criteria that demonstrate that design requirements or commitments are met, respectively.

In DCD Tier 1, Section 2.6.8, "Lighting Systems," the applicant provided design descriptions for the plant's normal and emergency lighting. Table 2.6.8-1, "Lighting System Inspections, Tests, Analyses, and Acceptance Criteria [2 sheets]," includes normal and emergency [alternating current (ac) and direct current (dc)] lighting systems. In DCD Tier 1, Section 2.6.9, "Communication Systems," and Table 2.6.9-1, "Communication Systems ITAAC," includes independent plant communication systems. Section 2.6.9 provides design descriptions and the inspections and tests for the plant's communication systems for intra-plant and plant-to-offsite communications during normal, transient, fire, accidents, off normal phenomena (e.g., loss-of-offsite power), and security related events.

The DCD Tier 1, Section 2.12, "Physical Security Hardware," provides design descriptions for PSS that are within the scope of the APR1400 standard design to detect, assess, and delay intrusion, communicate, and assist response to protect against the design-basis threat for radiological sabotage. The design descriptions include the following:

- Vital equipment and central alarm station (CAS) and secondary alarm station (SAS) locations.
- Bullet-resistant constructions for main control room and CAS and SAS.
- Lock, intrusion detection, and alarm of vital areas and access points.
- Vehicle barrier system is installed and located at safe standoff distance.
- Alarm annunciation and video assessment capabilities.
- Secondary security power supply systems.
- Supervision, tamper, and trouble indications for security alarms.
- Intrusion detection system capabilities and recording of functions.
- Communications capabilities from CAS to various locations.

The DCD Tier 1, Section 2.12 also provides specifics on engineered PSS that are not within the scope of the APR1400 standard design, which will not be certified and are addressed by the COL applicant. Section 2.12.1 Items 2.a; 2.b; 2.c; 3.a; 3.b; 3.c; 4.a; 4.c; 8.a; 8.b; and 9; are structures, systems, or components of a physical protection system that are located outside of the nuclear power block, within the plant protected area and owner control area, or engineered systems implementing elements of the physical security program that may be addressed by the COL applicant (i.e., outside of the scope a standard design).

The staff issued RAI 197-8176 (ML15247A004) Questions 14.3.12-1a, 12.c, and 12.d, requesting that the applicant provide additional design descriptions sufficient to describe the PSS within and outside of the scope of the APR1400 standard design for the physical security ITAAC, conforming to guidance in Revision 1 of SRP 14.3.12. In its response to RAI 197-8176 (ML15315A042) Question 14.3.12-1a, the applicant included proposed revisions to the design descriptions for engineered PSS, conforming to SRP 14.3.12. In response RAI 197-8176, Question 14.3.12-1.c, the applicant proposed to revise DCD Tier 1 Section 2.12.1, to identify the design descriptions to include that "[t]he alarm system will not allow the status of a detection

point, locking mechanism or access control device to be changed without the knowledge and concurrence of the alarm station operator in the other alarm station.” In response to RAI 197-8176, Question 14.3.12-1d, the applicant committed to update DCD Tier 1, Section 2.12.1, to establish item 11.c and provide a design description that states “[e]quipment will record onsite security alarm annunciation, including the location of alarm, false alarm, alarm check, and tamper indication; and the type of alarm, location, alarm circuit, date, and time,” and renumber a subsequent item as 11.d. The additional design descriptions for the intrusion detection and assessment system in Section 2.12.1 conforms to SRP Section 14.3.12 and the staff finds the applicant’s response acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Questions 14.3.12-1a, 14.3.12-1c and 14.3.12-1d. Therefore, RAI 197-8176, Questions 14.3.12-1a, 14.3.12-1c and 14.3.12-1d were resolved and closed.

DCD Tier 1, Table 2.12-1, “Physical Security Hardware ITAAC [4 sheets],” provides the ITAAC for the PSS that are within the scope for the APR1400 standard design. The design commitments include those related to vital equipment locations, physical barriers, physical controls and security measures for vital areas, intrusion detection, assessment, CAS and SAS, secondary power supply, access controls of vital areas, and communications meeting requirements of 10 CFR Part 73, “Physical Protection of Plants and Materials.” The applicant indicated that the descriptions of site-specific physical protection systems design and related ITAAC are to be addressed by the COL applicant that references the APR1400 DC. RAI 197-8176, Question 14.3.12-1b requested the applicant to provide additional design descriptions in sufficient detail in Section 2.12.1 to fully address the requirements in 10 CFR 73.55, conforming to SRP Section 14.3.12, and identify whether they are within the scope of the APR1400 standard design or will be addressed by the COL applicant. In its response to RAI 197-8176, Question 14.3.12-1b, the applicant revised the design descriptions for PSS, conforming to SRP 14.3.12. The staff therefore finds the applicant’s response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-1b. Therefore, RAI 197-8176, Question 14.3.12-1b, was resolved and closed. Revision 1 to Tier 1 DCD Table 2.12-1, “Physical Security Hardware ITAAC [7sheets],” incorporates changes to indicate the design commitments for physical security hardware ITAAC that are within the scope of the APR1400 standard design and those that will be addressed by the COL applicant. The revised design commitments (and as applicable ITA and acceptance criteria within the scope of the DC) conform to SRP Section 14.3.12.

In DCD Tier 1, Table 2.12-1, the applicant identified intrusion detection and assessment systems as those reserved for a COL applicant (i.e., site-specific PSS and ITAAC). The reserved ITAAC addressing these requirements are to be addressed as site-specific information provided by a COL applicant referencing the APR1400 standard design (i.e., COL 14.3(3)). COL 14.3(3) states that: “[t]he COL applicant is to provide the proposed ITAAC for the facility’s physical security hardware addressed in Section 14.3.2.12.” which requires a COL applicant that references the APR1400 DC to provide ITAAC and test abstracts that are not addressed in the DCD. The staff issued RAI 197-8176, Question 14.3.12-8 (ML15247A004), requesting the applicant to correct the COL 14.3(3) to indicate that the COL applicant will only address those physical security ITAAC not addressed in the DCD, instead of all physical security ITAAC. In its response to RAI 197-8176, Question 14.3.12-8 (ML15315A042), the applicant revised COL 14.3(3). The staff finds the applicant’s response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-

8. Therefore, RAI 197-8176, Question 14.3.12-8, was resolved and closed. Revision 1 of DCD Tier 2 Section 14.3.6 included changes resulting in renumbering of COL items, to establish COL item 14.3(4) to indicate that “[t]he COL applicant is to provide the proposed ITAAC for the facility’s physical security hardware not addressed in the DCD in accordance with RG 1.206.” In addition, DCD Tier 2 Section 14.3.2.12, “ITAAC for Physical Security Hardware,” also indicates the same COL commitment and references the COL item 14.3(4).

