14. VERIFICATION PROGRAMS

14.1 Preliminary Safety Analysis Report Information

Regulatory Guide (RG) 1.70, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants,” Revision 3, Section 14.1, “Specific Information to Be Included in Preliminary Safety Analysis Reports,” states that the applicant should provide information related to unique plant design features, compliance with test program RGs, utilization of operating and testing experience, test program schedule, and descriptions of organizations involved in testing and staffing. The applicant stated in Design Control Document (DCD) Tier 2, Section 14.1, “Specific Information to Be Included in Preliminary/Final Safety Analysis Reports,” that this section is “not applicable to the AP1000 design.” The U.S. Nuclear Regulatory Commission (NRC) staff determined that the applicant provided the technically relevant information specified in RG 1.70, Section 14.1, applicable to a design certification applicant under Title 10 of the Code of Federal Regulations (10 CFR) Part 52. DCD Tier 2, Section 14.2, “Specific Information to Be Included in Standard Safety Analysis Reports,” includes test plans for unique plant design features, methods to satisfy appropriate RGs, and test program administration. On this basis, the NRC staff accepts the applicant’s conclusion that the information to be included in Section 14.1 of a safety analysis report, as identified in RG 1.70, Revision 3, does not apply to the AP1000 design certification application.

14.2 Initial Plant Test Program

14.2.1 Introduction

The staff reviewed the applicant’s initial test program in accordance with the review guidance contained in Section 14.2, “Initial Plant Test Program—Final Safety Analysis Report,” of Revision 2 of the Standard Review Plan (SRP). The following sections document the results of the staff’s review.

14.2.1.1 General

The requirements of 10 CFR 52.47(a)(i) specify, in part, that an applicant for design certification submit the technical information required of applicants for operating licenses (see 10 CFR Part 50) that is technically relevant to the design and not site specific. In accordance with the requirements of 10 CFR 52.79(b) and 10 CFR 50.34(b)(6)(iii), an applicant for an operating license shall provide information concerning plans for preoperational testing and initial operations. RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Revision 2, dated August 1978, describes the general scope and depth of the initial test programs acceptable to the NRC staff for light-water-cooled nuclear power plants. Additionally, SRP Section 14.2, “Initial Test Program,” Revision 2, dated July 1981, provides guidance to the NRC staff for the review of a proposed initial test program.

As stated in RG 1.68, the primary objectives of an acceptable initial test program are (1) to provide assurance through testing that the facility has been adequately designed, (2) to validate, to the extent practical, the analytical models and verify the correctness or conservatism of assumptions used to predict plant responses to anticipated transients and postulated accidents, (3) to provide assurance through testing that construction and installation of equipment in the facility have been accomplished in accordance with the design, (4) to familiarize the plant's operating staff with the operation of the facility, and (5) to verify by trial use, to the extent practical, the adequacy of the facility's operating procedures and emergency operating procedures.

For each phase of the initial test program, a design certification applicant should provide test abstracts which include the objectives of each test, a summary of prerequisites and test method, and specific acceptance criteria. The initial test program should also address programmatic aspects, including consideration of organization and staffing; preparation, review, and technical content of test procedures; conduct of the test program; review, evaluation, and approval of test results; and utilization of reactor operating and testing experiences. Conformance of a proposed test program to the guidelines of RG 1.68 and the acceptance criteria outlined in SRP Section 14.2 provide reasonable assurance it meets these objectives. Initial test programs that satisfy these objectives should provide the necessary assurance that the facility can be operated in accordance with its design criteria and in a manner that will not endanger the health and safety of the public.

14.2.1.2 AP1000 Initial Test Program Review Methodology

DCD Tier 2, Section 14.2 describes the initial AP1000 test program, including preoperational and startup tests. Preoperational tests, which are performed after the construction and installation of plant equipment, but before initial fuel loading, demonstrate the capability of the plant systems to meet relevant performance requirements. Startup tests, which begin with initial fuel loading, demonstrate the capability of the integrated plant to meet performance requirements. Using the guidance contained in SRP Section 14.2, the staff reviewed the AP1000 test program administrative requirements and the technical adequacy of the preoperational and startup tests. The staff's initial test program review methodology consisted of (1) reviewing the test program's conformance with NRC RG regulatory positions related to testing; (2) designing a specific technical review to ensure that the test program adequately demonstrates the performance of the AP1000 structures, systems, and components (SSCs) important to safety; and (3) comparing the AP1000 test program to the previously reviewed and approved initial test program for the AP600. Each of these three review activities is described below:

14.2.1.2.1 Test Program Conformance with NRC Regulatory Guidance

In accordance with SRP Section 14.2, Item I.3, "Test Program's Conformance with Regulatory Guides," the staff reviewed the applicant's plans for achieving conformance with the RGs applicable to the initial test program. SRP Section 14.2 and RG 1.68 provide references to specific RGs applicable to the initial test program, as determined by the staff. For those instances in which the applicant did not conform to the RGs, the staff reviewed the applicant's justification for the exception to ensure that the test program scope remained sufficient. Section 14.2.7 of this report provides additional information.

14.2.1.2.2 Design-Specific Technical Review

Because the RGs and SRP Section 14.2 provide only representative guidance for the initial plant testing scope, the staff completed a design-specific testing review to verify that the test program would satisfactorily demonstrate the AP1000 plant features important to safety. When the initial AP1000 draft safety evaluation report (DSER) was issued on June 16, 2003, the staff had not completed this design-specific technical review. Therefore, the staff identified completion of this review as Open Item 14.2-1 in the DSER.

To ensure the adequacy of the AP1000 testing scope, general test methods, and test program acceptance criteria, the staff developed a review plan to address closure of Open Item 14.2-1. The review plan consisted of the following activities:

- Verify that the AP1000 initial test program adequately demonstrates the performance of SSCs important to safety. For the purposes of this testing review, the staff considered SSCs that (1) were safety-related, (2) within the scope of regulatory treatment of non-safety systems (RTNSS), or (3) within the scope of the design reliability assurance program (D-RAP) as important to safety.

- Verify that test abstracts included in DCD Tier 2, Section 14.2 adequately describe the required testing. The staff review focused on verifying that the applicant had adequately described the proposed testing method and acceptance criteria, that the testing could be accomplished as described, that the testing would not subject the plant to an unsafe condition, and that the applicant had assigned the testing to an appropriate test phase in order to minimize reliance on untested equipment.

- Verify that the preoperational test program was consistent with the system-based inspections, tests, analyses, and acceptance criteria (ITAAC) described in DCD Tier 1 information. This review ensured that the preoperational testing abstracts contained in DCD Tier 2, Chapter 14.2, were consistent with ITAAC requirements. Additionally, the staff verified that the preoccupational test program included all initial test program activities associated with the ITAAC and that they would be accomplished prior to initial fuel loading. Section 14.3 of this report discusses the staff's review of the ITAAC in further detail.

In the course of this review activity, the staff identified 28 specific areas where additional information was required from the applicant to complete the design-specific testing review. The staff identified each of these areas with an alphanumeric designator as a subpart to Open Item 14.2-1 (designated as Open Items 14.2-1.a through 14.2-1.bb). By E-mails dated August 12, 15, and 28, 2003, the NRC forwarded requests for additional information (RAIs) pertaining to Open Items 14.2-1.a through 14.2-1.bb to support closure of Open Item 14.2-1. On August 26, 2003, the applicant provided additional information to address 26 of the 28 issues identified by the NRC staff in Open Items 14.2-1.a through 14.2-1.z. On September 8, 2003, the applicant provided additional information to address Open Items 14.2-1.aa and 14.2-1.bb. The applicant revised DCD Tier 2, Section 14.2 to address Open Items 14.2-1.a through 14.2-1.z. Sections 14.2.9 and 14.2.10 of this report discuss the resolution of each of these 28 issues.

14.2.1.2.3 Comparison of the AP1000 to the AP600 Initial Test Program

The staff noted that the major safety-related and risk-significant system functions of the AP1000 design are similar to those of the AP600 design. The NRC staff previously reviewed and accepted the AP600 initial test program specified in Section 14.2 of NRC technical report (NUREG)-1512, “Final Safety Evaluation Report Related to the Certification of the AP600 Standard Design.” Therefore, the staff reviewed the differences between the AP1000 and AP600 initial test programs in order to gain added assurance that the scope of the AP1000 test program was adequate. This portion of the staff review focused on (1) identification of differences between the proposed AP1000 test program and the AP600 test program, and (2) applicability of the AP600 test program to the AP1000 design. When the NRC staff identified differences between the AP600 and AP1000 test programs, it conducted additional reviews to verify the adequacy of the AP1000 test program. The associated sections below describe these additional reviews.

14.2.2 Organization and Staffing

In DCD Tier 2, Section 14.2.2, “Organization, Staffing, and Responsibilities,” the applicant stated that the combined license (COL) holder is responsible for developing the specific plant organization and staffing appropriate for testing, operating, and maintaining the AP1000 plant. Further, the applicant identified this issue as a COL applicant responsibility in DCD Tier 2, Section 14.4.1. Because facility staffing will be determined by the COL applicant and is outside the scope of design certification, the NRC staff determined that it is acceptable to defer responsibility for the description of specific staff, staff responsibilities, authorities, and personnel qualifications for the AP1000 initial test program to the COL applicant. This is COL Action Item 14.4-1. Section 14.4 of this report discusses this item further.

14.2.3 Test Procedures

SRP Section 14.2 and RG 1.68 specify that test procedures should control the sequencing of testing steps; the preparation, review, and approval of test procedures; the use of temporary equipment; and the acceptance criteria. In DCD Tier 2, Section 14.4.2, “Test Specifications and Procedures,” the applicant stated that the COL applicant is responsible for providing test specifications and test procedures for preoperational and startup tests for review by the NRC. Additionally, the applicant stated that it will provide specifications and procedures for startup tests to NRC inspection personnel not less than 60 days prior to the scheduled fuel loading date, and that it will provide copies of the test specifications and test procedures for systems or components that perform safety-related or non-safety defense-in-depth functions to NRC inspection personnel approximately 60 days prior to the scheduled performance of the preoperational tests. Although the applicant proposed to defer test procedure preparation to the COL phase, DCD Tier 2, Section 14.2.3, “Test Specifications and Test Procedures,” provides general guidance for development and review of test specifications and procedures. The general guidelines include specification of test objectives, prerequisites, initial conditions, and criteria for evaluating and reconciling test results. The NRC staff concluded that the general test specification and test procedure guidelines specified in DCD Tier 2, Section 14.2.3, are acceptable because the guidelines are consistent with RG 1.68 and SRP Section 14.2 recommendations for test procedure content and development applicable to design certification. Because development of initial test program test procedures will require detailed plant-specific design information and review and approval by the COL applicant, the NRC staff concurs that deferring responsibility for the development of detailed preoperational and startup test specifications and procedures to the COL applicant is acceptable. This is COL Action Item 14.4-2. Section 14.4 of this report describes this item in more detail.

14.2.4 Review, Evaluation, and Approval of Test Results

In DCD Tier 2, Section 14.4.4, "Review and Evaluation of Test Results," the applicant stated that the COL applicant and holder is responsible for the review and evaluation of individual test results. In as much as test results will not be available until a facility is built, the NRC staff determined that it is appropriate and acceptable to defer the review and evaluation of individual test results to the COL applicant or COL holder, as appropriate. This is COL Action Item 14.4-4. Section 14.4 of this report provides additional detail on this item.

14.2.5 Utilization of Reactor Operating and Testing Experiences in the Development of the Test Program

SRP Section 14.2 states that the applicant should describe how it used the operating and testing experiences of other facilitates in the initial test program. DCD Tier 2, Section 14.2.5, "Utilization of Reactor Operating and Testing Experiences in the Development of the Test Program," states the following:

> The design, testing, startup, and operating experience from previous pressurized water reactor plants is utilized in the development of the initial preoperational and startup test program for the AP1000 plant. Other sources of experience reported and described in various documents such as NRC reports, including NRC bulletins, and Institute of Nuclear Power Operations (INPO) reports including Significant Operating Event Reports (SOERs), are also utilized in the AP1000 initial preoperational and startup test program.

The NRC staff noted that DCD Tier 2, Section 14.2.3, states that "available information on operating or testing experiences of operating reactors are factored into the test specifications and test procedures as appropriate." In DCD Tier 2, Section 14.4.2, the applicant stated that the COL applicant is responsible for providing test specifications and test procedures for preoperational and startup tests for review by the NRC. Additionally, DCD Tier 2, Section 14.4.3, states that the COL applicant is responsible for preparing a startup administration manual which contains the administrative procedures and standards that govern the activities associated with the plant initial test program. Therefore, the NRC staff finds it acceptable to defer the review of the utilization of operating and testing experience to the COL phase. COL Action Items 14.4-2 and 14.4-3 encompass this issue.

14.2.5.1 Special Tests for Initial AP1000 Plants

In DCD Tier 2, Section 14.2.5, the applicant stated that performance of nine special preoperational and initial operation tests would be necessary only for the first one or the first three AP1000 plants. The applicant proposed that subsequent plants may omit performance of these special tests after providing suitable justification. Seven of these tests are referred to as “first-plant-only” tests, while the remaining two of these tests are referred to as “first-three-plant” tests. As described in DCD Tier 2, Section 14.2.5, these special tests are associated with the establishment of certain unique phenomenological performance parameters of the AP1000 that will not change from plant to plant. Additionally, the performance of the “first-three-plant” tests are intended to affirm consistent passive system functions prior to allowing a subsequent COL applicant to omit performance of the testing. The following sections describe each of these special tests:

14.2.5.1.1 First-Plant-Only Tests

- In-Containment Refueling Water Storage Tank (IRWST) Heatup Test (DCD Tier 2, Section 14.2.9.1.3, “Passive Core Cooling System Testing,” Item (h))

  During preoperational testing of the passive core cooling system, thermocouples will be placed in the in-containment refueling water storage tank (IRWST) to observe the thermal profile developed during the heatup of the IRWST water during operation of the passive residual heat removal system heat exchanger (PRHR HX). This test will confirm the results of the AP1000 design certification program passive residual heat removal (PRHR) tests with regard to IRWST mixing, and quantify the conservatism in the transient analyses described in DCD Tier 2, Chapter 15, “Accident Analyses.” The applicant stated that as a result of the standardization of the AP1000, the heatup and thermal stratification characteristics of the IRWST will not vary from plant to plant. Consequently, the applicant classified this test as a first plant-only test.

- Pressurizer Surge Line Stratification Evaluation (DCD Tier 2, Section 14.2.9.1.7, “Expansion, Vibration and Dynamic Effects Testing,” Item (d))

  The NRC Bulletin (BL) 88-11, “Pressurizer Surge Line Thermal Stratification,” requested all applicants for a pressurized-water reactor (PWR) operating license to verify piping code conformance by analysis and hot functional testing. As part of the AP1000's conformance to NRC BL 88-11, the applicant stated that the COL applicant will implement a monitoring program for the first AP1000 plant. This monitoring program will include recording temperature distributions and thermal displacements of the surge line piping during hot functional testing and during the first fuel cycle, as discussed in DCD Tier 2, Section 3.9.3, “ASME Code Classes 1, 2, and 3 Components, Component Supports, and Core Support Structures.”