The applicant stated in DCD Tier 2, Section 14.3.2.12 that: “[t]he standard plant physical security ITAAC are consistent with the guidance provided in SRP Section 14.3. (Reference 2) and the applicable generic ITAAC in SRP Section 14.3.12 (Reference 14).” The verification of APR1400 standard design includes the PSS described in DCD Tier 1, Section 2.12.

The staff finds the following:

- The applicant has adequately identified and described attributes for a physical protection system meeting design bases and security functions of detection, assessment, communications, delays, and responses as ITAAC for verification. The APR 1400 DCD Tier 1 identified general design commitments and ITAAC that conform with those described in SRP 14.3.12, that address vital areas and vital area access controls, illumination, bullet-resistant barriers, vehicle barrier system’s stand-off distance, alarm stations, secondary power supply, interior intrusion detection and assessment systems signal display and recording transmission line supervision and monitoring, emergency exits controls, and security communications.
- The applicant has adequately identified other PSS, such as protected area barriers; isolation zones, protected area (PA) intrusion detection; personnel, vehicles, material access control, and personnel identification systems that are outside the scope of the APR1400 standard design and will be addressed by the COL applicant. COL 14.3(1) requires a COL applicant that references the APR1400 standard design to provide ITAAC for the site-specific portions of the plant systems specified in Section 14.3.3, “Interface Requirements.”
- The staff concludes that the identified PSS ITAAC selected for verification, in parts within the scope of the DC, are adequate to verify and demonstrate that the construction, installation, or configurations of PSS will operate and meet intended security functions in accordance with the design bases of the APR1400 standard design. The applicant adequately identified PSS ITAAC in the DCD Tier 1 for meeting the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.2 Verification Program and Processes

The applicant, in DCD Tier 2, Section 14.2, “Initial Plant Test Program,” described the initial test program (ITP) that is performed during initial startup of the APR1400 plant. The ITP includes test activities commencing with the completion of construction and installation and ending with the completion of reactor power ascension testing.

The verification program included preoperational tests that provide reasonable assurance that systems and equipment perform in accordance with the safety analysis report. Test results are analyzed to verify that systems and components are performing satisfactorily and if not, to

provide a basis for recommended corrective action. Table 14.2-1, "Preoperational Tests," lists the preoperational tests, which included Sections 14.2.12.136 through 14.2.12.146, addressing PSS or features identified as ITAAC in the DCD Tier 1. The preoperational tests also included normal and emergency lighting systems that are relied on for safety and security functions.

The applicant indicated that the organization and staffing for performing the APR1400 initial test program are the responsibility of the COL applicant. The organization and staff are responsible for planning, executing, and documenting the plant initial testing and related activities, and developing site-specific organization and staffing level appropriate for its facility. The COL applicant also develops the management systems and processes, developing site-specific procedures and guidelines for conducting tests; submitting detailed test procedures for NRC review; preparing and planning conduct of test program; reviewing, evaluating and approving test results; and maintain records of tests. The testing program for establishing schedules and plans for operational testing for plant startup, with review and inspection of procedures prior to testing sequences for tests are described in Section 14.2.12, "Test Descriptions." The applicant described the procedure test abstracts for developing detailed test procedures for the test program.

Section 14.2.13, "Combined License Information," COL 14.2(1) through COL 14.2(7) established that the COL applicant will develop the details for the management systems (processes and procedures) and organization and staffing necessary for planning and implementing an initial test program.

The applicant described the management controls and processes for the test program that included the following:

- Test specifications that included test objectives, prerequisites, test method, data required, acceptance criteria, and special considerations, along with a process for preparation and approval procedures.
- Review, approval, closure, and documentation of test activities that verify ITAAC and managing unresolved test deficiencies, test closure and records.
- Organization and personnel for implementing verification program.

In DCD Tier 2, Section 14.3.5.1, "Design ITAAC Closure Process," the applicant described options for design ITAAC closure through an amendment of the DC rule, closure through the COL application review process, or closure after COL issuance.

The staff finds the following:

- The applicant identified COL information items for establishing the test organization and the management controls and processes for the initial test program. The applicant has established that a COL applicant that references the APR1400 standard design will address management systems and processes needed to implement verifications of ITAAC, including procedurally control and document the preparations, reviews, approvals, closeouts, and records.
- The system test process, as described in Tier 2 Sections 14.2 and 14.3, which the COL applicant must establish, if adequately implemented, will demonstrate

through testing that engineered physical security structures, systems, or components perform their intended security functions as designed.

- The staff concludes that the applicant has established, in the APR1400 DCD, the requirements that a COL applicant referencing the APR1400 standard design would establish the management systems, processes, and organization that will verify the installation, construction, and performance that are identified for ITAAC under the verification program.

14.3.12.4.3 Test Abstracts for Physical Security Systems ITAAC

The applicant described procedure test abstracts (also referred to as test abstracts) in DCD Tier 2, Section 14.2.12.1, "Preoperational Tests," to support ITA for verifying the identified physical security ITAAC in Tier 1 of the DCD. The physical security ITAAC procedure test abstracts are provided in the same format used for safety related and other plant system preoperational tests described in the DCD Tier 2, Chapter 14. The test abstracts provided the framework for the development of detailed test procedures for the conducting of inspections, tests, and analyses that will be performed and the verification of acceptance criteria that, if met, will demonstrate that the plant incorporated the DC and the identified PSS built will operate in accordance with the DC.

The applicant described test abstracts consisting of objectives, prerequisites, methods (inspections, tests, and/or analyses), data required, and acceptance criteria for the verification of the following:

- Locations of vital equipment.
- Access to vital equipment.
- Equipment to permit observation of abnormal presence or activity of persons or vehicles.
- Vehicle barrier system to protect against the design basis threat vehicle bombs.
- Vital area with active intrusion detection systems.
- Security alarm annunciation and video assessment information.
- Location and equipment of the central and secondary alarm stations.
- Secondary security power supply system.
- Intrusion detection and assessment systems.
- Equipment and emergency exits.
- Security communication systems.