- Reactor Vessel Internals Vibration Testing (DCD Tier 2, Section 14.2.9.1.9, "Reactor Vessel Internals Vibration Testing")

  The preoperational vibration test program for the reactor internals to be conducted on the first AP1000 plant is consistent with the guidelines of RG 1.20, "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing," for a comprehensive vibration assessment program. DCD Tier 2, Section 3.9.2, "Dynamic Tests and Analysis," discusses this program.

- Natural Circulation Tests (DCD Tier 2, Sections 14.2.10.3.6, "Natural Circulation," and 14.2.10.3.7, "Passive Residual Heat Removal Heat Exchanger")

  Natural circulation tests using the steam generators (SGs) and the PRHR HX will be performed at low-core power during the startup test phase. The applicant classified this test as a first-plant-only test because its purpose is to obtain data to benchmark the operator training simulator.

- Rod Cluster Control Assembly Out-of-Bank Measurements (DCD Tier 2, Section 14.2.10.4.6, "Rod Cluster Control Assembly Out-of-Bank Measurements")

  Rod cluster control assembly out-of-bank measurements are performed during power ascension tests. The test is performed between 30 to 50 percent power so that the plant does not exceed peaking factor limits. The applicant stated that this test is required to be performed only for the first plant because its purpose is to validate calculation tools and instrument responses.

- Load Follow Demonstration Test (DCD Tier 2, Section 14.2.10.4.22, "Load Follow Demonstration")

  Although RG 1.68 does not specify a load follow demonstration test, the AP1000 performs load follow with grey control rods. Therefore, the applicant has included a proof of principle load follow demonstration for the first AP1000 plant to demonstrate its ability to follow a design-basis daily load follow cycle.

14.2.5.1.2 First-Three-Plant Tests

- Core Makeup Tank (CMT) Heated Recirculation Tests (DCD Tier 2, Section 14.2.9.1.3, Items (k) and (w))

  During preoperational testing of the passive core cooling system, a natural circulation heatup of the CMTs, followed by a test to verify the ability of the CMTs to transition from a recirculation mode to a draindown mode while at elevated temperature and pressure, will be performed. The applicant classified this test as a first-three-plant test because the natural circulation of the CMTs will not vary from plant to plant. Additionally, the applicant noted that performance of this test results in significant thermal transients on Class 1 components, including the CMTs and the direct vessel injection nozzles.

- Automatic Depressurization System (ADS) Blowdown Test (DCD Tier 2, Section 14.2.9.1.3, Item(s))

  During preoperational hot functional testing of the reactor coolant system (RCS), an ADS blowdown test will be performed. This will result in a significant blowdown of the RCS into the IRWST. This test verifies proper operation of the ADS valves and demonstrates the proper operation of the ADS spargers to limit the hydrodynamic loads in containment to less than design limits. The applicant classified this test as a first-three-plant test because operation of the ADS and the resultant hydrodynamic loads will not vary from plant to plant. Additionally, the applicant noted that performance of this test results in significant thermal transients on Class 1 components, including the primary components. It also results in hydrodynamic loads in containment, including the IRWST.

The NRC staff noted that DCD Tier 2, Section 14.4.6, "First-Plant-Only and Three-Plant-Only Tests," states the following:

> The COL applicant or holder for the first plant and the first three plants will perform the tests listed in [DCD Tier 2, Section] 14.2.5. For subsequent plants, the COL applicant or licensee shall either perform the tests listed in [DCD Tier 2, Section] 14.2.5, or shall provide a justification that the results of the first-plant-only tests or the first-three-plant tests are applicable to the subsequent plant.

The staff reviewed the information provided by the applicant in DCD Tier 2, Section 14.2.5, regarding the performance of certain special tests on a first-plant-only and first-three-plant-only basis. The staff noted that DCD Tier 2, Section 14.4.6, "First-Plant-Only and Three-Plant-Only," provides that the COL applicant or licensee for the first plant or the first three plants will perform the tests listed in DCD Tier 2, Section 14.2.5. DCD Tier 2, Section 14.4.6, further provides that for subsequent plants, the COL applicant or licensee shall either perform the tests listed in DCD Tier 2, Section 14.2.5, or shall justify that the results of the first-plant-only tests or the first-three-plant tests apply to subsequent plants. Based on this information, the staff concludes that it is the responsibility of a subsequent COL holder to either perform or justify not performing any of the special tests identified in DCD Tier 2, Section 14.2.5. Therefore, the staff will obtain additional information during the COL application stage to determine the acceptability of performance of these special tests on a first-plant-only or first-three-plant basis. Consequently, the staff has not evaluated the acceptability of performing these special tests on either a first-plant-only or first-three-plant basis during the design certification review. This is COL Action Item 14.4-6. Section 14.4 of this report discusses this item further.

14.2.6 Trial Use of Plant Operating and Emergency Procedures

SRP Section 14.2 states that the applicant should incorporate the plant operating, emergency, and surveillance procedures into the test program or otherwise verify these procedures through use, to the extent practicable during the test program. In DCD Tier 2, Section 14.2.6, "Use of Plant Operating and Emergency Procedures," the applicant stated that as appropriate and to the extent practical plant normal, abnormal, and emergency operating procedures will be used when performing preoperational startup tests. In DCD Tier 2, Section 14.4.2, the applicant stated that the COL applicant is responsible for providing specifications and procedures for preoperational and startup tests for review by the NRC. Additionally, DCD Tier 2, Section 14.4.3, “Conduct of Test Program,” indicates that the COL applicant is responsible for a startup administration manual which contains the administrative procedures and standards that govern the activities associated with the plant initial test program. Therefore, the NRC staff concludes it is acceptable to defer the review of the trial use of operating and emergency procedures to the COL phase. COL Action Items 14.4-2 and 14.4-3 encompass this issue.

14.2.7 Conformance of Test Programs with Regulatory Guides

SRP Section 14.2 states, in part, that the applicant should establish and describe an initial test program that is consistent with the regulatory positions in RG 1.68. Additionally, SRP Section 14.2 includes a list of supplemental RGs that provide more detailed information pertaining to the testing. 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. The NRC staff reviewed the AP1000 initial test program to verify that the program either complied with these RGs or that the applicant provided adequate justification for exceptions.

DCD Tier 2, Appendix 1A, “Conformance with Regulatory Guides,” describes compliance of the AP1000 initial test program with the NRC RGs applicable to the test program. The applicant identified several areas where the proposed AP1000 test program did not conform to staff regulatory positions. The staff reviewed each proposed RG exception to verify that the applicant provided adequate justification for nonconformance with testing regulatory positions. The staff evaluated each of these specific exceptions, as described below:

- RG 1.41, “Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper Load Group Assignments,” Revision 0

  RG 1.41 states that, as part of the preoperational testing program, certain onsite electrical power systems should be tested to verify the existence of independence among redundant onsite power sources and their load groups. In DCD Tier 2, Appendix 1A, the applicant provided the following information related to RG 1.41:

  > The guidelines are followed for Class 1E dc [direct current] power systems during the preoperational testing of the AP1000 redundant onsite electric power systems to verify proper load group assignments, except as follows. Complete preoperational testing of the startup, sequence loading, and functional performance of the load groups is performed where practical. In those cases where it is not practical to perform complete functional performance testing, an evaluation is used to supplement the testing.

  The staff initially lacked sufficient information to determine the acceptability of this exception to RG 1.41. Specifically, the staff could not identify to which regulatory position in RG 1.41 the exception applied, if the exception applied to both alternating current (ac) and dc systems, and in which cases the performance of functional testing was not practical. Therefore, in RAI 261.014, the staff requested the applicant to provide additional specific information regarding this exception. This was Open Item 14.2.7-1 in the DSER.

The staff requested, in RAI 260.014, the applicant to identify (1) the specific regulatory position in RG 1.41 that the does not conform to the AP1000 test program; (2) the specific electrical systems (ac, dc, or both) affected by the exception; and (3) the specific cases in which performance of functional testing was not practical. The staff also requested the applicant provide supporting justification. The applicant responded to RAI 261.014 by letter dated May 14, 2003, and stated that RG 1.41 applies only to the Class 1E dc and uninterrruptible power supply (UPS) system. The applicant clarified that the proposed exception applies to the portion of RG 1.41, Regulatory Position 2, that requires functional performance testing of squib valve electrical loading. The applicant stated that while functional testing of squib valves powered from the Class 1E dc and UPS system is not practical, testing of other load types on the Class 1E dc and UPS system according to RG 1.41 is reasonable. The applicant stated that the electrical connection at the squib valve actuator would be removed and the leads connected to a test device to confirm the presence or absence of an actuation signal. Because energizing a squib valve would be a destructive test, the staff concluded that the exception to RG 1.41 for the functional testing of squib valves connected to the Class 1E dc and UPS system is reasonable. Based on this response to RAI 261.014 and Open Item 14.2.7-1, the NRC staff determined that this response was acceptable; therefore, Open Item 14.2.7-1 is resolved.

- RG 1.68, “Initial Test Program for Water-Cooled Nuclear Power Plants,” Revision 2, Appendix A, Test 4.t

  RG 1.68, Appendix A, Test 4.t specifies performance of natural circulation tests of the reactor coolant system during low power testing. In DCD Tier 2, Appendix 1A, the applicant provided the following information:

  > For the AP1000, natural circulation heat removal to cold conditions using the steam generators is not safety-related, as in current plants. This safety function is performed by the PRHR. Natural circulation heat removal via the PRHR is tested for every plant during hot functional testing.

  Because the PRHR HX serves as the safety-related heat sink for the AP1000 design, the staff determined that natural circulation testing of the PRHR, rather than the reactor coolant system and SGs, met the intent of RG 1.68 and was therefore acceptable. However, the NRC found that the exception to RG 1.68, Appendix A, Test 4.t contradicts the low-power test abstracts in DCD Tier 2, Section 14.2.10.3.6, “Natural Circulation (First Plant Only),” and DCD Tier 2, Section 14.2.10.3.7, “Passive Residual Heat Removal Heat Exchanger (First Plant Only).” Specifically, the exception to RG 1.68

states, in part, that "the PRHR is tested for every plant during hot functional testing." However, the low-power natural circulation test abstracts 14.2.10.3.6 and 14.2.10.3.7 state that these tests are "first-plant-only" tests.

Additionally, DCD Tier 2, Section 14.2.10.3.7, stated, in part, that performance of the PRHR natural circulation testing is not required if a large-scale test of the AP600 or AP1000 type PRHR HX has been conducted and confirms adequate heat removal capability. Because of the conflicting information contained in the DCD, the staff initially could not complete the review of this regulatory position exception. Therefore, in RAI 261.015, the NRC staff requested the applicant to clarify and justify the inconsistent natural circulation testing provisions in test abstracts 14.2.10.3.6 and 14.2.10.3.7. Specifically, the staff asked the applicant to clarify the circumstances under which it would perform natural circulating testing. This issue was Open Item 14.2.7-2 in the DSER. Additionally, in Open Item 14.2-1.v, the staff requested the applicant to clarify or delete the note in test abstract 14.2.10.3.7 regarding the use of a large-scale test facility in lieu of an actual plant low-power test.

In response to Open Items 14.2-1.v and 14.2.7-2, the applicant deleted the reference to large-scale test facility testing in low-power test abstract 14.2.10.3.7 to preclude the use of large-scale testing in lieu of actual plant testing. Additionally, the applicant revised the comments associated with the exception to RG 1.68, Appendix A, Test 4.t referenced in DCD Tier 2, Appendix 1A, to delete the reference to performing natural circulation testing during hot functional testing for every plant. The staff noted that the preoperational test program includes testing to verify natural circulation heat removal capability in test abstract 14.2.9.1.3, "Passive Core Cooling System Testing." This action resolves Open Items 14.2-1.v and 14.2.7-2. However, the staff will require additional information during the COL application stage to determine the acceptability of performing tests 14.2.10.3.6 and 14.2.10.3.7 on a first-plant-only basis. This is COL Action Item 14.4-6. Section 14.4 of this report discusses this item further.

- RG 1.68, "Initial Test Program for Water-Cooled Nuclear Power Plants," Regulatory Position C.1, Appendix A.5, Power Ascension Tests

  RG 1.68, Regulatory Position C.1, states that testing of SSCs used for shutdown and cooldown of the reactor under normal, transient, and postulated accident conditions should be conducted. In DCD Tier 2, Section 1.9.4, "Generic Issue," I.G.2, "Scope of Test Program," the applicant states:

  > The conformance with Standard Review Plan, Section 14 is outlined in AP1000 Compliance with SRP Acceptance Criteria, WCAP-15799.

  In WCAP-15799, "AP1000 Compliance with SRP Acceptance Criteria," Revision 0, dated April 2002, the NRC staff found that the applicant took exception to the remote shutdown panel testing described in RG 1.68, Regulatory Position C.1. The applicant stated the following:

> Since the remote shutdown panel is similar to the main control room work station, it is unnecessary to perform a preoperational test to place the plant in safe-shutdown condition and maintain it there from the remote shutdown workstation. Remote shutdown capability testing is performed by testing the controls and indications of the remote shutdown workstation and separately demonstrating the ability of the PRHR system to maintain safe shutdown.

The NRC staff concluded that the reference to performance of this test during the preoperational test phase is inconsistent with the guidance in RG 1.68. Specifically, RG 1.68, Appendix A, Test 5.d.d, recommends performing this test during the power ascension test phase, rather than during the preoperational test phase.

The staff reviewed the test abstract in DCD Tier 2, Section 14.2.10.4.28, "Remote Shutdown Workstation," and finds that the DCD specifies that this test is to be performed during the power ascension test phase when the plant is operating in a steady-state condition at 10–20 percent power. Accordingly, the staff concludes that the remote shutdown workstation test abstract in DCD Tier 2, Chapter 14, meets the guidance in RG 1.68 relating to Test 5.d.d and is, therefore, acceptable. Because the applicant conformed with the RG 1.68 guidance for remote shutdown panel testing, the staff concluded that the applicant should delete this unnecessary RG exception from WCAP-15799. This was Open Item 14.2.7-3 in the DSER.

In response to DSER Open Item 14.2.7-3, the applicant prepared Revision 1 to WCAP-15799, dated August 2003, which states that test abstract 14.2.10.4.28 meets the guidance relating to Test 5.d.d in Appendix A.5 to RG 1.68, Regulatory Position C.1. The staff finds this revision to be acceptable. Therefore, Open Item 14.2.7-3 is resolved.

- RG 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," Revision 1, Regulatory Positions C.1 and C.2.a-b

  RG 1.140, Regulatory Positions C.1 and C.2.a-b, provide design criteria, including operating parameters, instrumentation, and seismic capabilities, for atmospheric cleanup systems installed in a normal ventilation exhaust system. In DCD Tier 2, Appendix 1A, the applicant identified exceptions to Regulatory Positions C.1 and C.2a-b contained in Revision 1 to RG 1.140. The NRC staff reviewed the exceptions to RG 1.140 and noted that the applicant had not evaluated whether the AP1000 design conforms to Revision 2 of RG 1.140, issued in June 2001. In RAI 480.007, the staff requested the applicant to conform to Regulatory Positions C.1 and C.2.1-2.4 in Revision 2 of RG 1.140. The applicant revised DCD Tier 2, Appendix 1A, to indicate the applicant's conformance with RG 1.140, Revision 2, Regulatory Positions C.1 and C.2.1-2.4. The staff concludes that the applicant adequately addressed this issue. Therefore, RAI 480.007 is resolved.

- RG 1.128, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants"

  RG 1.128 states that, with certain exceptions, conformance with Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) 484-75 provides an adequate basis for complying with the requirements of Appendix A and Appendix B to 10 CFR Part 50 with respect to quality standards for the installation design and installation of large lead storage batteries.

  The applicant states the following in DCD Tier 2, Appendix 1A:

  > Regulatory Guide 1.128 endorses IEEE Std 484-75 ([DCD] Reference 36) which has been superseded by IEEE Std 484-1996 ([DCD] Reference 37). The AP1000 uses the latest version of the industry standard (as of 4/2001). This version is not endorsed by a regulatory guide but its use should not result in deviation from the design philosophy otherwise stated in Regulatory Guide 1.128.

  The staff compared the standards contained in the 1975 and 1996 versions of IEEE Std 484 and determined that the use of IEEE Std 484-1996 for the testing of large lead storage batteries is equivalent to the testing required by IEEE Std 484-75. Because testing performed in accordance with IEEE Std 484-1996 achieves the same purpose as testing in accordance with RG 1.128, the staff finds this exception to RG 1.128 to be acceptable.

- RG 1.139, "Guidance for Residual Heat Removal (for Comment)"

  In RG 1.139, Regulatory Positions C.1.a and C.1.c specify that the design should allow the reactor to be taken from normal operating conditions to cold shutdown using only safety-grade systems that satisfy General Design Criteria (GDC) 1 through 5. Additionally, the systems should be capable of bringing the reactor coolant system to a cold-shutdown condition within 36 hours following shutdown with only offsite power or onsite power available, assuming the most limiting single failure.

  The applicant states the following in DCD Tier 2, Appendix 1A:

  > Continued operation of the [passive residual heat removal] heat exchanger brings the reactor coolant system pressure and temperature down to the point where the stress in the reactor coolant pressure boundary is low. This temperature is about [204 °C] 400 °F which allows a reactor coolant system pressure of 1/10 of design ([1.72 MPa] 250 psia).
  >
  > The passive residual heat removal heat exchanger does not rely on pumps, ac power sources, air systems, or water cooling systems.

For the AP1000 design, the staff noted in Section 6.3.1.4 of this report, that for non-loss-of-coolant accident (non-LOCA) events, the PRHR HX, in conjunction with the passive containment coolant system, can bring the plant to a stable safe-shutdown condition and cool the RCS to about 215.6 °C (420 °F) in 36 hours, with or without the reactor coolant pumps operating. In DCD Tier 2, Chapter 16, “Technical Specifications,” Table 1.1-1, Mode 4, “Safe Shutdown” is defined to occur when the average reactor coolant temperature is between 215.6 °C $\geq T_{avg} >$ 93.3 °C (420 °F $\geq T_{avg} >$ 200 °F). Thus, the PRHR can reach the safe-shutdown condition, as defined in the AP1000 technical specifications (TS), within 36 hours. The normal residual heat removal system can be used to reach Mode 5 (cold shutdown) condition with $T_{avg} \leq$ 93.3 °C ($T_{avg} \leq$ 200 °F) in a time period greater than 36 hours. Accordingly, although RG 1.139 specifies that the residual heat removal system should be capable of achieving a cold shutdown condition within 36 hours, the staff finds it acceptable to use the safety-related PRHR to bring the plant to safe-shutdown condition of less than 215.6 °C (420 °F) because of its functional limitations. The staff addressed this position regarding the PRHR in passive plant designs in SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety System in Passive Plant Designs,” which the Commission approved in the Staff Requirements Memorandum (SRM) dated June 30, 1994. In addition, the staff finds that the safety-grade PRHR system requires only dc power to achieve safe-shutdown conditions and can perform its function regardless of the availability of offsite or onsite ac power. Therefore, the staff finds the exceptions to RG 1.139 outlined in DCD Tier 2, Appendix 1A to be acceptable.

- Regulatory guides referenced in DCD Tier 2, Appendix 1A

  The NRC staff also reviewed all RGs referenced in DCD Tier 2, Appendix 1A and recommended by SRP Section 14.2 that the applicant had determined not to be applicable to the AP1000 design. They include the following:

  - RG 1.9, “Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units Used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants”

  - 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”

  - RG 1.95, (WITHDRAWN January 2002), “Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release”

  - RG 1.116, “Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems”

  - RG 1.136, “Materials, Construction, and Testing of Concrete Containments (Articles CC-1000, -2000, and -4000 through -6000 of the ‘Code for Concrete Reactor Vessels and Containments’)”

> Because the AP1000 design does not include a concrete containment, Class 1E diesel generators, or safety-related engineered safeguards ventilation cleanup systems, the staff finds that RGs 1.9, 1.52, and 1.136 do not apply to the AP1000 design certification. Additionally, the NRC withdrew RG 1.95, and therefore, it is not applicable to a design certification review. Finally, RG 1.116 applies to the installation, inspection, and testing of plant equipment during construction and is, therefore, not applicable to design certification. Consequently, the staff concludes that these five RGs do not apply to the AP1000 design certification.

The NRC staff finds that the AP1000 test program adequately conforms to RG 1.68 and the test program regulatory positions stated in SRP Section 14.2, and that the applicant has adequately justified any exceptions.

14.2.8 Test Program Schedule and Sequence

SRP Section 14.2, Subpart II.7, “Test Program Schedule and Sequence,” states, in part, that the test program schedule should establish that testing will be accomplished as early in the test program as feasible, and that the safety of the plant will not depend entirely on the performance of untested systems, components, or features.

In DCD Tier 2, Section 14.2.8, “Test Program Schedule,” the applicant stated the following:

> The schedule for the initial fuel load and for each major phase of the initial test program includes the timetable for generation, review and approval of procedures as well as the actual testing and analysis of results.
>
> Preoperational testing is performed as systems and equipment availability allows. The interdependence of systems is considered.
>
> Sequencing of startup tests depends on specified power and flow conditions and intersystem prerequisites. The startup test schedule establishes that, prior to core load, the test requirements are met for those plant structures, systems, and components that are relied upon to prevent, limit or mitigate the consequences of postulated accidents. Testing is sequenced so that the safety of the plant is not dependent on untested systems, components, or features.

The COL applicant is responsible for the test program schedule. Therefore, the staff finds it acceptable to defer the review of the test program schedule and sequence to the COL phase. COL Action Items 14.4-1, 14.4-2, and 14.4-3 encompass this issue.

14.2.9 Preoperational Test Abstracts

Preoperational testing consists of tests conducted following completion of construction and construction-related inspection and tests, but prior to fuel loading. Preoperational testing will demonstrate, to the extent practical, the capability of SSCs to meet design criteria. The extent of testing should be sufficient to demonstrate that the facility can operate in accordance with the design criteria. The scope of preoperational testing should also ensure that plant safety during later phases, including initial fuel loading and startup testing, does not depend entirely on untested systems.

In DCD Tier 2, Section 14.2.9, “Preoperational Test Descriptions,” the applicant provided 16 test abstracts for safety-related functions, 21 test abstracts for non-safety-related, defense-in-depth functions, 6 test abstracts for non-safety-related radioactive system functions, and 21 test abstracts for additional non-safety-related functions. The following is a list of the preoperational test abstracts found in DCD Tier 2, Section 14.2.9:

Safety-Related Functions

14.2.9.1.1 Reactor Coolant System Testing
14.2.9.1.2 Steam Generator System Testing
14.2.9.1.3 Passive Core Cooling System Testing
14.2.9.1.4 Passive Containment Cooling System Testing
14.2.9.1.5 Chemical and Volume Control System Isolation Testing
14.2.9.1.6 Main Control Room Emergency Habitability System Testing
14.2.9.1.7 Expansion, Vibration and Dynamic Effects Testing
14.2.9.1.8 Control Rod Drive System
14.2.9.1.9 Reactor Vessel Internals Vibration Testing
14.2.9.1.10 Containment Isolation and Leak Rate Testing
14.2.9.1.11 Containment Hydrogen Control System Testing
14.2.9.1.12 Protection and Safety Monitoring System Testing
14.2.9.1.13 Incore Instrumentation System Testing
14.2.9.1.14 Class 1E DC Power and Uninterruptable Power Supply Testing
14.2.9.1.15 Fuel Handling and Reactor Component Servicing Equipment Test
14.2.9.1.16 Long Term Safety-Related System Support Testing

Defense-in-Depth Functions

14.2.9.2.1 Main Steam System Testing
14.2.9.2.2 Main and Startup Feedwater System
14.2.9.2.3 Chemical and Volume Control System Testing
14.2.9.2.4 Normal Residual Heat Removal System Testing
14.2.9.2.5 Component Cooling Water System Testing
14.2.9.2.6 Service Water System Testing
14.2.9.2.7 Spent Fuel Pool Cooling System Testing
14.2.9.2.8 Fire Protection System Testing
14.2.9.2.9 Central Chilled Water System Testing
14.2.9.2.10 Nuclear Island Non-radioactive Ventilation System Testing
14.2.9.2.11 Radiologically Controlled Area Ventilation System
14.2.9.2.12 Plant Control System Testing
14.2.9.2.13 Data Display Processing System Testing
14.2.9.2.14 Diverse Actuation System Testing

14.2.9.2.15 Main AC Power System Testing
14.2.9.2.16 Non-Class 1E DC and Uninterruptable Power Supply System Testing
14.2.9.2.17 Standby Diesel Generator Testing
14.2.9.2.18 Radiation Monitoring System Testing
14.2.9.2.19 Plant Lighting System Testing
14.2.9.2.20 Primary Sampling System Testing
14.2.9.2.21 Annex/Auxiliary Building Nonradioactive HVAC System

Non-Safety-Related Radioactive System Functions

14.2.9.3.1 Liquid Radwaste System Testing
14.2.9.3.2 Gaseous Radwaste System Testing
14.2.9.3.3 Solid Radwaste System Testing
14.2.9.3.4 Radioactive Waste Drain System Testing
14.2.9.3.5 Steam Generator Blowdown System Testing
14.2.9.3.6 Waste Water System Testing

Additional Non-Safety-Related Functions

14.2.9.4.1 Condensate System Testing
14.2.9.4.2 Condenser Air Removal System Testing
14.2.9.4.3 Main Turbine System and Auxiliaries Testing
14.2.9.4.4 Main Generator System and Auxiliaries Testing
14.2.9.4.5 Turbine Building Closed Cooling Water System Testing
14.2.9.4.6 Circulating Water System Testing
14.2.9.4.7 Turbine Island Chemical Feed System Testing
14.2.9.4.8 Condensate Polishing System Testing
14.2.9.4.9 Demineralized Water Transfer and Storage System Testing
14.2.9.4.10 Compressed and Instrument Air System Testing
14.2.9.4.11 Containment Recirculation Cooling System Testing
14.2.9.4.12 Containment Air Filtration System Testing
14.2.9.4.13 Plant Communications System Testing
14.2.9.4.14 Mechanical Handling System Crane Testing
14.2.9.4.15 Seismic Monitoring System Testing
14.2.9.4.16 Special Monitoring System Testing
14.2.9.4.17 Secondary Sampling System Testing
14.2.9.4.18 Turbine Building Ventilation System
14.2.9.4.19 Health Physics and Hot Machine Shop HVAC Testing
14.2.9.4.20 Radwaste Building HVAC System
14.2.9.4.21 Main, Unit Auxiliary and Reserve Transformer Test

For each of the above preoperational test abstracts, the NRC staff reviewed the test description, purpose, prerequisites, general test acceptance criteria, and test methods using the methodology described in Section 14.2.1.2 of this report. In comparing the AP1000 preoperational test program to the preoperational testing recommended in RG 1.68, Appendix A, Section 1, “Preoperational Testing,” the staff identified several areas where it required additional information to complete its review. Descriptions of the specific issues and their resolution follow:

- Containment Valve Closure Time Testing

  In RAI 261.001, the staff noted that RG 1.68, Appendix A, “Initial Test Programs,” Section 1.i, “Primary and Secondary Containment,” recommends the performance of containment isolation valve closure timing tests during preoperational testing. However, the staff was unable to locate a preoperational test abstract in DCD Tier 2, Section 14.2.9.1, that described this testing. In its October 1, 2002, response to this RAI, the applicant stated that DCD Tier 2, Section 14.2.9.1.10, “Containment Isolation and Leak Rate Testing,” includes verification of proper operation of the safety-related containment isolation valves listed in DCD Tier 2, Table 6.2.3-1 by the performance of baseline inservice tests, as specified in DCD Tier 2, Section 3.9.6. The applicant stated that the baseline inservice tests include stroke time measurement. The staff determined that containment isolation valve stroke time measurements, as described in DCD Tier 2, Sections 14.2.9.1.10 and 3.9.6.2.2, meet the intent of RG 1.68 and are, therefore, adequate.

- Instrumentation and Control System Tests

  In RAI 261.002, the staff noted that RG 1.68, Appendix A, Section 1.j, “Instrumentation and Control Systems,” recommends testing associated with (1) the failed fuel detection system, (2) the hotwell level control system, (3) instruments used to detect external and internal flooding conditions that could result from such sources as fluid system piping failures, and (4) instruments, such as the reactor vessel water level monitors, that can be used to track the course of postulated accidents. In reviewing the AP1000 preoperational test program, the staff was unable to locate information pertaining to these tests. In an October 1, 2002, response to RAI 261.002, the applicant provided additional information related to these tests. The staff’s evaluation of this additional information as related to each of the above items is provided below:

  (1) Failed Fuel Detection System

  The NRC staff noted that AP1000 DCD Tier 2, Section 4.2.4.3, “Letdown Radiation Monitoring,” indicated that the chemical and volume control system letdown radiation monitor may be used to indicate a breach in the fuel rod pressure boundary. However, the staff was unable to locate a preoperational test abstract that described testing of this function. In its October 1, 2002, response the applicant stated that the letdown radiation monitor was within the scope of the radiation monitoring system testing described in DCD Tier 2, Section 14.2.9.2.18. Upon further review of this RAI response, the staff determined that the AP1000 design does not have a letdown radiation monitor. In a February 13, 2003, revision to its initial RAI response, the applicant stated that it revised DCD Tier 2, Section 4.2.4.3, to state that grab samples are used for letdown radiation monitoring. Because the AP1000 design does not use a failed fuel detector, the staff determined that the failed fuel detection system testing recommendations in RG 1.68 did not apply to the AP1000.