The staff issued RAI 197-8176, Question 14.3.12-6 (ML15247A004) requesting the applicant to provide descriptions of construction activities, preoperational testing, and test procedures for verifying PSS constructions and installations within the scope of the APR1400 standard design.

In its response to RAI 197-8176, Question 14.3.12-6 (ML15315A042), the applicant included procedure test abstracts for physical security ITAAC within the APR1400 standard design. The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-6. Therefore, RAI 197-8176, Question 14.3.12-6, was resolved and closed. Revision 1 to the DCD Tier 2 Section 14.2.12 describes the procedure test abstracts for physical security ITAAC in Sections 14.2.12.1.142 through 14.2.12.1.153. The revisions include two additional procedure test abstracts, Section 14.2.12.1.145 and Section 14.2.12.152, "Equipment to permit observation of abnormal presence or activity of persons or vehicles," and "Bullet-Resisting barriers," respectively. The applicant provides adequate and reasonable descriptions of the test objectives, prerequisites, test methods, and acceptance criteria in the additional procedure test abstracts for verifying PSS.

The staff finds that the applicant's descriptions for elements of the procedure test for PSS (i.e., objectives, prerequisites, test methods, data required, and acceptance criteria) are adequate. The procedure test abstracts consist of the descriptions for the verification of identified physical security ITAAC and support the DCD Tier 1 descriptions of ITAAC for meeting 10 CFR 52.47(b)(1). The staff concludes that the test abstracts for PSS conform to guidance provided in NUREG-0800, and are adequate and reasonable for describing the framework for developing specific ITA for the verification of PSS identified as ITAAC within the scope of the APR1400 standard design.

14.3.12.4.3.1 Inspections, Tests, and Analyses for Vital Equipment and Vital Areas

The applicant, in DCD Tier 2, Section 14.2.12.1.136, "Location of vital equipment," describes the procedure test abstract for physical security ITAAC 1.a, and addressed the ITA protocol for verifying design commitments for meeting regulatory requirements and design specific requirements for the vital area. The applicant indicated that the objective is to demonstrate that vital equipment is located within the vital areas protected in accordance with regulatory requirements. The verification method included inspections of the installed location of vital equipment listed in the applicant's TeR APR1400-E-A-NR-14002-SGI, "Physical Security Design Features." The acceptance criterion is the vital equipment listed is located within a vital area.

DCD Tier 2, Section 14.2.12.1.137, "Access to vital areas," describes the test abstract for physical security ITAAC 1.b for the design requirement that access to vital equipment requires passage through the vital area barrier. The objective is demonstrating that the access to vital equipment requires passage through at least two physical barriers. The methods included inspections that locate each component of vital equipment and verification that access to each component met the objective stated. The list of vital equipment in the applicant's TeR APR1400 E-A-NR-14002-SGI, is identified as information needed for verification of physical security ITAAC 1.b. The acceptance criterion is the access to each component of vital equipment requires passage through at least two physical barriers, one of which can be the protected area barrier (and the other is the vital area barrier).

DCD Tier 2, Section 14.2.12.1.140, "Vital area with active intrusion detection system," describes the test abstract for physical security ITAAC 10 for locked and alarmed access into vital areas. The test objective is to determine that vital areas are locked and alarmed personnel access barrier and unauthorized access are detected and alarm at the central and secondary alarm stations upon intrusion into a vital area. The test methods included testing unauthorized

opening of each vital area access door to verify that an intrusion alarm is generated; verifying that alarm is detected by alarm annunciator computers and displays in the CAS and SAS; verifying that alarm information; and verifying authorized access and recording of access information. The test and inspection verifications apply to all vital areas, which are locked with activated intrusion detection systems, and demonstrate that activated intrusion detection systems annunciate in the CAS in the event of an unauthorized and attempted access of an unoccupied vital area.

DCD Tier 2, Section 14.2.12.1.145, "Equipment and emergency exits," describes the test abstract for physical security ITAAC 15.a for vital area emergency exits. The test abstract identified that the objective is to verify that each of the emergency exits from the vital areas have installed locking devices which will allow emergency egress and installed alarms that will notify the alarm station operator that the door has been opened. The test methods included inspections and tests of alarm initiation and indication and the tests of locking devices. The tests operate the emergency egress locking mechanism in the vital area, verify that an alarm is generated when the door is opened, and the alarmed information is displayed at the CAS and SAS.

The prerequisites identified in the test abstracts included the completion of construction for physical barriers, protection of penetrations, installation of locking devices, intrusion detection and alarm systems, completion of CAS, etc., before verification by selected test methods. The acceptance criteria identified for the ITAAC related to the vital areas are the successful inspections and tests that verify locking, intrusion detection, and alarms in accordance with requirements of 10 CFR 73.55(e)(9)(i) through (iii) and 10 CFR 73.55(e)(8)(iii).

The staff finds that the applicant has provided adequate and reasonable descriptions of the test objectives, prerequisites, test methods, and acceptance criteria that support the identified ITAAC related to the vital equipment and vital areas and emergency exit controls for the vital areas in DCD Tier 2, Tier 1, Section 2.12.1, "Design Description," and Table 2.12-1, "Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria." The test abstract supports the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.3.2 Inspections, Tests, and Analyses for Alarms, System Supervision, Assessment, and Records

DCD Tier 2, Section 14.2.12.1.141, "Security alarm annunciation and video assessment information," describes the test abstract for physical security ITAAC 11.a for security alarm annunciation and video assessment. The test abstract identified that the objective is to verify that the intrusion alarm system at the protected area perimeter generates the appropriate alarms and that the video assessment equipment captures the necessary images to perform assessment of the alarms. The test methods include testing of intrusion detection systems, security alarm annunciation, and video assessment capabilities in the CAS and SAS. This abstract addresses additional intrusion alarms and assessment at the vital areas that are verified under physical security ITAAC 10, where an alarm is generated when the door is opened and the door information is displayed at the CAS and SAS for assessment. The test methods included testing of intrusion detection systems, security alarm annunciation, and video assessment capabilities in the CAS and SAS, and include observations of video images from alarm zones to assess the cause of the alarm. The test and inspection verifying the video images being captured in varying lighting situations to determine that assessment capability is

available under all expected lighting circumstance. The acceptance criteria identified for the ITAAC related to the CAS and SAS are the successful inspections and tests that verify alarm indications and video assessment capabilities in accordance with prescriptive requirements of 10 CFR 73.55(i)(2).

DCD Tier 2, Section 14.2.12.1.142, "Location of equipment of the central and secondary alarm stations," describes the test abstract for physical security ITAAC 11.b for CAS and SAS. The applicant indicated that the objective is to verify the locations of CAS and SAS meet the regulatory requirements and that the equipment located in each alarm station is equivalent and redundant. The test methods included determining the locations of CAS and SAS are in vital areas, not visible from outside the protected area, have equipment for alarm annunciation and assessment, and have all the required communication equipment. The acceptance criteria identified for the ITAAC related to the CAS and SAS design and configurations of equipment for performing alarm station functions at the CAS and SAS are in accordance with 10 CFR 73.55(i)(4)(ii)(A) and 10 CFR 73.55(i)(4)(iii). In addition to the verifications described in Section 14.2.12.1.142, for location and equipment of CAS and SAS, the staff identified that the test abstract did not address the verification of locations of and analyses for a single act identified in physical security ITAAC 11.c. The staff issued RAI 465-8565 (ML16110A100), Question 14.3.12-10.c requesting the applicant to address ITAAC 11.c in the test abstract, which may be described in either Section 14.2.12.1.142 or Section 14.2.12.1.139, which will verify that the vehicle barrier system is installed at a minimum safe-standoff distance that protects the CAS and SAS. In its response to RAI 465-8565 (ML16183A350), Question 14.3.12-10.c, the applicant committed that a test abstract 14.2.12.1.142 will be revised to include in the objective and acceptance criteria verification of locations of the CAS and SAS to satisfy the no single act exposure criteria. The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 465-8565, Question 14.3.12-10.c. Therefore, RAI 465-8565, Question 14.3.12-10.c was resolved and closed. Revision 1 to the DCD Section 14.2.12 included an additional procedure test abstract in Section 14.2.12.1.144, "Vehicle barrier system to protect against the design basis threat vehicle bombs." The addition establishes the objective to verify that a vehicle barrier is installed and located at the minimum safe-standoff distance to protect against the design basis vehicle bombs. The procedure test abstract consisting of the objective, pre-requisites, test method, data required, acceptance criteria, and special precautions, are sufficiently described for developing detailed procedures and tests for the ITA of required vehicle barrier system

DCD Tier 2, Section 14.2.12.1.144, "Intrusion detection and assessment systems," describes the test abstract for ITAAC 13.b and 14 for intrusion and assessment systems and alarm recording equipment. The objective is to demonstrate that intrusion detection systems and video assessment are capable of detecting and assessing and record onsite security alarm annunciation and disposition of each alarm. The prerequisites identified include complete installation of security alarms, complete construction of alarm station and installation of equipment in ITAAC 11.a and 11.b. The test method includes test and verification of intrusion detection system to perform detection of attempted penetration of the PA physical barriers. The test abstract established acceptance criteria that the intrusion detection system for each zone is capable of detecting penetration or attempted penetration of the protected area barrier and the video assessment equipment are capable of recording and playing back video images to allow assessment for physical security ITAAC 14 and the security alarm indicates the types of alarms and their locations with visual and audible indications in accordance with requirements of 10 CFR 73.55(i)(3)(i) through 10 CFR 73.55(i)(3)(v). The test abstract includes a test method for

alarm recording equipment performance for recording the types of alarms and their dispositions. The acceptance criteria includes verifying recording of types of alarms, locations of alarms, alarm circuit, dates, and time and status alarm, in accordance with 10 CFR 73.55(i)(4)(ii)(H).

The applicant did not describe the test abstract for physical security ITAAC 13.a, for security alarms tamper indication and system supervision of security alarm devices and transmission lines. The objectives to demonstrate that security alarm devices including transmission lines to annunciators are tamper indicating and self-checking, the test methods that will be applied are tests to verify tamper indication from security alarm devices and alarm system circuit self-checking functions, and the acceptance criteria, such as the security alarm devices including transmission lines to annunciators are tamper indicating and self-checking to meet the requirements of 10 CFR 73.55(i)(3)(iv) and 10 CFR 73.55(i)(3)(iv), has not been established for reasonable assurance that the procedure developed will adequately verify ITAAC 13.a. RAI 465-8565, Question 14.3.12-10.d was issued to the applicant to provide a procedure test abstract (consisting of objectives, prerequisites, test method, data required, acceptance criteria, and special precautions) for physical security ITAAC 13.a in DCD Tier 1, Table 2.12-1. In its response to RAI 465-8565 (ML16183A350), Question 14.3.12-10.d, the applicant committed that a new test abstract 14.2.12.1.148 will be added to Section 14.2.12.1 to cover ITAAC Item 13.a in Table 2.12-1 on physical security hardware (e.g., alarm, devices and transmission lines). The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 465-8565, Question 14.3.12-10.d. Therefore, RAI 465-8565, Question 14.3.12-10.d was resolved and closed. Revision 1 to DCD Tier 2 Section 14.2.12.1.153, incorporates procedure test abstract for verifying security alarm devices and transmission lines to the alarm annunciation system are tamper indicating and self-checking and verifying that the alarm annunciation at the CAS and SAS indicates type of alarm. The procedure test abstract consisting of the objective, pre-requisites, test method, data required, acceptance criteria, and special precautions, are sufficiently described for developing detailed procedures and tests for the ITA physical security ITAAC13.a.

The staff finds that the applicant has provided adequate and reasonable descriptions of the test objectives, prerequisites, test methods, and acceptance criteria that support the identified ITAAC related to security alarms, assessment, and intrusion detection system recording in DCD Tier 1, Section 2.12.1, "Design Description," and Table 2.12-1, "Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria." The test abstracts support the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.3.3 Inspections, Tests, and Analyses for Security Communications

In DCD Tier 2, Section 14.2.12.146, "Security communication systems," the applicant described the test abstract for physical security ITAAC 16.a, 16.b, and 16.c for security communications that the objective is "to verify the regulatory required capabilities of the installed communication system to support security requirements." The prerequisites include the complete installation of plant communication systems and components for the public address system, plant telephone system, and wireless communication system and complete installations of operational communications equipment in the CAS, SAS, and Main Control Room (MCR).