(2) Hotwell Level Control System

In reviewing DCD Tier 2, Section 14.2.9.4.1, “Condensate System Testing,” the staff was unable to locate specific testing provisions for the hotwell level control system. In its October 1, 2002, RAI response, the applicant stated that the condensate hotwell level control system is part of the condensate system controls. The applicant added that proper calibration and operation of the system instrumentation, controls, actuation signals, and interlocks are verified in accordance with DCD Tier 2, Section 14.2.9.4.1. On the basis that the hotwell level control system is tested in conjunction with the verification of proper calibration and operation of condensate system controls, the staff has determined that the AP1000 preoperational test program satisfies RG 1.68 and therefore is adequate.

(3) Flood Detection Instrumentation

Based on information contained in DCD Tier 2, Section 14.3, “Certified Design Material,” and Table 14.3.5, “Flood Protection,” the staff determined that the AP1000 design included a flood protection feature. However, the staff was unable to locate test standards for flood detection instrumentation in DCD Tier 2, Section 14.2. In its October 1, 2002, RAI response, the applicant stated that although flood protection is a design feature for the AP1000, no instruments are included for detecting floods (other than those for containment flooding which is covered in other initial test program sections). On the basis that the AP1000 design does not include specific flood detection instrumentation, the staff concluded that the flood detection instrumentation testing recommendations of RG 1.68 are not applicable to the AP1000 design certification. Section 3.4.1.2 of this report discusses internal flooding.

(4) Postaccident Monitoring Instrumentation

In comparing the AP600 preoperational test program to the proposed AP1000 test program, the staff noted that the AP1000 test program does not include a specific test abstract related to postaccident monitoring instrumentation. DCD Tier 2, Table 7.5-1, “Safety-Related Display Information,” lists the instruments used for postaccident monitoring. The staff located the test standards for many of the postaccident instruments listed in DCD Tier 2, Table 7.5-1 within test abstracts for other systems, including DCD Tier 2, Section 14.2.9.1.1, “Reactor Coolant System Testing”; DCD Tier 2, Section 14.2.9.1.12, “Protection and Safety Monitoring System Testing”; and DCD Tier 2, Section 14.2.9.2.20, “Primary Sampling System Tests.” However, the staff could not locate test standards for the reactor vessel level indication system (RVLIS) and humidity monitors, two of the postaccident monitoring instruments listed in RG 1.68, Appendix A, Item 1.j.22.

In an October 1, 2002, RAI response, the applicant indicated that under the criteria in DCD Tier 2, Section 7.5, “Post Accident Monitoring System,” the AP1000 does not need the RVLIS or the humidity monitors for postaccident monitoring functions and therefore they are not included in Table 7.5-1. However, the applicant stated that reactor vessel level indication testing is addressed under the hot leg instrumentation initial testing described in DCD Tier 2, Section 14.2.9.1.1, “Reactor Coolant System Testing.” With regard to humidity monitors, the applicant stated that the containment humidity monitors are part of the containment leak rate test system and are installed inside containment for Type A testing. On the basis that the reactor vessel level instrument and the humidity monitors are not classified as postaccident monitoring instruments, the staff concludes that the testing recommendations of RG 1.68 for RVLIS and humidity monitors are not applicable to the AP1000.

- Radiation Protection System Tests

  RG 1.68, Appendix A, Item 1.k, “Radiation Protection Systems,” states that appropriate tests should be conducted to demonstrate proper operation of systems and components used to provide for personal protection or to control or limit the release of radioactivity. Specifically, RG 1.68 states that testing of high-efficiency particulate air (HEPA) filter and charcoal adsorber efficiency should include in-place leak testing and verification of redundancy and electrical independence consistent with the provisions of RG 1.52. The staff noted that DCD Tier 2, Section 9.4.1.2.2, “Component Description,” references use of RG 1.140, rather than RG 1.52 for testing of HEPA filters and charcoal adsorbers. In RAI 261.003, the staff requested the applicant to provide additional information to explain its use of RG 1.140 rather than RG 1.52 for accomplishing this testing.

  In its October 1, 2002, response to this RAI, the applicant stated that the nuclear island (NI) nonradioactive ventilation system (described in DCD Tier 2, Section 9.4.1, “Nuclear Island Nonradioactive Ventilation System,”) and the containment air filtration system (described in DCD Tier 2, Section 9.4.7, “Containment Air Filtration System,”) use HEPA filters and charcoal adsorbers. The applicant stated that DCD Tier 2, Sections 14.2.9.2.10 and 14.2.9.4.12, respectively, describe the initial test program associated with these systems. Because this testing is being performed during the preoperational test phase when there is no fuel in the reactor vessel, the staff determined that RG 1.140 provides the appropriate guidance for testing non-safety-related HEPA filters and charcoal absorbers. The staff determined that because the NI nonradioactive ventilation and containment air filtration system are non-safety-related systems, RG 1.140 is the appropriate guidance for this testing.

- Fuel Storage and Handling System Tests

  RG 1.68, Appendix A, Section 1.m, “Fuel Storage and Handling Systems,” recommends that the preoperational test program include operability and leak tests of sectionalizing devices and drains and leak tests of gaskets or bellows in the refueling canal and fuel storage pool. The staff noted that DCD Tier 2, Section 14.2.9.1.15, “Fuel Handling and Reactor Component Servicing Equipment Test,” does not include preoperational leak tests of gaskets or bellows in the refueling canal and fuel storage pool. In RAI 261.004, the staff requested the applicant to provide additional information related to the performance of this testing. In its October 1, 2002, response to this RAI, the applicant stated that the critical gasket in the design, the double-gasketed blind flange at the refueling canal end, is tested in accordance with DCD Tier 2, Section 14.2.9.1.10, “Containment Isolation and Leak Rate Testing.” In DCD Tier 2, Section 14.2.9.2.7, “Spent Fuel Pool Cooling System Testing,” the applicant added Item (g) to state that “the gates, drains, bellows, and gaskets in the refueling canal and fuel storage pool are checked for unacceptable leakage.” Based on this response, the staff concluded that the preoperational test program adequately addresses operability and leak tests, satisfies RG 1.68, Appendix A, Section 1.m, and is, therefore, acceptable.

- Irradiated Fuel Pool and Building Ventilation System Tests

  RG 1.68, Appendix A, Item 1.m, recommends that preoperational testing of the irradiated fuel pool or building ventilation system be conducted. The staff was unable to locate test abstracts related to this system in DCD Tier 2, Section 14.2.9.1.15. In RAI 261.008, the staff requested that the applicant provide more information related to this testing. In its October 1, 2002, RAI response, the applicant stated that DCD Tier 2, Section 14.2.9.2.11, “Radiologically Controlled Area Ventilation System,” describes performance testing during a series of individual component and integrated system tests to verify that the system performs its defense-in-depth function. The staff determined that the radiologically controlled area ventilation system performs the functions of the fuel pool or building ventilation system referenced by RG 1.68, Appendix A, Item 1.m. In its RAI response, the applicant also stated that DCD Tier 2, Section 9.4.3.4, identifies that a system air balance test and adjustment to design conditions will be conducted in the course of the plant’s preoperational test program. Accordingly, the staff concludes that the testing described by the applicant adequately addresses irradiated fuel pool or building ventilation system testing, satisfies RG 1.68, Appendix A, Item 1.m, and is, therefore, acceptable.

In performing the design-specific testing review, the staff identified several areas where it required additional information to support its technical review of preoperational test abstracts. Discussions of these areas, identified as Open Items 14.2-1.a through 14.2-1.l, 14.2-1.z, 14.2-1.aa, and 14.2-1.bb, follow:

- In Open Items 14.2-1.a through 14.2-1.l, the staff requested additional information to support the review of preoperational testing abstracts. These open items addressed the following items: clarification of test parameters and acceptance criteria for testing of the passive containment cooling system (Open Items 14.2-1.a through 14.2-1.e), clarification of test methods for steam generator loose parts monitoring (Open Item 14.2-1.f), provisions for the use of test switches for blocking unwanted device actuations during protection and safety monitoring system testing (Open Item 14.2-1.g), clarification of plant communication system testing acceptance criteria to address maximum potential noise levels (Open Item 14.2-1.h), resolution of test parameter and acceptance criteria discrepancies for ventilation system testing (Open Item 14.2-1.i), clarification of the functions to be tested during reactor coolant system testing (Open Item 14.2-1.j), acceptance criteria for passive core cooling system testing (Open Item 14.2-1.k), and clarification of normal residual heat removal testing (Open Item 14.2-1.l). In a letter dated August 26, 2003, the applicant responded to these open items and provided information to (1) clarify inconsistent test parameters, performance criteria, and acceptance criteria for plant equipment, (2) provide additional test methods for plant equipment (i.e., a special monitoring system with steam generator acoustic monitors for loose parts monitoring, testing communication equipment under maximum noise levels, test switches or racking out circuit breakers to block device actuation/operation), (3) add information to test abstracts to clarify performance and acceptance criteria, and (4) correct inconsistencies between design value numbers in DCD Tier 2, Table 14.3-2, "Design-Basis Accident Analysis," and DCD Tier 2, Table 6.2.2-1, "Passive Containment Cooling System Performance Parameters." The staff verified that the revisions to the DCD were consistent with this additional information. Based on this information, Open Items 14.2-1.a through 14.2-1.l are resolved.

- In Open Item 14.2-1.z, the staff requested additional information to resolve omissions and inconsistencies in preoperational test abstract 14.2.9.1.9, "Reactor Vessel Internals Vibration Testing." In a letter dated August 26, 2003, the applicant responded to Open Item 14.2-1.z and provided information on the number of transducers to be used during the testing, described transducer locations and their direction of sensitivity, and resolved inconsistencies between test abstract 14.2.9.1.9 and WCAP-15949-P, "AP1000 Reactor Internals Flow-Inducted Vibration Assessment Program." The staff verified that the revisions to the DCD were consistent with this additional information. Based on this information, Open Item 14.2-1.z is resolved.

- The staff reviewed preoperational test abstract 14.2.9.1.7, "Expansion, Vibration, and Dynamic Effects Testing," which described preoperational testing for safety-related, high-energy piping systems and components. Although the DCD Tier 2 material included an adequate test abstract description, it did not reference any applicable Tier 1 material (i.e., ITAAC), nor does it appear that any ITAAC have been written to provide documentation of the test measurements for thermal expansion and vibration amplitudes, and their comparison to allowable values. The staff requested the applicant to update the AP1000 DCD Tier 1 material by providing appropriate ITAAC information for those systems, or portions thereof, described in test abstract 14.2.9.1.7, that will be subject to preoperational, hot functional testing prior to fuel load. This issue was Open Item 14.2-1.aa.

In response to Open Item 14.2-1.aa, in a letter dated September 8, 2003, the applicant stated that the purpose of the testing is to verify that the ASME Class 1, 2, and 3 piping systems are designed consistent with the piping stress analyses that is performed to demonstrate conformance with the ASME Code. The applicant noted that the Tier 1 material includes suitable ITAAC to demonstrate that the design and construction of the as-built piping systems designated as ASME Code Section III is in accordance with ASME Code Section III requirements. Further, the applicant noted that every Tier 1 system description that contains ASME Code piping also includes this design commitment. Therefore, the ITAAC require that an ASME Code Section III design report exists for the as-built piping. However, the applicant did not include an additional ITAAC specifically for the expansion, vibration and dynamic effects testing in the AP1000 DCD. Additionally, the applicant stated that, in accordance with accepted practice, the Tier 2 material does not reference Tier 1 material, except as discussed in DCD Tier 2, Section 14.3.

The staff determined that the applicant’s initial response to Open Item 14.2-1.aa was incomplete because the referenced ITAAC did not appear to address all necessary testing. Specifically, while the response correctly stated the purpose of the expansion, vibration, and dynamic effects testing, the ITAAC referenced in the response does not fully accomplish this testing. The referenced ITAAC does not consider the potential effects of unanticipated constraint from other installed SSCs on an individual piping system when considered in the context of the as-built condition of the entire plant. The ITAAC referenced in the response proposes reconciling the as-built condition of the piping system itself with the requirements of the ASME Code design report. However, this design reconciliation alone, while satisfying design requirements, does not verify that the piping will have sufficient clearance with all other installed equipment to allow analytically predicted movement during transient events.

In a letter to the NRC staff dated October 21, 2003, the applicant responded to the staff’s comments noted above regarding Open Item 14.2-1.aa. The staff’s concern with the previous applicant response was that the acceptance criteria for the ITAAC referenced in the response did not appear to explicitly address preoperational testing activities, including the piping expansion, vibration, and dynamic effects testing outlined in DCD Tier 2, Section 14.2.9.1.7. The acceptance criteria for the ITAAC referenced in the applicant’s response (Revision 1) state that ASME Code Section III design reports exist for the as-built piping classified as ASME Code Section III. It was unclear whether the reconciliation of the as-built condition of the piping with the ASME III piping design reports included preoperational testing results for the respective piping systems and components.

The applicant’s revised response specifically identifies preoperational testing, including piping expansion, vibration, and dynamic effects testing, as information which the as-built reconciliation of piping systems designed and constructed to ASME Code Section III requirements must address. The applicant committed to revising DCD Tier 2, Section 3.6.2.5, “Evaluation of Dynamic Effects of Pipe Ruptures,” to identify reconciliation of ASME Code Section III piping systems as a COL applicant activity in the context of the verification of the final pipe break hazard analysis report. The proposed revision of the final paragraph of DCD Tier 2, Section 3.6.2.5 adds preoperational testing to the list of activities which must be evaluated in the as-built reconciliation of ASME Code Section III piping. In its review of this proposed DCD revision, the staff concluded that it is an acceptable resolution of the original concern because it provides an explicit reference to preoperational testing as a part of the as-built reconciliation of the ASME Code Section III piping design reports.

The staff also requested the applicant to provide a similar revision to DCD Tier 2, Section 3.9.3. This additional revision would serve to define more completely the as-built reconciliation for ASME Code, Section III, Class 1, 2, and 3 piping and components as a COL applicant activity. This additional revision would also provide consistency among DCD Tier 2, Sections 3.6.2.5, 3.6.4.1, “Pipe Break Hazard Analysis,” 3.9.3, and 3.9.8.2, “Design Specifications and Reports,” which discuss the types of activities to be specifically included in as-built reconciliation efforts.

The applicant’s revised response dated November 7, 2003, revised the DCD to add references which provided a link between the piping expansion, vibration, and dynamic effects testing outlined in DCD Tier 2, Section 14.2.9.1.7 and existing Tier 1 ITAAC acceptance criteria. The staff finds the revised response and the DCD revision to be acceptable. Therefore, Open Item 14.2-1.aa is resolved.

- Although the NRC staff found that test abstract 14.2.9.1.8, “Control Rod Drive System,” is adequate, the applicant made no reference to any applicable Tier 1 material (ITAAC), nor does it appear that any ITAAC have been written to provide documentation of these tests, including a comparison to specified acceptance criteria. Because of the safety significance of these components, the DCD Tier 1 material should include the corresponding tests of the as-built configuration and the comparison of test results to applicable acceptance criteria. The staff requested the applicant to update the DCD Tier 1 material by providing appropriate ITAAC information for those components described in DCD Tier 2, Section 14.2.9.1.8 that will be subject to preoperational, hot functional testing prior to fuel load. This was Open Item 14.2-1.bb.