The test methods include a performance test of communications systems to verify availability of public address system, plant telephone system, voice communications with offsite local law enforcement authorities, wireless communications system (radios), and non-portable security

communication system. The tests are performed to verify communications between CAS, SAS, and MCR, test the portable radio system and backup plant system between CAS and SAS and security personnel and defensive positions, and verify continuity of communications capabilities on secondary power supply (i.e., loss of normal power). The test method includes the verification of systems capabilities for open and cleared communications that can be heard where plant personnel are located. The identified test include use of local law enforcement remote radio system provided to the CAS and SAS to communicate with the local law enforcement agency. The applicant indicated that security communication system and plant communication systems are independent of each other. The verification of Table 2.12-1, Items 16a, 16.b, and 16.c, are performed independently from those of the plant communication systems, which are addressed in DCD Tier 2, Section 9.5, "Other Auxiliary Systems."

The staff issued RAI 197-8176, Question 14.3.12-4 (ML15247A004), requesting the applicant to provide additional design descriptions for the security and plant communication systems captured in the DCD and provide a procedure test abstract for verifying security communication systems in Table 2.12-1 and Table 2.6.9-1 for PSS within the scope of the standard APR1400 standard design. In its response to RAI 197-8176, Question 14.3.12-4 (ML15322A217), the applicant included additional design descriptions and procedures test abstracts for security and plant communications systems within the APR1400 standard design. The applicant committed to revise the DCD to provide descriptions of the security communication system from DCD Tier 2, Sections 9.5.2.2.1.5 and 9.5.2.2.1.8 to separate Sections 9.5.2.2.3 and 9.5.2.2.3.1 through 9.5.2.2.3.3. In addition, the revision would include Section 14.2.13 and Table Nos. 14.2-7 (11 of 18) and 1.8-2 (25 of 29) to indicate independence of the security communication systems and revise DCD Tier 2, Table 14.2-1, "Preoperational Tests," to identify Section 14.2.12.1.146. The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-4. Therefore, RAI 197-8176, Question 14.3.12-4 was resolved and closed.

Revision 1 to DCD Tier 2 Section 9.5.2.1.e, indicates that security communications measures are provided as required by 10 CFR 73.55(j) to support capabilities for onsite and offsite, alarm stations, on-duty security force personnel, and uninterruptable power supply for security operations. DCD Tier 2 Section 9.5.2.2, "System Description," for communication system included communications for the security alarm stations and security building. DCD Tier 2 Section 9.5.2.2.3, "Security Communication System," addresses the design requirements for independent plant telephone and wireless communication subsystems and power supply.

In Revision 1 to DCD Tier 2 Section 9.5.2.2.3.2, the applicant indicated that: "[t]he COL applicant is to provide the security radio system which consists of a base unit, mobile units, and portable units (COL 9.5(10))." The description of this COL information item was removed from Section 9.5.2.2.1.8, "Wireless Communication System." COL 9.5(1) is provided to include the items identified in Section 9.5.10, "Combined License Information," which are to be addressed by a COL applicant that references the APR1400 Certified Design. Individual Test on Table 14.2-7, "Conformance Matrix for RG 1.68 Appendix A versus Individual Test Description," identifies an exception for Individual Test, which states that "[t]he COL applicant will prepare the site-specific preoperational and start-up test specification and test procedures and/or guidance for plant and offsite plant communication systems (COL 14.2(17))." The Revision 1 to DCD Tier 1 Table 1.8-2, "Combined License Information Items," incorporated COL 14.2(17) as previously described.

The acceptance criteria identified include: (a) communications between the CAS, SAS, and the MCR can be accomplished and remain operable in the event of loss of normal power; (b) the public address system can be used to broadcast security alerts and instructions to plant areas; (c) the plant telephone system can communicate with local law enforcement agency to call for assistance; (d) the wireless communication system provides continuous communication with the security force members and remains operable from the secondary power supply; (e) secondary power supply to non-portable wireless communication system components is located in a vital area; and (f) the local law enforcement remote radio equipment in CAS and SAS can be used to contact local law enforcement agencies during an emergency, in accordance with requirements of 10 CFR 73.55(j)(4)(i) through (4)(ii), 10 CFR 73.55(j)(3), 10 CFR 73.55(e)(9)(vi), and 10 CFR 73.55(e)(9)(vi)(B).

The staff finds that the applicant has provided an adequate and reasonable description of the test objectives, prerequisites, test methods, and acceptance criteria that support the identified physical security ITAAC related to security communications in DCD Tier 1, Section 2.12.1, "Design Description," and Table 2.12-1, "Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria." The test abstracts support the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.3.4 Inspections, Tests, and Analyses for Security Secondary Power Systems

In DCD Tier 2, Section 14.2.12.1.143, "Secondary security power supply system," the applicant described the test abstract for physical security ITAAC 12 for the secondary security power supply system. The applicant stated that the objectives are to "verify that the secondary security power supply system is located in a vital area and is switched on [i.e., transferred to secondary power supply] when the normal power is lost." The inspection includes locations of the secondary power supply equipment and verifies that it is within a vital area and tests to switch off the normal power to security alarm annunciation equipment and verifies that secondary power supply system can be switched on to repower the alarm annunciation equipment, in accordance with requirements of 10 CFR 73.55(e)(9)(vi) and 10 CFR 73.55(e)(9)(iv)(A). DCD Tier 2, Section 14.2.12.1.146, describes test abstract for security communication for verification of secondary power supply for security communication systems in accordance with the requirement of 10 CFR 73.55(e)(9)(vi)(B).

The staff finds that the applicant has provided adequate and reasonable descriptions of the test objectives, prerequisites, test methods, and acceptance criteria that support the verification of identified ITAAC related to security secondary power systems in DCD Tier 1, Section 2.12.1, "Design Description," and Table 2.12-1, "Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria." The test abstracts support the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.3.5 Inspections, Tests, and Analyses for Security Lighting Systems

DCD Tier 1, Section 2.6.8, "Lighting Systems," and Table 2.6.8-1, "Lighting Systems ITAAC," describes the design commitments for the plant lighting systems, which include normal and emergency lighting systems. DCD Tier 1, Section 2.12.1, "Design Description," includes a design commitment for the security lighting system to provide illumination of the exterior area of the PA and the isolation zone. Table 2.12-1, "Physical Security Hardware ITAAC," identified ITAAC 5, for security lighting providing illumination for security functions.