  In response to Open Item 14.2-1.bb, in a letter dated September 8, 2003, the applicant stated that DCD Tier 1, Section 2.1.3, “Reactor System,” included testing of the control rod drive system. This section provides the Tier 1 design commitments and associated ITAAC for the control rod drive mechanisms. Further, the applicant stated that in accordance with accepted practice, the Tier 2 material does not reference Tier 1 material, except as discussed in DCD Tier 2, Section 14.3. The staff finds this response to be acceptable; therefore, Open Item 14.2-1.bb is resolved.

The staff finds that the preoperational test abstracts in DCD Tier 2, Section 14.2.9 adequately address testing scope, general test methods, performance criteria, and acceptance criteria. The staff concludes that the AP1000 preoperational test program meets the guidance in SRP Section 14.2 and RG 1.68 and is sufficient to demonstrate that the SSCs important to safety will meet their performance and acceptance criteria.

14.2.10 Initial Fuel Loading, Initial Criticality, Startup, and Power Ascension Tests

RG 1.68 and SRP Section 14.2 provide general guidance on the conduct of the initial test program after the completion of preoperational testing. Following verification of SSC functional capability during preoperational testing, the initial test program transitions to initial fuel loading, precritical testing, initial startup, low-power testing, and power ascension testing. Initial fuel loading and precritical tests ensure safe initial core loading and maintain sufficient shutdown margin. After the core is loaded, sufficient tests and checks should be performed to ensure that the facility is in a final state of readiness to achieve criticality and perform low-power testing. The initial approach should be conducted in a deliberate and orderly manner consistent with methods that will be used for subsequent startups. As described in RG 1.68, after the initial reactor startup, low-power testing is conducted to (1) confirm the design, (2) validate analytical models and verify correctness of conservatism of assumptions used in the safety analysis to the extent practical, and (3) confirm the operability of plant systems and design features that could not be completely tested during the preoperational test phase because of the lack of an adequate heat source for the reactor coolant system and the main steam system. Finally, power ascension testing is conducted to demonstrate that the facility can be operated in accordance with design during normal steady-state conditions, and, to the extent practical, during and following anticipated transients. The SRP Section 14.2 acceptance criteria for startup and power ascension testing include verification that test abstracts include objectives, prerequisites, test methods, and acceptance criteria to establish the functional adequacy of SSCs and design features.

The NRC staff reviewed the following startup and power ascension AP1000 test abstracts:

<u>Initial Fuel Loading Tests</u>

14.2.10.1.1 Fuel Loading Prerequisites and Periodic Checks
14.2.10.1.2 Reactor System Sampling for Fuel Loading
14.2.10.1.3 Fuel Loading Instrumentation and Neutron Source Requirements
14.2.10.1.4 Inverse Count Rate Ratio Monitoring for Fuel Loading
14.2.10.1.5 Initial Fuel Loading
14.2.10.1.6 Post-Fuel Loading Precritical Sequence
14.2.10.1.7 Incore Instrumentation System Precritical Verification
14.2.10.1.8 Resistance Temperature Detector—Incore Thermocouple Cross Calibration
14.2.10.1.9 Nuclear Instrumentation System Precritical Verifications
14.2.10.1.10 Setpoint Precritical Verification
14.2.10.1.11 Rod Control System
14.2.10.1.12 Rod Position Indication System
14.2.10.1.13 Control Rod Drive Mechanism
14.2.10.1.14 Rod Drop Time Measurements
14.2.10.1.15 Rapid Power Reduction System
14.2.10.1.16 Process Instrumentation Alignment
14.2.10.1.17 Reactor Coolant System Flow Measurement
14.2.10.1.18 Reactor Coolant System Flow Coastdown
14.2.10.1.19 Pressurizer Spray Capability and Continuous Spray Flow Verification

Verification Programs

14.2.10.1.20 Feedwater Valve Stroke Test

Initial Criticality Tests

14.2.10.2.1 Initial Criticality and Low-Power Test Sequence
14.2.10.2.2 Initial Criticality
14.2.10.2.3 Nuclear Instrumentation System Verification During Initial Criticality
14.2.10.2.4 Post-Criticality Reactivity Computer Checkout

Low-Power Testing

14.2.10.3.1 Low-Power Test Sequence
14.2.10.3.2 Determination of Physics Testing Range
14.2.10.3.3 Boron Endpoint Determination
14.2.10.3.4 Isothermal Temperature Coefficient Measurement
14.2.10.3.5 Bank Worth Measurement
14.2.10.3.6 Natural Circulation (First Plant Only)
14.2.10.3.7 Passive Residual Heat Removal Heat Exchanger

Power Ascension Tests

14.2.10.4.1 Test Sequence
14.2.10.4.2 Incore Instrumentation System
14.2.10.4.3 Nuclear Instrumentation System
14.2.10.4.4 Setpoint Verification
14.2.10.4.5 Startup Adjustments of Reactor Coolant System
14.2.10.4.6 Rod Cluster Control Assembly Out-of-Bank Measurements
14.2.10.4.7 Axial Flux Difference Instrumentation Calibration
14.2.10.4.8 Primary and Secondary Chemistry
14.2.10.4.9 Process Measurement Accuracy Verification
14.2.10.4.10 Process Instrumentation Alignment at Power Conditions
14.2.10.4.11 Reactor Coolant System Flow Measurement at Power Conditions
14.2.10.4.12 Steam Dump Control System
14.2.10.4.13 Steam Generator Level Control System
14.2.10.4.14 Radiation and Effluent Monitoring System
14.2.10.4.15 Ventilation Capability
14.2.10.4.16 Biological Shield Survey
14.2.10.4.17 Thermal Power Measurement and Statepoint Data Collection
14.2.10.4.18 Dynamic Response
14.2.10.4.19 Reactor Power Control System
14.2.10.4.20 Load Swing Test
14.2.10.4.21 100 Percent Load Rejection
14.2.10.4.22 Load Following Demonstration (First Plant Only)
14.2.10.4.23 Hot Full Power Boron Endpoint
14.2.10.4.24 Plant Trip from 100 Percent Power
14.2.10.4.25 Thermal Expansion

14.2.10.4.26 Loss of Offsite Power
14.2.10.4.27 Feedwater Heater Loss and Out of Service Test
14.2.10.4.28 Remote Shutdown Workstation

For each of the above test abstracts, the staff reviewed the test description, purpose, prerequisites, general test acceptance criteria, and test methods using the methodology described in Section 14.2.1.2 of this report. The following sections describe the staff's review of the initial fuel loading tests, initial criticality tests, low-power testing, and power ascension testing.

14.2.10.1 Initial Fuel Loading Tests

For initial fuel loading, RG 1.68, Appendix A, Section 2, "Initial Fuel Loading and Precritical Tests," specifies safety measures to preclude inadvertent reactor criticality during initial fuel loading. These measures include control and monitoring of fuel loading activities, measurement and prediction of core physics parameters, and operability of reactivity control systems. Following core load, tests are performed at hot conditions to bring the plant to a final state of readiness prior to initial criticality. Initial fuel loading testing, described in DCD Tier 2, Section 14.2.10.1, "Initial Fuel Loading and Precritical Tests," is performed after completion of preoperational testing, but prior to initial criticality. These tests include those performed prior to the core load to verify the readiness of the plant for core loading, the loading of the core, and the tests performed under hot conditions after the core has been loaded, but prior to initial criticality. These tests verify that the systems necessary to monitor the fuel loading process are operational and that the core loading is conducted properly.

In performing the design-specific testing review, the staff identified several areas where it required additional information to support its technical review of the initial fuel loading test abstracts. These were identified as Open Items 14.2-1.m through 14.2-1.s. Specifically, the staff required additional information on test performance methodology and acceptance criteria related to (1) operator actions for deviations in RCS boron concentrations (Open Item 14.2-1.m), (2) the expected correct response of neutron monitoring instrumentation (Open Item 14.2-1.n), (3) criteria and guidance for suspension of fuel loading activities (Open Items 14.2-1.o and 14.2-1.p), (4) the sequencing of instrumentation testing to minimize reliance on untested equipment (Open Item 14.2-1.q), (5) operator guidance for test result deviations during rod drop time testing (Open Item 14.2-1.r), and (6) acceptance criteria for pressurizer spray testing (Open Item 14.2-1.s).

By letter dated August 26, 2003, the applicant responded to these open items and provided additional information on initial fuel loading tests to clarify the testing scope, test methods, performance criteria, and acceptance criteria to address Open Items 14.2-1.m through 14.2-1.s. The additional information includes performance and acceptance criteria for boron concentrations, correct response of neutron monitoring instrumentation, neutron count rate during "stop loading" or "unload" actions, core moderator chemistry (particularly boron concentration), and core loading procedures for fuel and control rod assemblies in test abstracts 14.2.10.1.2, 14.2.10.1.3, 14.2.10.1.4, and 14.2.10.1.5. The additional information also included final calibration of source range instrumentation and verification of alarms and protective functions for source and intermediate range monitors to support precritical tests in test abstract 14.2.10.1.6, as well as the appropriate pressure control system design specifications documentation for the pressurizer spray valves in test abstract 14.2.10.1.19. The staff finds that the applicant added sufficient information in its revision of DCD Tier 2, Section 14.2.10.1. Therefore, Open Items 14.2-1.m through 14.2-1.s are resolved.

The staff also concludes that the testing scope, general test methods, and performance and acceptance criteria are sufficient to test the SSCs important to safety during the initial fuel load test phase. The staff finds that all AP1000 test programs adequately address the initial fuel loading and precritical testing and meet the associated guidance in SRP Section 14.2 and RG 1.68.

14.2.10.2 Initial Criticality Tests

RG 1.68, Appendix A, Section 3, "Initial Criticality," provides recommendations for conducting initial criticality testing, including control of core reactivity and monitoring of core performance. In DCD Tier 2, Section 14.2.10.2, "Initial Criticality Tests," the applicant stated that following completion of the core loading and precriticality testing, the plant is brought to initial criticality, according to test procedures in Section 14.2.10.2.1, "Initial Criticality Test Sequence."

The staff compared the AP1000 initial criticality test program to the initial criticality testing provisions of RG 1.68 and noted four areas where the information contained in the AP1000 initial criticality test program differed from the guidance contained in RG 1.68. In RAI 261.005, the staff requested the applicant to provide additional information relating to these four areas of initial criticality testing. A discussion of the resolution of these four areas follows:

- The NRC staff identified several precautions, prerequisites, and measures described in RG 1.68, Appendix A, Section 3, that the AP1000 initial criticality test abstracts did not address. The precautions, prerequisites, and measures not covered by the AP1000 test abstracts included (1) operational readiness of the reactor protection system and emergency shutdown systems, (2) minimum neutron count rate on nuclear instruments prior to commencement of startup, (3) movement of control rods during the initial startup and control rod insertion limits, (4) reactivity addition sequence and minimum reactor period after criticality is achieved, (5) compliance with TS requirements, and (6) setting of high-flux scram trips to their lowest value (approximately 5–20 percent of full power).

  In its November 15, 2002, RAI response, the applicant noted that the AP1000 test abstracts provide an overview of the tests to be performed on the plant. The applicant noted that the scope of the DCD does not include detailed test specifications or procedures, however, the COL applicant will submit them to the NRC for review, as identified in DCD Tier 2, Section 14.4.2. As described in Section 14.2.3 of this report, the staff finds it acceptable to defer responsibility for the development of detailed preoperational and startup test specifications and procedures to the COL applicant. This is COL Action Item 14.4-2.

- The title of test abstract 14.2.10.2.1, “Initial Criticality and Low-Power Test Sequence,” appeared to be redundant to the test abstract described in DCD Tier 2, Section 14.2.10.3.1, “Low-Power Test Sequence.” In its November 15, 2002, RAI response, the applicant stated that it will revise the title of DCD Tier 2, Section 14.2.10.2.1, to read “Initial Criticality Test Sequence.” The staff determined that the test abstracts provided in Sections 14.2.10.2.1 and 14.2.10.3.1 are not redundant and that the revision to the title of DCD Tier 2, Section 14.2.10.2.1, eliminated ambiguity. The applicant revised the test abstract in DCD Tier 2, Section 14.2.10.2.1 to better reflect the scope of testing. Therefore, the staff considers this issue to be resolved.

- The guidance contained in test abstract 14.2.10.2.2, “Initial Criticality,” regarding control rod movement and boron dilution rate, appeared to be inconsistent with certain provisions of RG 1.68. Specifically, test abstract 14.2.10.2.2 states, “as criticality is approached, slow or stop dilution rate to allow criticality to occur during mixing or by rod withdrawal.” However, the staff noted that RG 1.68, Appendix A, Section 3, states that for reactors that will achieve initial criticality by boron dilution, control rods should be withdrawn before dilution begins. Because the wording in test abstract 14.2.10.2.2 indicates that rod withdrawal may occur after a dilution to criticality has begun, the staff questioned the consistency of this test abstract with RG 1.68.

  In its November 15, 2002, RAI response, the applicant noted that the test method section of test abstract 14.2.10.2.2 specified a controlled rod withdrawal using the same rod withdrawal sequence as that employed for normal plant startup prior to dilution of the reactor coolant system boron concentration. Further, the applicant noted that after the rods are withdrawn, they may be slightly inserted for control purposes. Therefore, to clarify the intent of the test abstract, the applicant revised the test abstract to read, “as criticality is approached, slow or stop dilution rate to allow criticality to occur during mixing or withdrawal of rods that have been slightly inserted for control.” The staff has determined that a slight withdrawal of control rods that may have been inserted for control purposes would not represent a significant addition of reactivity due to rod withdrawal and is, therefore, acceptable after reactor coolant boron dilution has commenced. Thus, the staff concludes that this test abstract meets the RG 1.68 precautions.

- The staff noted that the title to test abstract 14.2.10.2.3, “Nuclear Instrumentation System Verification During Initial Criticality,” does not reflect the performance of the nuclear instrument system verification prior to and during initial criticality. In its November 15, 2002, RAI response, the applicant stated that it revised the title of test abstract 14.2.10.2.3 to read, “Nuclear Instrument System Verification.” The staff concludes that the revised DCD adequately addresses its comments and is therefore acceptable.

In Open Item 14.2-1.t, the staff determined that the applicant had not specified in the initial criticality test abstract that the plant operators take appropriate action if the measured reactivity and the corresponding values indicated by the plant computer deviated from the tolerance limits. The staff requested that the applicant supplement the appropriate test abstract to verify proper operation of associated alarms and protective functions for source range and intermediate range monitors. On October 30, 2003, the applicant stated that it will revise the prerequisites of DCD Tier 2, Section 14.2.10.2.4, "Post-Critical Reactor Computer Checkout," to require completion of DCD Tier 2, Section 14.2.10.2.3 prior to the initiation of this test. Specifically, the applicant committed to add the following information to the prerequisites of DCD Tier 2, Section 14.2.10.2.4:

> The systems, structures, and components required by Technical Specifications shall be operable as required for the specified plant operational mode prior to initiation of precritical, low power physics, and power ascension testing. Verification of proper operation of source-range and intermediate-range excore nuclear instrumentation and associated alarms and protective functions in Startup Test 14.2.10.2.3 shall be completed prior to initiation of this startup test.