DCD Tier 1, Table 2.1.2-1, "Physical Security Hardware ITAAC," included ITAAC 5, which verifies the design commitment that isolation zones and exterior area within the protected areas are provided with illumination to permit observation of abnormal presences or activity of persons or vehicles. DCD Tier 2, Section 14.2.12.1.138, "Equipment to permit observation of abnormal presence or activity of persons or vehicles," describes test abstract objective to verify that CCTV equipment is in place to observe the isolation zones and areas at the PA for abnormal presence or activity of persons and/or vehicles. The test methods included inspection of monitors to allow observation of a subject individual on the CCTV monitors in the isolation zone and the PA, determination of the clarity and visual range of CCTV cameras, and testing of camera capability to zoom and pan to assess plant areas. The acceptance criteria include assurance that the camera and systems provide fields of observations of persons, vehicles, and activities in the isolation zone and areas of the PA barriers. Although the applicant addresses verification of camera system(s) for observation, along with test abstracts in Section 14.2.12.1.144, the test abstract described does not verify that equipment is provided and adequate exterior illuminations at the isolation zone and the PA permits observations of abnormal presence or activity of person or vehicle. RAI 465-8565 (ML16110A100), Question 14.3.12-10.a, was issued for the applicant to address the verification of system and equipment that will provide illumination, along with CCTV, to permit observation and assessment of the isolation zone and the PA in DCD Tier 2, Section 14.2.12.1.138. In its response RAI 465-8565 (ML16183A350), Question 14.3.12-10.a, the applicant committed to revise Test Abstract 14.2.12.1.138 to address the illumination equipment discussed in ITAAC Item 5 in Table 2.12-1. The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 465-8565, Question 14.3.12-10.a. Therefore, RAI 465-8565, Question 14.3.12-10.a was resolved and closed. Revision 1 to DCD Tier 2, Section 14.2.12.1.143, "Equipment to permit observation of abnormal presence or activity of person or vehicles," incorporates and provides adequate descriptions for the verification of systems and equipment that will provide illumination levels that are sufficient to allow observation of persons and/or vehicles in the exterior area of the protected area.

DCD Tier 2, Sections 14.2.12.1.80, "Normal Lighting System Test," and 14.2.12.1.81, "Emergency Lighting System Test," describes the test abstracts for verifying the normal and emergency lighting systems provide illuminations of plant areas within the nuclear island or structures. In addition, DCD Tier 2, Sections 14.2.12.1.86 through 14.2.12.1.88, include verification of the continuity of power sources for plant lighting systems, to ensure that portions of the plant systems, including building interior lighting, remain available during accident scenarios and power failures. The ITAAC for plant normal and emergency lighting systems are established in DCD Tier 1, Table 2.6.8-1, "Lighting Systems ITAAC." The lighting systems are credited by safety and security programs for illumination necessary to perform required response in the event of a safety or security event. The staff's findings for descriptions of test abstract for verifying design commitments for normal and emergency plant lighting are addressed under review of DCD Tier 2, Section 14.3.2.6, "ITAAC for Electrical Systems," and are not included in this portion of the staff security review and finding for verification of dedicated PSS.

Title 10 CFR 73.55(i)(6)(i), requires that "the licensee shall ensure that all areas of the facility are provided with illumination necessary to satisfy the design requirements of 10 CFR 73.55(b) and implement the protective strategy." Section 73.55(i)(6)(ii) requires a minimum of illumination level of 0.2-foot (2.4 inches)-candles in the isolation zones and appropriate exterior areas within the protected areas. The applicant described design and performance requirements of security lighting within the facilities in Tier 1, which provides design descriptions

for the plant normal and emergency lighting that satisfy these requirements. Tier 2, Sections 14.2.12.1.80; 14.2.12.1.81; 14.2.12.1.86, "Emergency Diesel Generator Mechanical System Test"; Section 14.2.12.87, "Emergency Diesel Generator Electrical System Test"; and Section 14.2.12.1.88, "Emergency Diesel Generator Auxiliary Systems Test"; address the verification of interior plant lighting systems and subsystems relied on to perform safety and security (e.g., implementing security functions and the protective strategy). In these sections, the applicant provided information that adequately and reasonably described the ITA that specifically addressed the verification of plant lighting for meeting the requirements of 10 CFR 73.55(i)(6)(i).

The staff issued RAI 197-8176, Question 14.3.12-3.a (ML15247A004), requesting the applicant to discuss whether the plant emergency DC lighting subsystem, described in Section 2.6.8.1, Item No. 4.b, is relied on for illumination for performing security functions. In its response to RAI 197-8176, Question 14.3.12-3.a (ML15322A217), the applicant stated:

In the APR1400 lighting system, the isolation zones and exterior areas within the protected area are provided with the illumination, a minimum of 0.2 foot-candle, by the dedicated security lighting system as described in DCD Tier 2, Subsection 9.5.3.2 (paragraph c). The interior areas for internal security response, as well as the plant operation areas, are provided with the illumination by the plant lighting systems such as the normal, emergency AC, and DC lighting system as described in DCD Tier 2, Subsection 9.5.3.2 (paragraphs a and b). In the event of a loss of plant normal lighting, the emergency AC and DC lighting systems provide sufficient illumination to perform security functions with the illumination levels as described in DCD Tier 2, Subsection 9.5.3.2 (paragraph b). For the security alarm stations, the lighting equipment is supplied from the security power system, which is backed up by a dedicated uninterruptible power supply (UPS) for the security power system. The minimum illumination level in the security alarm stations is included in the response to Question "d". The ITAAC for the plant lighting system and the security lighting system for the isolation zones and exterior areas are included in DCD Tier 1, Table 2.6.8-1 and Table 2.12-1, respectively. The ITAAC for the lighting equipment in the security alarm stations will be included in DCD Tier 1, Subsection 2.12.1 and Table 2.12-1.

The staff finds the applicant's response to be acceptable. Therefore, RAI 197-8176, Question 14.3.12-3.a was resolved and closed.

The staff issued RAI 197-8176, Question 14.3.12-3.d (ML15247A004), requesting the applicant to specify the minimum illumination level that will be provided by design of a plant emergency lighting system (or a dedicated security lighting system) for illumination in security alarm stations or other security locations. In its response to RAI 197-8176, Question 14.3.12-3.d (ML15322A217), the applicant committed to revise to DCD Tier 2, Section 9.5.3.2, to indicate that "[t]he self-contained battery lighting provides not less than an average of 1 foot-candle and at least 0.1 foot candle at the floor level for 8 hours for access and egress," and "[t]he lighting for the security alarm station is powered from the security power system and backed up by an UPS for the security power system. The normal and minimum emergency illumination level for security alarm stations are 75 foot-candle and 10 foot-candles, respectively." The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as

committed in the response to RAI 197-8176, Question 14.3.12-3.d. Therefore, RAI 197-8176, Question 14.3.12-3.d, was resolved and closed.