In addition, the applicant committed to add the following statement to the performance criterion of DCD Tier 2, Section 14.2.10.2.4:

> Adjustment and re-calibration or repair of the reactivity computer may be required if the deviation between the two independent sources of reactivity is not within design tolerances.

The applicant revised DCD Tier 2, Section 14.2.10.2.4 to add the information to the test abstract stated above. The staff reviewed the changes to the DCD and confirmed that they were consistent with RG 1.68 and SRP Section 14.2. Therefore, Open Item 14.2-1.t is resolved.

The staff found that the initial criticality test abstracts met the guidance in SRP Section 14.2 and RG 1.68 and are, therefore, acceptable. Thus, the staff concludes that initial criticality testing prerequisites, precautions, general test methods, and performance and acceptance criteria are sufficient to test the SSCs important to safety during the initial criticality phase of the initial test program.

14.2.10.3 Low-Power Tests

The low-power test program should confirm the design, and to the extent practical, validate the analytical models and verify the correctness or conservatism of assumptions used in the safety analysis report. Additionally, the low-power test program should also confirm the operability of plant systems and design features that could not be adequately tested during the preoperational test phase because of a lack of an adequate heat source for the reactor coolant system. In DCD Tier 2, Section 14.2.10.3, "Low-Power Tests," for the AP1000 design, the applicant stated that following successful completion of the initial criticality tests, low-power tests are conducted, typically at power levels less than 5 percent, to measure physics characteristics of the reactor system and to verify operability of the plant systems at low-power levels. Based on a review of the low-power test abstracts, the staff had concerns in two areas and issued RAIs 261.006 and 261.009 to obtain additional information to complete the review of the proposed AP1000 low-power test program. A discussion of the resolution of these two staff concerns follows:

- The staff was unable to locate 20 low-power tests that were listed in RG 1.68 as applicable to PWRs in the AP1000 low-power test program. In RAI 261.006a, the staff requested the applicant to provide additional information regarding the verification of the functions addressed by the low-power tests recommended in RG 1.68. In its November 15, 2002, response to this RAI, the applicant provided a table identifying how the AP1000 test program addressed each of the 20 RG 1.68 low-power tests. The staff reviewed the table provided in the applicant's response and determined that the applicant's test program included the necessary low-power tests recommended in RG 1.68. Therefore, the staff concludes that the AP1000 test program adequately addresses all applicable low-power tests recommended in RG 1.68.

- The staff noted that the power ascension test abstract described in DCD Tier 2, Section 14.2.10.4.3, "Nuclear Instrumentation System," includes a demonstration of instrumentation overlap between the source range and intermediate range nuclear instruments. However, the staff determined that overlap between the source and intermediate range occurs well below the reactor power level associated with power ascension testing. Therefore, in RAI 261.006b, the staff requested that the applicant either justify performing the source and intermediate range overlap testing during the power ascension test phase, or conduct this testing during low-power testing. In its November 15, 2002, RAI response, the applicant deleted the overlap from test abstract 14.2.10.4.3 and stated that the initial criticality test abstract 14.2.10.2.3, "Nuclear Instrumentation System Verification," verifies the overlap between the source range and intermediate range neutron monitors. Because both the source range and intermediate range nuclear instruments can monitor the low-core power level during the initial criticality test phase, the staff concludes that the initial criticality test phase is appropriate for demonstrating the overlap between the source and intermediate range nuclear instruments.

- RG 1.68, Appendix A, Item 4.c recommends performance of pseudo-rod ejection testing to verify calculation models and accident analysis assumptions during low-power testing. The staff could not locate an AP1000 low-power test abstract that describes this testing. In RAI 261.009, the staff requested that the applicant provide additional information regarding the performance of pseudo-rod ejection testing for the AP1000 design. In its November 15, 2002, RAI response, the applicant stated that sufficient test data have been obtained from previous plant startups, and that licensees of new plants only need to confirm calculational models. The applicant also provided several licensing precedents associated with this position.

  The staff determined that the applicant's November 15, 2002, response to RAI 261.009 lacked sufficient information regarding the applicant's decision not to perform low-power pseudo-rod ejection testing. Therefore, in RAI 261.016, the staff requested that the applicant provide additional information relating to the conduct of pseudo-rod ejection testing during the low-power test phase. This was Open Item 14.2.10-1 in the DSER.

On July 31, 2003, the applicant provided a response to Open Item 14.2.10-1, stating that the pseudo-rod ejection test is performed in the 30–50 percent power range. The test is performed in the first unit only as part of the rod cluster control assembly out-of-bank measurement test. This 30–50 percent range is the preferred range in which to perform the test because the range is low enough to validate the calculation tools and accident analyses assumptions. Although the response addressed the staff's concern about the power level at which the pseudo-rod ejection test would be performed during power ascension testing, the staff determined that the applicant's July 31, 2003, response failed to adequately address why it did not perform pseudo-rod ejection testing during the low-power test phase. The applicant submitted a revised response to Open Item 14.2.10-1 on October 6, 2003, stating that this testing is not performed at low power (i.e., it is not consistent with RG 1.68, Item 4.c) because the applicant has amassed sufficient data from the low-power operation of currently operating plants to conclude that the Westinghouse nuclear physics codes are established nuclear design tools with validating performance records. Therefore, the applicant deemed the reverification of the calculation models and accident analysis assumptions at low power to be unnecessary. The applicant noted that Westinghouse letter PGD-82-109, "Core Physics Code Validation," dated March 16, 1982, contains the referenced data.

Although the staff concurs that pseudo rod ejection testing at low power is not needed to verify calculation models, the staff concluded that the applicant did not provide an adequate basis for its decision not to perform pseudo-rod ejection testing at low power. Specifically, the staff questioned if this low-power test should be performed to identify potential errors in the fuel loading of the core.

In its November 7, 2003, supplemental response to Open Item 14.2.10.1, the applicant stated that the in-core instrumentation system test performed for each AP1000 plant would detect fuel load errors. The staff determined that test abstract 14.2.10.4.2, "Incore Instrumentation System," includes a test objective to obtain data for in-core thermocouples and flux maps at various power levels during ascension to full power to determine the flux distributions and verify proper core loading and fuel enrichment.

Based on the staff's review of DCD test abstract 14.2.10.4.2, as well as a review of the applicant's response to Open Item 14.2.10-1 dated November 7, 2003, the staff found that the applicant adequately justified its decision not to perform pseudo-rod ejection tests at low power; however, the applicant only partially addressed the identification of fuel load errors or fuel misloadings in the wrong location or orientation. Specifically, test abstract 14.2.10.4.2 requires the verification of proper core loading and fuel enrichment, but it does not address the detection of fuel loading errors or fuel misloadings. The staff determined that the applicant should add test information to DCD Tier 2, test abstract 14.2.10.4.2 about the methods used to detect fuel loading errors or fuel misloadings. This issue was part of Open Item 14.2.10-1 in the DSER.

In its response dated January 13, 2004, the applicant added the following to the test method section of test abstract 14.2.10.4.2:

> Use data from the in-core maps to verify that core power distribution is consistent with design predictions and the limits imposed by the plant TS, including detection of potential fuel load errors, and to calibrate other plant instrumentation. Refer to Technical Specification 3.2, "Power Distribution Limits."

The applicant revised test abstract 14.2.10.4.2, to incorporate the above information. The staff confirmed that this revision is consistent with SRP Section 14.2 and RG 1.68. Therefore, Open Item 14.2.10-1 is resolved.

In performing the design-specific testing review, the staff identified that it required additional information to support its technical review of the low-power test abstracts. These were Open Items 14.2-1.u and 14.2-1.v.

In Open Item 14.2-1.u, the staff requested additional information about test abstract 14.2.10.3.4, "Isothermal Temperature Coefficient Measurement." Specifically, the staff requested the following:

> The "prerequisites" do not include Xenon and Samarium equilibrium. Also, no required action is specified if the moderator temperature coefficient (MTC) is equal to or significantly exceeds the technical specification (TS) value. Please specify the missing prerequisites in the test.

In a letter to the NRC staff dated August 26, 2003, the applicant stated the following:

> The basis for successfully measuring the MTC reactivity effects during low-power physics testing is to stabilize all reactivity contributors so that reactor coolant system temperature changes performed during the test are the only source of core reactivity changes. Therefore, it is inherent in the test requirements that no other significant reactivity variations can occur during MTC testing.
>
> This test is performed by manually varying T_{ave} and determining the amount of reactivity inserted or removed by the temperature change. This test takes a very short time (a few minutes) to complete, so that Xenon and Samarium concentration changes during the duration of this test are not significant. In addition, for an initial core loading, there is no Xenon or Samarium initially in the core. Due to the low power conditions while conducting the physics testing, neither fission product poison concentration changes enough during the testing to significantly impact MTC measures. Therefore, Xenon and Samarium equilibrium conditions are not required as prerequisites for this low-power physics test...
>
> ... For some startup tests, actions are required in the event that performance criteria are not met, or adjustments or repairs to equipment being tested can be performed in the event that performance criteria are not met. However, it is unlikely that corrective actions by either the operators or test personnel actions

could be taken in the event that the Technical Specification MTC limit is not met, if the test is correctly performed. Therefore, no specific operator guidance is provided in the DCD in the unlikely event that rod drop tests are outside of the expected range.

The staff determined that this low-power test does not require xenon and samarium to be in equilibrium as a prerequisite because (1) no xenon and samarium initially exists within the core, and (2) the concentration changes of these elements during the short duration of this test are not significant. Should the MTC exceed the TS limit value, no change to the DCD is needed because the limiting condition for operation (LCO) in TS 3.0.3 specifies the required actions if the MTC exceeds the TS LCO 3.1.4 limit. Therefore, Open Item 14.2-1.u is resolved.

In Open Item 14.2-1.v, the staff questioned the basis for the use of a large-scale test facility to test the PRHR HX function rather than an actual plant test during the low-power test phase. In a revision to low-power test abstract 14.2.10.3.7, "Passive Residual Heat Removal Heat Exchanger (First Plant Only)," the applicant deleted use of the large-scale test facility to test the PRHR HX function. The NRC staff finds this to be acceptable. This issue also relates to the resolution of Open Item 14.2.7-2, discussed in further detail in Section 14.2.7 of this report. Therefore, Open Item 14.2-1.v is resolved.

The staff finds that the low-power tests meet the guidance in SRP Section 14.2 and RG 1.68, and are, therefore, acceptable. Based on a review of the low-power test abstracts, the staff finds that the testing scope, general test methods, and performance and acceptance criteria are sufficient to test applicable functions applicable to safety during the low-power test phase.

14.2.10.4 Power Ascension Tests

As described in RG 1.68, power ascension tests should demonstrate that the facility operates in accordance with its design, both during normal and steady-state conditions and, to the extent practical, during and following anticipated transients. In DCD Tier 2, Section 14.2.10.4, the applicant stated that after low-power testing is completed, testing is performed at specified elevated power levels to demonstrate that the facility can operate in accordance with the design during normal and steady-state operations and, to the extent practical, during and following anticipated transients. During power ascension, tests are performed to obtain operational data and to demonstrate the operational capabilities of the plant.

In comparing the AP1000 power ascension test program to the recommendations of RG 1.68, the staff identified several areas where it required additional information to complete its review. Consequently, the staff issued RAIs 261.007 and 261.010 to obtain this additional information. A discussion of the resolution of these two areas of concern to the staff follows:

- The staff was unable to locate all 40 power ascension tests listed in RG 1.68 as applicable to PWRs in the AP1000 power ascension test program. In RAI 261.007a, the staff requested the applicant to provide additional information regarding the verification of the functions addressed by the RG 1.68 power ascension tests. In its November 15, 2002, response to this RAI, the applicant provided a table identifying how the AP1000 test program addressed each of the 40 power ascension tests listed in RG 1.68. The staff reviewed the table provided in the applicant's response and finds that the applicant's test program includes the necessary power ascension tests recommended in RG 1.68. Therefore, the staff concludes that the AP1000 test program addresses all applicable power ascension tests recommended in RG 1.68.

- Based on a review of power ascension test abstracts, the staff identified specific questions on five power ascension tests. Specifically, the staff requested additional information to evaluate power ascension testing associated with the measurement of power reactivity coefficients, performance of pseudo-rod ejection testing during power ascension testing, demonstration of the capability of the nuclear instrumentation system to detect a rod misalignment, verification of proper operation of the failed fuel detection system, and demonstration of satisfactory plant response following main steam isolation valve closure. In RAI 261.007b, the staff requested the applicant to provide additional information about these five power ascension tests to assist the staff in completings its review of the power ascension test program. The applicant's responses related to each of the five testing areas identified above follow:

  (1) RG 1.68, Appendix A, Section 5.a recommends using power ascension testing to verify that the power reactivity coefficients are in accordance with design values. RG 1.68 recommends that reactivity coefficients be measured at 25 percent, 50 percent, 75 percent, and 100 percent of rated reactor power. While the test program provides for such measurements, the staff noted that the testing of the isothermal temperature coefficient measurement, described in DCD Tier 2, Section 14.2.10.3.4, "Isothermal Temperature Coefficient Measurement," occurs only in the low-power test phase. In RAI 261.007b, the staff requested that the applicant provide additional information for testing power reactivity coefficients. In its November 15, 2002, RAI response, the applicant stated that performance of boron endpoint tests occurs at both full power and at no load. The results of the boron endpoint tests will be used to confirm the necessary power coefficient and power defect parameters. Additionally, the staff determined that the applicant includes verification of the power reactivity coefficients during initial criticality, low-power, and power ascension tests. For example, test abstracts 14.2.7.2, "Initial Criticality"; 14.2.10.3.3, "Boron Endpoint Determination"; 14.2.10.3.5, "Bank Worth Measurements"; 14.2.10.4.2, "Incore Instrumentation System"; 14.2.10.4.3, "Nuclear Instrumentation System"; 14.2.10.4.6, "Rod Cluster Control Assembly Out of Bank Measurements"; and 14.2.10.4.23, "Hot Full Power Boron Endpoint," include this verification. Based on this information, the staff determined that appropriate reactivity coefficient testing will occur during initial criticality, low-power, and power ascension tests.

  (2) RG 1.68, Appendix A, Item 5.e recommends performance of pseudo-rod ejection testing during the power ascension test phase to validate the rod ejection accident analysis. RG 1.68 further states that this test need not be repeated for facilities using calculation models and designs identical to prototype facilities. The staff could not locate a power ascension test abstract that addressed this

testing. In RAI 261.007b, the staff requested that the applicant provide additional information regarding the performance of this testing. In its November 15, 2002, RAI response, the applicant stated, in part, that this test was part of the rod cluster control assembly out-of-bank measurements described in DCD Tier 2, Section 14.2.10.4.6, “Rod Cluster Control Assembly Out of Bank Measurements.” The applicant noted that this test is proposed to be performed on a first-plant-only basis.

The staff determined that the pseudo-rod or rod cluster control assembly ejection tests are performed in test abstract 14.2.10.4.6; therefore, RAI 261.007b, Item 2 is partially resolved. However, the applicant did not initially include test abstract 14.2.10.4.6 in the list of first-plant-only tests cited in DCD Tier 2, Section 14.2.5. The staff determined that the applicant should clarify whether it was intended that this test be performed for every AP1000 plant or whether it was intended to be a first-plant-only test, as described in DCD Tier 2, Section 14.2.5. This was Open Item 14.2.10-2 in the DSER.

In response to Open Item 14.2.10-2, on October 6, 2003, the applicant stated the following:

> This testing is performed on the first plant only, which meets the guidance of RG 1.68, Item 5e—i.e., at greater than 10% power and need not be performed for facilities using calculation models and designs identical to prototype facilities (in the case of AP1000, first unit).

The staff verified that the applicant added test abstract 14.2.10.4.6 to the list of “first-plant-only” tests found in DCD Tier 2, Section 14.2.5. The staff also notes that DCD Tier 2, Section 14.4.6, provides that either the COL applicant or the licensee must perform the tests listed in DCD Tier 2, Subsection 14.2.5, or justify that the results of the first-plant-only tests will apply to subsequent plants. Therefore, the staff will obtain additional information at the COL stage to determine the acceptability of performing this test on a first-plant-only basis. The staff agrees that the pseudo-rod ejection testing, as proposed, meets the guidance of RG 1.68 and SRP Section 14.2. Based on the information provided above, Open Item 14.2.10-2 is resolved.

(3) RG 1.68, Appendix A, Section 5.i recommends that the power ascension test program include in-core and ex-core nuclear instrumentation testing to demonstrate the capability to detect a control rod misalignment equal to or less than the TS limits at 50 percent and 100 percent of rated reactor power. However, as described in DCD Tier 2, Section 14.2.10.4.6, this test is performed between 30–50 percent of rated thermal power. In RAI 261.007b, the staff requested the applicant to provide additional information justifying its decision not to perform this testing at 100 percent of rated thermal power. In its response dated November 15, 2002, the applicant stated that the rod cluster control

assembly out-of-bank measurements test is not performed at full power because it would cause the plant to exceed peak power limits such as departure from nucleate boiling ratio (DNBR). The staff agrees that this test should not be performed at a power level that could cause the plant to exceed thermal limits. However, the staff questioned whether the applicant should include performance of this test at a higher power level than that which was proposed, consistent with RG 1.68. This was Open Item 14.2.10-3 in the DSER.

In response to RAI 261.017 and Open Item 14.2.10-3, the applicant stated the following on May 13, 2003:

> Westinghouse limits the test to the 30 to 50 percent power level in order to assure that plant peaking factor limits are not exceeded. Testing at this range of power levels is sufficient to validate the calculation tools and calibrate instrument responses such that the intent of RG 1.68, Appendix A, Section 5, Item (i) is met.

The staff determined that the applicant adequately justified not performing this test at 100 percent power. The staff also determined that performance of these tests at the 30–50 percent power level will detect rod cluster control assembly misalignments. These tests should be performed before the plant proceeds to a higher power level. The staff determined that this response addressed Open Item 14.2.10-3. The NRC staff found that this test could potentially damage fuel cladding at 100 percent power. Therefore, this exception to RG 1.68 is acceptable and Open Item 14.2.10-3 is resolved.

(4) RG 1.68, Appendix A, Section 5.q recommends verification of the proper operation of failed fuel detection systems be during power ascension testing at 25 percent and 100 percent of rated thermal power. In reviewing the power ascension test program, the staff was unable to locate a test abstract that addressed this testing. In RAI 261.007b, the staff requested that the applicant provide additional information regarding performance of the failed fuel detection system testing during power ascension testing. In its November 15, 2002, RAI response, the applicant stated that the primary sampling system detects failed fuel in the AP1000 design. This system is tested prior to power ascension tests. While proper operation of the primary sampling system depends on system temperature and pressure, it does not depend on plant power. The staff has determined that the proposed testing of the sampling system is adequate to verify its capability, as the capability to obtain a primary sample does not depend on reactor power. Therefore, the staff concludes that the applicant adequately addressed failed fuel testing.

(5) RG 1.68, Appendix A, Section 5.m.m recommends that the power ascension test program demonstrate that the dynamic response of the plant is in accordance with the design for the case of automatic closure of all main steamline isolation valves (MSIVs). In reviewing the power ascension test program test abstracts,

the staff noted that no MSIV closure testing occurs during power ascension testing. In RAI 261.007b, the staff requested that the applicant provide additional information regarding performance of MSIV closure testing. In its November 15, 2002, RAI response, the applicant stated that the dynamic response of the plant to closure of all MSIVs is bounded by a plant trip from 100 percent power, which is performed in test abstract 14.2.10.4.24.

In RAI 261.018, the staff requested the applicant to provide additional information regarding the basis for the statement that a plant trip from 100 percent power bounds the MSIV closure transient. This was Open Item 14.2.10-4 in the DSER.

In a letter dated August 1, 2003, the applicant stated the following:

> Rather than say the plant trip from 100% power, which is performed in test abstract 14.2.10.4.24, ‘bounds’ the MSIV test identified in RG 1.68, Appendix A, Test 5.m.m, it would be more correct to say that the proposed test allows sufficient information to be obtained to demonstrate that the dynamic response of the plant is in accordance with the design. The pressure transient in the plant resulting from opening the main generator breakers during the proposed test can be compared to analyses and is sufficient to confirm that the plant responds as predicted.

The applicant stated that licensees have not traditionally performed Test 5.m.m on its plants because closure of the MSIVs at full power or reduced power would lead to a severe transient, which could lead to opening of the plant’s safety valves. The staff determined that this information provides an acceptable basis for the applicant’s decision not to perform the MSIV closure transient at 100 percent power and is consistent with SRP Section 14.2 and RG 1.68. Therefore, Open Item 14.2.10-4 is resolved.

- In RAI 261.010, the staff identified two additional power ascension tests where it required additional information to complete its review. These tests involve the determination that steady-state core performance is acceptable, and gaseous and liquid radioactive waste processing, storage, and release systems are in accordance with the design. The RAI responses and the associated NRC staff evaluation are described below:

  (1) RG 1.68, Appendix A, Item 5.b, recommends that power ascension testing determine that the steady-state core performance is in accordance with the design. Specifically, RG 1.68 states that sufficient measurements and evaluations should be conducted to establish that flux distributions, local surface heat flux, linear heat rate, departure from nucleate boiling ratio, radial and axial power peaking factors, and other important parameters are in accordance with the design values throughout the permissible range of power to flow conditions.

In reviewing the proposed AP1000 power ascension test program, the staff noted that the test abstract in DCD Tier 2, Section 14.2.10.4.2, does not reference (1) the test methods necessary to generate data from in-core maps to verify that core power peaking and axial distributions are consistent with design predictions, or (2) the data collection methods necessary to establish local surface heat flux, linear heat rate, departure from nucleate boiling, and radial power peaking factors.

In its November 15, 2002, response to RAI 261.010, the applicant noted that the COL applicant is responsible for providing test specifications and test procedures for startup tests and that these procedures will meet appropriate regulatory guidance. The applicant also revised the test abstract wording in DCD Tier 2, Section 14.2.10.4.2, to generally state that in-core maps would verify that core power distribution is consistent with design predictions and TS requirements, rather than specifically referencing peaking factor measurements. In a February 13, 2003, conference call with the applicant, the staff requested additional information concerning testing of the thermal limits noted in RG 1.68. The applicant stated that the TS surveillance test program for thermal limits currently includes this information; therefore, the applicant considered it repetitious to place the information in DCD Tier 2, Section 14.2.10.4.2. The applicant revised DCD Tier 2, Section 14.2.10.4.2, to add a cross reference to TS 3.2, “Power Distribution Limits,” to address the applicable surveillance test for thermal limits. Because the TS surveillance test program verifies the thermal limits, and the cross reference makes this clear, the staff concludes that this issue is satisfactorily resolved.

(2) RG 1.68, Appendix A, Section 5.c.c recommends that power ascension testing include demonstration that the gaseous and liquid radioactive waste processing, storage, and release systems operate in accordance with design. In reviewing the initial test program, the staff noted that the test abstracts described in DCD Tier 2, Sections 14.2.9.3.1, “Liquid Radwaste System Testing,” and 14.2.9.3.2, “Gaseous Radwaste System Testing,” specify performance of gaseous and liquid radioactive waste system testing during low-power testing, rather than power ascension testing. The staff determined that the applicant did not adequately justify performance of these tests at a power level below those typical for power ascension testing. The staff noted that performance of this testing at a lower power level could reduce the production of liquid and gaseous radioisotopes as compared to performance of this testing during the power ascension test phase.

In its November 15, 2002, RAI response, the applicant stated that testing of the gaseous and liquid radioactive waste processing, storage, and release systems is performed at low power to minimize the negative impact of any system not performing as designed. The applicant noted that low-power testing confirms that the systems perform as designed and, therefore, additional testing at high plant power is not necessary. However, the staff disagreed with the conclusion that low-power testing of these systems adequately demonstrates their capability. In a February 13, 2003, conference call with the staff, the applicant agreed to add appropriate test abstract information to DCD Tier 2, Section 14.2.10.4, "Power Ascension Tests," to perform the testing recommended by RG 1.68, Item 5.c.c. This was Confirmatory Item 14.2.10-2 in the DSER.

In a March 12, 2003, response to this issue, the applicant stated that monitoring of system performance is done continuously, as described in DCD Tier 2, Sections 11.2.1.2.4, "Controlled Release of Radioactivity," 11.3.3, "Radioactive Releases," and 11.5.3, "Effluent Monitoring and Sampling."

The applicant also noted that the value of testing the system during the power ascension tests is limited by the complexity of the interaction between radwaste source terms and system performance. Instead, the low-power testing confirms that system equipment (i.e., pumps, valves, etc.) performs as expected and the continuous monitoring constitutes continuous testing and verification of adequate purification performance.

The staff determined that DCD Tier 2, Section 14.2.10.4.14, "Radiation and Effluent Monitoring System," also addresses radioactive waste processing, storage, and release system testing. Based on the system testing described and the information given above, the staff found that added testing during the power ascension test phase was unnecessary. This conclusion is consistent with SRP Section 14.2 and RG 1.68. Therefore, Confirmatory Item 14.2.10-2 is resolved.

During the design-specific review for the power ascension test program, the staff identified three other areas for which it required additional information to complete its review. These issues, identified as Open Items 14.2-1.w, 14.2-1.x, and 14.2-1.y, are discussed below:

- In Open Item 14.2-1.w, the staff requested that the applicant "explain why Xenon and Samarium equilibrium is not part of the prerequisites if it is expected that T_{avg} will return to T_{ref}." In its response to Open Item 14.2-1.w, dated August 26, 2003, the applicant stated the following:

  This test is performed by manually varying T_{avg} and then placing the reactor coolant system in automatic and confirming that T_{avg} is restored to T_{ref} setpoint tolerance without manual intervention. This test takes a very short time (a few minutes) to complete, so that Xenon and Samarium concentration changes during the duration of the test are not significant. Therefore, since Xenon and Samarium time constants are significantly longer that the control rod response, Xenon and Samarium equilibrium conditions are not required for this power ascension test.

  Specific information on Xenon and Samarium concentrations variations and equilibrium conditions and any other related power ascension testing

> guidance are provided in the detailed startup test procedures and the startup test program reference document developed by the COL applicant to support plant startup testing. Due to the short duration of this test, no prerequisites are needed to the DCD discussion or the detailed test procedures for this test.

The NRC staff agreed with the applicant's response that the short duration of this test does not require prerequisites. Based on this response, the staff concludes that no revision to the DCD is needed. Therefore, Open Item 14.2-1.w is resolved.

- In Open Item 14.2-1.x, the staff requested that the applicant clarify load swing tests from 100 percent power. Specifically, the applicant should clarify that test abstract 14.2.10.4.20, "Load Swing Test," does not call for a 10 percent load increase from 100 percent power, or the applicant should specify the required operator response. In its response dated August 26, 2003, the applicant stated the following:

> Since 100 percent reactor power is not allowed to be exceeded, the load swing test at 100 percent power consists of a 10 percent power load decrease to 90 percent power, followed by a 10 percent power load step increase. This prevents exceeding 100 percent power.

The applicant revised the test abstract 14.2.10.4.20, to state that "core power should not exceed 100 percent as indicated by the excore nuclear instrumentation." The staff finds this revision to be acceptable. Therefore, Open Item 14.2-1.x is resolved.

- In Open Item 14.2-1.y, the staff requested that the applicant explain the origin of the core burnup data for the startup test of a new plant in test abstract 14.2.10.4.23, "Hot Full Power Boron Endpoint." In its response dated August 26, 2003, the applicant stated the following:

> The current core burnup data identified in the prerequisites for Startup Test 14.2.10.4.23, are generated during core power operation associated with the power ascension testing. The power generation results in a small amount of fuel burnup and, therefore, core burnup data can be taken during the power ascension testing for use in the hot full power boron endpoint test procedure.

The staff agreed that only a small amount of fuel burnup occurs during power ascension testing, and the hot full power boron endpoint test procedure covers this detailed information; therefore, the staff finds that a revision to the DCD is not needed. Therefore, Open Item 14.2-1.y is resolved.

In conclusion, the staff reviewed all the power ascension test abstracts used to verify that the testing scope, general test methods, performance criteria and acceptance criteria are sufficient to test the SSCs important to safety during the power ascension test phase. The staff found that the applicant took one exception to RG 1.68, Appendix Action, Section 5L. The staff concluded that this exception prevents damage to fuel cladding; therefore, it is acceptable (see Section 14.2.10.4, Item (3) of this report). The staff found that all of the other power ascension test abstracts met the power ascension test attributes in SRP Section 14.2 and the applicable power ascension tests recommended in RG 1.68.

14.2.11 Conclusions

For each phase of the initial test program, the applicant provided test abstracts which included the objectives of each test, a summary of prerequisites and test method, and specific acceptance criteria. The initial test program addressed programmatic aspects, including consideration of organization and staffing; preparation, review, and technical content of test procedures; conduct of the test program; review, evaluation, and approval of test results; and utilization of reactor operating and testing experiences.

The staff completed its review of the AP1000 initial test program for design certification in accordance with the requirements of 10 CFR 52.79(b) and 50.34(b)(6)(iii) and Appendix A, “General Design Criteria,” and Criterion XI, “Test Control,” of Appendix B, “Quality Assurance,” to 10 CFR Part 50. The staff determined that the applicant adequately addressed the methods and guidance in SRP Section 14.2, Revision 2, and all the applicable RGs (e.g., RG 1.68) referenced in SRP Section 14.2 in developing the AP1000 initial test program. The AP1000 initial test program will demonstrate, with reasonable assurance, that the SSCs important to safety will adequately perform their intended function.

Based on a review of the testing scope, general test methods, test objectives, and test performance criteria and acceptance criteria discussed in DCD Section 14.2, “Initial Test Program,” the staff concludes that the applicant provided sufficient information in the initial test program to test all SSCs important to safety in the AP1000 design to satisfy the requirements of SRP Section 14.2 and the RGs referenced in SRP Section 14.2. Therefore, the staff finds the initial test program for the AP1000 design to be acceptable. On this basis, Open Item 14.2-1 is resolved.