The staff issued RAI 197-8176, Question 14.3.12-3.b (ML15247A004) for the applicant to provide the design descriptions for the dedicated “security lighting system,” with the appropriate descriptions of interface between plant and security specific systems, if the plant emergency lighting is not relied on to enable performing security functions during loss of normal plant lighting, as implied in Tier 2, Section 9.5.3, “Light Systems,” In its response to RAI 197-8176, Question 14.3.12-3.b (ML15322A217), the applicant committed to revise DCD Tier 2, Section 2.12.1 and Table 2.12-1, to include a (item 5.a) design description and ITAAC for the illumination of at least 10 foot-candle for alarm stations to perform security functions. The staff finds the applicant’s response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-3.b. Therefore, RAI 197-8176, Question 14.3.12-3.b, was resolved and closed.

The staff issued RAI 197-8176, Question 14.3.12-3.c (ML15247A004) requesting the applicant to verify that the minimum illumination design requirement (i.e., 0.1 foot-candle/square feet at the floor level) also includes a criteria for system performance of minimum illumination of not less than average of 1 foot candle (10.8 lux) for Section 2.6.8, Item No. 4.b and corresponding lighting system ITAAC No. 4.b. In its response to RAI 197-8176, Question 14.3.12-3.c (ML15322A217), the applicant committed to revise DCD Tier 2, Section 2.6.8.1, Item 4.b and Table 2.6.8-1 (2 of 2) to indicate “[t]he emergency illumination level is not less than an average of 1 foot-candle and at least 0.1 foot-candle at the floor level for 8 hours for access and egress route.” The staff finds the applicant’s response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-3.c. Therefore, RAI 197-8176, Question 14.3.12-3.c, was resolved and closed.

The staff finds the following:

- The applicant has provided descriptions of the test objectives, prerequisites, test methods, required data, and acceptance criteria for plant emergency and normal lighting that may be credited to support security functions. The adequacy and reasonable findings for the test abstracts described in Section 14.2.12.1.80, Section 14.2.12.1.81, and Sections 14.2.12.1.86 through 14.2.12.1.88 for verification of the plant normal and emergency lighting systems ITAAC as established in Table 2.6.8-1, “Lighting Systems ITAAC,” is documented by the staff’s evaluation of Section 14.3.2.6, “ITAAC for Electrical Systems.”
- The ITA described in the test abstract provided for security lighting that is within the scope of the DC addressed the requirement of 10 CFR 73.55(i)(6)(i). The applicant described the design and performance requirements of security lighting within the facilities in DCD Tier 1, Section 2.6.8, “Lighting Systems,” which provides design descriptions for the plant normal and emergency lighting. DCD Tier 1, Table 2.6.8-1, “Lighting System Inspections, Tests, Analyses, and Acceptance Criteria [2 sheets],” includes security lighting systems and DCD Tier 2, Sections 14.2.12.1.80 and 14.2.12.1.81, address the verification of interior plant lighting systems relied on to perform security functions and implement the protective strategy.

- The staff concludes that the selected physical security system ITAAC addresses verification of the requirements of 10 CFR 73.55(i)(6)(ii) and conforms to the staff's guidance provided in SRP 14.3.12. The verification of PSS performance meeting the requirement of 10 CFR 73.55(i)(6)(i), which includes areas within the interior of the facility, is not specifically necessary to conform to SRP 14.3.12 for physical security ITAAC, and is addressed by ITAAC identified in Table 2.6.6-1 and supporting test abstracts. The test abstracts support the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.4.3.6 Inspections, Tests, and Analyses for Verifying Physical Barriers and Vehicle Barrier Systems

Bullet Resisting Barriers: The applicant's test abstract for physical security ITAAC 6 for bullet-resisting barriers for MCR, CAS, SAS, is not described in Sections of 14.2. RAI 465-8565 (ML16110A100), Question 14.3.12-10.b, was issued for the applicant to provide a procedure test abstract for physical security hardware ITAAC No. 6 in Table 2.12-1. In its response RAI 465-8565 (ML16183A350), Question 14.3.12-10.b, the applicant committed to revise DCD Tier 1 Table 2.12-1, Item 6 to incorporate the requirement of design and verification of physical barriers for bullet-resisting. The staff finds the applicant's response to be acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 465-8565, Question 14.3.12-10.b. Therefore, RAI 465-8565, Question 14.3.12-10.b was resolved and closed. Revision 1 to DCD Tier 2, Section 14.2.12.1.152, "Bullet-Resisting Barriers," provides the test abstract that adequately described the test objective, prerequisite, test method, data required, acceptance criteria, and specification for the ITA of ITAAC Item 6.

Vehicle Barrier System: DCD Tier 2, Section 14.2.12.1.139, "Vehicle barrier system to protect against the design basis threat vehicle bombs," describes the test abstracts for verifying the vehicle barrier system protects against the design basis threat vehicle bombs. The applicant stated that the objective is to demonstrate that the vehicle barrier system (VBS) is installed and located at the necessary stand-off distance to protect against the DBT vehicle bombs. The verification method is inspection to validate that the VBS is installed at the minimum stand-off distance (MSSD) or a distance greater than the MSSD to determine that the system and components are installed in accordance with manufacturer's specifications. The applicant also described prerequisites, data required, and acceptance criteria. The acceptance criterion that must be met is the distance measured exceeds the minimum safe stand-off distances required in the applicant's TeR APR1400-E-A-NR-14002-SGI, "Physical Security Design Features," that is incorporated by reference.

The staff finds that the applicant has provided an adequate and reasonable description of the test objectives, prerequisites, test methods, required data, and acceptance criteria in Tier 2, Section 14.2, that support the identified physical security ITAAC related to bullet-resisting barriers in DCD Tier 1, Chapter 2, Section 2.12, "Physical Security Hardware," and DCD Tier 1, Table 2.12-1, "Physical Security Hardware Inspections, Tests, Analyses, and Acceptance Criteria," for verification of the design features that will be incorporated for physical protection in the APR1400 standard design. The test abstracts supports the verification of PSS ITAAC identified in DCD Tier 1 to meet the regulatory requirement of 10 CFR 52.47(b)(1).

14.3.12.5 Combined License Information Items

The staff reviewed the applicant's descriptions and commitments for COL information items for physical security ITAAC that must be addressed by a COL applicant if the design is certified. DCD Tier 2, Section 14.3.6 states that COL 14.3(3) requires "the COL applicant is to provide proposed ITAAC for the facility's physical security hardware not addressed in the DCD in accordance with RG 1.206." Revision 1 of DCD Tier 2, Section 14.3.6 identifies COL 14.3(4) to indicate that "[t]he COL applicant is to provide the proposed ITAAC for the facility's physical security hardware not addressed in the DCD in accordance with RG 1.206." In addition, DCD Tier 2 Section 14.3.2.12, "ITAAC for Physical Security Hardware," indicates the same commitment and references COL 14.3(4).

The applicant initially identified COL 14.2(11), which established that the COL applicant is to develop the test procedure of the communication system. The staff issued RAI 197-8176, Question 14.3.12-7 (ML15247A004), requesting the applicant to remove COL 14.2(11) which defers the development of test procedure of the communication system described in the Tier 1 and Tier 2 of the APR1400 DC and to provide test descriptions, individual pre-operational test addressing general system testing requirements for the plant communication systems described in Tier 1, Section 2.6.9 and Communication System ITAAC identified in Table 2.6.9-1. The staff also requested the applicant to provide, in Section 14.2.12.1, test descriptions, individual pre-operational test addressing general system testing requirements for the security communication systems, including plant system credited for security communications. In response to

RAI 197-8176, Question 14.3.12-7 (ML15315A042), the applicant committed to delete COL 14.2(11) and to add a new test abstract to section 14.2.12.1 to address the testing of security communication systems. The staff finds the applicant's response acceptable. The staff confirmed that DCD Tier 2 was revised as committed in the response to RAI 197-8176, Question 14.3.12-7. Therefore, RAI 197-8176, Question 14.3.12-7 was resolved and closed. Revision 1 to DCD Tier 2, Section 14.2.13, deleted the previously identified COL information for the COL applicant to develop the test procedure for communication systems. The revised (and renumbered) COL 14.2(11) establishes a commitment for the COL applicant to provide a schedule for the development of plant procedures.

DCD Tier 1, Chapter 2, Table 2.12-1 identified (i.e., reserved) physical security hardware ITAAC that a COL applicant will provide. The reserved ITAAC that will be provided by a COL applicant are the PSS or hardware as follows:

- ITAAC 2.a, 2.b, and 2.c, "Protected Area Barriers."
- ITAAC 3.a, 3.b, and 3c, "Isolation Zone."
- ITAAC 4.a and 4.c, "Protected Area Perimeter Intrusion Detection System."
- ITAAC 8.a and 8.b, "Access Control Points."
- ITAAC 9, "Picture Badge Identification System."

The staff finds the following:

- The applicant has adequately described the ITAAC outside the scope of the APR1400 DC and established clearly the ITAAC that must be addressed by a

COL applicant that references the APR1400 certified design. The combined ITAAC described within the scope of the APR1400 DC and those described for fulfilling COL 14.3(4), conforms to the staff guidance, SRP 14.3.12.

- The staff finds that the applicant has provided an adequate and reasonable description of test abstracts supporting physical security ITAAC within the scope of the DC, and established COL 14.3(4) for a COL applicant referencing the APR1400 standard design to describe specific ITAAC and abstracts for PSS outside the scope of the APR1400 DC.

The DCD Tier 2 Section 14.3.2.12 contains two COL items pertaining to physical security hardware. The staff finds that the applicant has provided an adequate and reasonable description of requirements (i.e., COL 14.3(1) and COL 14.3(4)) for a COL applicant referencing the APR1400 standard design to describe the ITAAC for PSS that are outside the scope of the APR1400 DC.

Table 14.3-17 Combined License Items Identified in the DCD

Item No.	Description	Section
COL 14.3(1)	The COL applicant is to provide the ITAAC for the site-specific portion of the plant systems specified in DCD Tier 2, Subsection 14.3.3.	14.3
COL 14.3(4)	The COL applicant is to provide the proposed ITAAC for the site specific facility's physical security hardware not addressed in the DCD in accordance with RG 1.206.	14.3

14.3.12.6 Conclusion

The staff finds the following:

- The applicant has proposed and adequately identified and described attributes for physical security ITAAC for verification to meet the regulatory requirement of 10 CFR 52.47(b)(1).
- The applicant has identified an appropriate and reasonable set of design commitments, test methods (inspections, tests, or analyses), and acceptance criteria for certification of the APR1400 standard design.
- The applicant has appropriately established in the DC the requirement that a COL holder (i.e., licensee) that references the APR1400 certified design establishes a process that will identify requirements, construction verifications that review the as-built systems and conditions, and compliance determination for PSS performance and acceptance tests not specifically identified as ITAAC.
- The applicant has provided adequate descriptions of elements of the test abstracts (or protocols) for PSS (i.e., objectives, prerequisites, test methods, data required, and acceptance criteria) that support Tier 1 descriptions of physical security ITAAC to meet the regulatory requirement of 10 CFR 52.47(b)(1).

- The applicant has identified appropriate and reasonable descriptions of test abstracts that establish the framework for developing the detailed test procedures for conducting ITA that will be performed and, if met, will demonstrate that the plant incorporated the certified standard design, and the identified PSS built or installed and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and Commission's rules and regulations.
- The applicant has provided an adequate and reasonable description of requirements (i.e., COL 14.3(1) and COL 14.3(4)) for a COL applicant referencing the APR1400 standard design to describe the ITAAC for PSS that are outside the scope of the APR1400 DC.

The staff concludes that the applicant has met 10 CFR Part 52, Subpart B, Section 52.47, which requires information submitted for a DC to include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, and procurement specifications and construction and installation specifications by an applicant. The applicant has met 10 CFR 52.47(b)(1), which requires the APR1400 DC application to contain the proposed ITAAC necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria are met, a plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the Atomic Energy Act of 1954, as amended, and NRC regulations.

14.3.13 Design Reliability Assurance Program – Inspections, Tests, Analyses, and Acceptance Criteria

The staff's evaluation of the design reliability assurance program ITAAC contained in DCD Tier 1, Section 2.13, Table 2.13-1, "Design Reliability Assurance Program ITAAC," and Tier 2 Section 14.3.2.13, "ITAAC for the Design Reliability Assurance Program," are evaluated in Section 17.4 of this SER.