14.3 Tier 1 Information

14.3.1 Introduction

This section describes the staff’s evaluation of the DCD Tier 1 information for the AP1000 design. The Tier 1 information is derived from the AP1000 Tier 2 information. Specifically, this information includes the following:

- definitions and general provisions
- design descriptions
- inspections, tests, analyses, and acceptance criteria
- significant site parameters
- significant interface requirements

The applicant intends to have this Tier 1 information certified in a design certification rulemaking pursuant to Subpart B of 10 CFR Part 52. To be certified, the Tier 1 information must verify the complete scope of the AP1000 design and that the regulations applicable to the AP1000 scope of design are met. 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 staff reviewed the Tier 1 information in accordance with the guidance provided in SRP Section 14.3, “Inspections, Tests, Analyses, and Acceptance Criteria—Design Certification,” the requirements in 10 CFR 52.47 and the Atomic Energy Act of 1954, as amended. The NRC prepared the draft SRP Section 14.3 based on the experience gained in its review of the evolutionary designs (ABWR and System 80+), which were certified in 1997.

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. Therefore, Tier 1, Section 2.0, “System-Based Design Description and ITAAC,” establishes the design descriptions and ITAAC for all of the systems in the AP1000 design; Tier 1, Section 3.0, “Non-System Based Design Descriptions and ITAAC,” establishes the non-system-based design descriptions and ITAAC that apply to multiple systems or structures. In DCD Tier 1, Section 2.0, “System Based Design Descriptions and ITAAC,” the applicant provided a Tier 1 entry (subsection) for every system in its design, thereby meeting the requirement to verify the full scope of the standard plant design. In addition, although the applicant provided a Tier 1 entry for every system that is either fully or partially captured within the scope of the AP1000 standard plant design, the amount of information in a given subsection is proportional to the safety significance of the particular system. The ITAAC portion of the Tier 1 information is used to verify that the as-built facility conforms to the applicable regulations.

14.3.2 Inspection, Test, Analyses, and Acceptance Criteria

As stated above, the staff performed its review of the system and non-system-based ITAAC in accordance with draft SRP Section 14.3. Several open and confirmatory items were identified in the DSER. The following describes the resolution of these open and confirmatory items:

- Open Item 14.3.2-1: In DCD Tier 1, Section 2.2.1, “Containment System,” the staff found that Item 2 under the design description for the containment system stated that the components identified in DCD Tier 1, Table 2.2.1-1 and the piping identified in DCD Tier 1, Table 2.2.1-2 are designed and constructed in accordance with ASME Code Section III requirements. However, during the April 2–5, 2003, design audit, the staff found that the applicant did not complete the final analyses and design of the containment vessel, including attached components and piping systems (see Section 3.8.2.1 of this report). The staff designated this issue related to the containment design as Open Item 14.3.2-1 in the DSER.

  During the audits conducted from October 6–9, 2003, and December 15–16, 2003, the staff reviewed the evaluation reports prepared by the applicant and found the applicant’s evaluation of the containment vessel design adequacy to be acceptable. Section 3.8.2.1 of this report discusses the details of the staff's review. Therefore, Open Item 14.3.2-1 is resolved.

- Open Item 14.3.2-2: In DCD Tier 1, Section 2.2.1, the applicant should add the phrase "structural integrity and" to (1) design description Item 5 for the containment system, and (2) Subitem 5.ii under the acceptance criteria in ITAAC Table 2.2.1-3. The sentence should read "... the seismic Category I equipment can withstand seismic design basis dynamic loads without loss of structural integrity and safety function." This issue was Open Item 14.3.2-2 in the DSER.

  The staff confirmed that the applicant added the phrase "structural integrity and" in the above-mentioned locations of DCD Tier 1, Section 2.2.1. On this basis, Open Item 14.3.2-2 is resolved.

- Open Item 14.3.2-3: In DCD Tier 1, Section 2.2.1, the applicant should designate the thickness of the steel containment vessel as Tier 1 information and specify it in DCD Tier 1, Section 2.2.1 or list it in DCD Tier 2, Table 3.3-1. This was Open Item 14.3.2-3 in the DSER.

  The applicant revised DCD Tier 2, Section 3.8.2.1.1, "General [Description of Containment]," to designate the thickness of the steel containment vessel as Tier 2* information for which any proposed change to the containment wall thickness will require NRC approval prior to implementation of the change. The staff accepts the designation of the wall thickness as Tier 2* information. Therefore, Open Item 14.3.2-3 is resolved.

- Open Item 14.3.2-4: In DCD Tier 1, Section 2.3.2, "Chemical and Volume Control System," the staff found that incomplete design commitments related to controls and displays exist in the current system-based ITAAC. For example, one current description states that, "[c]ontrols exist in the MCR [main control room] to cause the pumps identified in [DCD Tier 1,] Table 2.3.2-3, to perform the listed function." The staff recommends revising this design commitment to indicate that not only should the controls exist in the MCR and perform their intended functions, but the design of the controls should make them usable by operators. The staff suggested the following revision to accommodate this change, "[c]ontrols exist in the MCR to cause the pumps identified in [DCD Tier 1,] Table 2.3.2-3 to perform the listed function and are designed in accordance with state-of-the-art human factors principles as required by 10 CFR 50.34(f)(2)(iii)." The same concern applies to the current design commitment statements related to displays. As an example, the current design commitment, "[s]afety-related displays identified in [DCD Tier 1,] Table 2.3.2-1 can be retrieved from the MCR," should be changed to "[s]afety-related displays identified in [DCD Tier 1,] Table 2.3.2-1 can be retrieved from the MCR, perform their intended function, and are designed in accordance with state-of-the-art human factors principles as required by 10 CFR 50.34(f)(2)(iii)." These recommended changes to the examples cited above apply to other current design commitments for system-based ITAAC. This was Open Item 14.3.2-4 in the DSER.

In its June 21, 2003, response, the applicant indicated that the proposed words do not need to be added to the system-based Tier 1 ITAAC because DCD Tier 1, Section 3.2, “Human Factors Engineering,” is the appropriate place to have the design commitments that demonstrate compliance with 10 CFR 50.34(f)(2)(iii). DCD Tier 1, Section 3.2 stipulates that the design of the MCR controls are consistent with state-of-the-art human factors principles. This applies to each individual control covered by the various system-based ITAAC. Based on this information, the staff agrees with the applicant’s response; therefore, Open Item 14.3.2-4 is resolved.

- Open Item 14.3.2-5: In DCD Tier 1, Section 2.3.5, “Mechanical Handling System,” the design descriptions (Items 3.b and 3.c) for the equipment hatch hoist and the maintenance hatch hoist are not identified as single-failure proof as they are in Tier 2. In addition to not being identified as single-failure proof, DCD Tier 1, Table 2.3.5.2 does not require a test, inspection, or analysis to demonstrate whether these equipment items will meet their design criteria. As such, the staff finds the design description in Tier 2, is inconsistent with that of the ITAAC. This was Open Item 14.3.2-5 in the DSER.

  The applicant revised DCD Tier 2, Section 9.1.5, “Overhead Heavy Load Handling Systems,” to state that the maintenance hatch hoist is non-single-failure proof, but is operational after a seismic event. The equipment hatch hoist is single-failure proof. In addition, the applicant revised DCD Tier 1, Section 2.3.5, “Design Description,” to be consistent with the information in DCD Tier 2. DCD Tier 1, Table 2.3.5-2, “Inspection, Test, Analysis and Acceptance Criteria,” includes an inspection, test, and analysis for the equipment hatch hoist. Consequently, the design description in Tier 2 is now consistent with the ITAAC (Tier 1). Therefore, Open Item 14.3.2-5 is resolved.

- Open Item 14.3.2-6: The open item associated with DCD Tier 1, Section 2.3.9, “Containment Hydrogen Control System,” remained open because hydrogen control was an open item in the DSER (see Section 6.2.5 and the resolution of DSER Open Item 6.1.1-1 in this report for details). The AP1000 Tier 2 information was written in anticipation of a rule change to 10 CFR 50.44 that would relax certain requirements, but this change was not finalized when the DSER was issued. This was Open Item 14.3.2-6 in the DSER.

  Subsequent to the publication of the DSER, the NRC completed the anticipated change to its regulations regarding the control of combustible gas in containment. Accordingly, the staff has completed its review in Section 6.2.5 of this report with no open items. However, as part of its review, the staff requested that the applicant revise DCD Tier 2, Section 6.2.4, “Containment Hydrogen Control System,” to reflect that the containment hydrogen monitors are powered by the non-Class 1E dc and UPS (uninterruptible power system) system. This change demonstrates compliance with the revised regulations specified in 10 CFR 50.44 and is consistent with draft RG 1.7, Revision 3. The staff also requested that the applicant add an equivalent statement to DCD Tier 1, Section 2.3.9, and implementing provisions to DCD Tier 1, Table 2.3.9-3. The staff verified that this information was added to the DCD. Therefore, Open Item 14.3.2-6 is resolved.

- Open Item 14.3.2-7: In DCD Tier 1, Section 2.3.19, “Communication Systems,” the applicant did not identify ITAACs for the communication system (EFS), as discussed in DCD Tier 2, Section 9.5.2, beyond those given in DCD Tier 1, Tables 2.3.19-2 and 3.1-1 (emergency response facilities). The applicant provided no assurance that its proposal will satisfy the appropriate tests and confirmatory criteria to meet regulatory requirements, especially 10 CFR 73.55(e) through (g) and noise level considerations for worst-case postulated noise levels. The staff asked the applicant to provide appropriate ITAAC for all of the AP1000 communication systems. This was Open Item 14.3.2-7 in the DSER.

  The applicant addressed this item in a response to RAI 420.048 dated May 14, 2003. The applicant updated DCD Tier 2, Sections 13.6.9, “Security Power Supply System,” 13.5.1, “Combined License Information Item,” 9.5.2.2.1, “Wireless Telephone System,” 9.5.2.5.2, “Emergency Offsite Communications,” and 14.2.9.4.13, “Passive Core Cooling System Testing,” to address this issue. In addition, the RAI response stated that the COL applicant will test the communication equipment to verify that this equipment can operate under maximum plant noise conditions. The staff finds that these responses have addressed the appropriate tests, and confirmatory criteria will be applied to meet the requirements of 10 CFR 73.55(e) through (g) and noise level considerations for worst-case postulated noise levels. Therefore, Open Item 14.3.2-7 is resolved.

- Open Item 14.3.2-8: The staff had not completed its review of the ITAAC In DCD Tier 1, Sections 2.6.9, “Plant Security System,” and 2.6.10, “Closed Circuit TV System,” because the review of the security program for the AP1000 had not yet been completed (see Section 13.6 of this report). This was Open Item 14.3.2-8 in the DSER.

  The staff subsequently completed its review of DCD Tier 2, Section 13.6, “Security.” As a result, the staff informed the applicant that the plant security system, as listed in DCD Tier 2, Table 1.7-2, “AP1000 System Designators and System Diagrams,” was fully in scope for the design certification review, which was inconsistent with the language in DCD Tier 2, Section 13.6. In addition, the closed circuit TV system was listed as partially out of scope, which also was inconsistent because this item was not discussed in DCD Tier 2, Section 13.6 and appeared to be the responsibility of the COL applicant.

  In response to this issue, the applicant revised DCD Tier 2, Table 1.7-2 to indicate that the plant security system was partially out of scope and the closed circuit TV system was wholly out of scope. In addition, the applicant revised DCD Tier 2, Table 14.3-1, “ITAAC Screening Summary,” to indicate that the closed circuit TV system was not selected for ITAAC. The applicant also deleted the reference to the closed circuit TV system in DCD Tier 1, Section 2.6.10 and renumbered the sections. The staff reviewed the applicant’s changes to the DCD and found them acceptable.

  The staff also reviewed DCD Tier 1, Table 3.3-6, Item 14, concerning a security ITAAC included in DCD Tier 1, Section 3.3, “Buildings.” The staff determined that additional information was required to verify that the security design characteristics had been incorporated in the as-built AP1000 design. In a conference call on May 6, 2004, the applicant committed to revise Item 14 and add four additional ITAACs (Items 15 through 18) to ensure the specific security design commitments were included in the ITAACs. Security design characteristics to be included in the ITAACS are: bullet resistant barriers, vital area designations for the central alarm station and main control room, security power supply located in a vital area, vital area design, alarm annunciation and locks. In addition, the applicant committed to revise DCD Tier 1, Section 3.3 to include the new design commitments specified in Items 14 through 18 as discussed above. The staff reviewed the changes to the DCD and concluded that they are acceptable. Therefore, Open Item 14.3.2-8 is resolved.

- <u>Open Item 14.3.2-9</u>: In RAI 252.001, the staff requested information related to the geometry, fabrication, materials, accessibility for inspection, and operating conditions for control rod drive system penetrations, based upon recent operating experience (see NRC Bulletins 2001-01, 2002-01, and 2002-02). Since the RAI was issued, the staff has issued Order EA-03-009 to operating license holders. This order is related to the inspection for cracks in these penetrations and attachment welds. The staff subsequently issued followup questions to the applicant related to changes in design and fabrication to reduce residual stresses, the ability to visually inspect 360 degrees around each nozzle, preservice volumetric inspection, and the determination of operating head temperature. The applicant responded to the followup questions in a letter dated April 7, 2003. The staff requested that the applicant provide a proposed ITAAC related to the issues noted above and discussed in the RAI responses. This was Open Item 14.3.2-9 in the DSER.

  In a letter dated May 21, 2003, the applicant stated that the AP1000 design provides access and inspectability for inservice inspection of ASME Code components and control rod drive system penetrations. Furthermore, the staff has determined, based on experience with operating reactors, that future reactor pressure vessel insulation will be removable to facilitate inspections. The staff finds the design for access and inspectability and the preservice baseline inspections described in DCD Tier 2, Section 5.3.4.7, “Inservice Surveillance,” to be acceptable. Therefore, the staff concludes that an ITAAC in this area is not necessary and Open Item 14.3.2-9 is resolved.

- <u>Open Item 14.3.2-10</u>: Operating experience continues to show cracking of Alloy 600 components. Recent experience appears to indicate that cracking has even occurred in welds or components not previously expected to crack, based on the temperature of the weld or component and the time in service. The staff believes that using Alloy 690 materials in contact with reactor coolant is a substantial improvement over the materials currently employed by the industry. However, data currently available do not demonstrate that cracking in these welds and components will not occur over the projected 60-year design lifetime of an AP1000 plant (40-year period of the COL plus a potential 20-year license renewal period). The staff also believes that bare metal visual inspection of these locations is highly effective in identifying locations where cracking occurs. The staff asked the applicant to provide information to describe the extent to which the design of the insulation of all Alloy 600/690 components and welds in the reactor coolant pressure boundary (not just in the upper reactor vessel head penetrations) will readily facilitate bare metal visual inspection during refueling outage conditions. The staff requested that the applicant provide a proposed ITAAC to verify that all Alloy 600/690 components and welds in the reactor coolant pressure boundary are identified and are readily accessible for bare metal visual inspection. This was Open Item 14.3.2-10 in the DSER.

In a letter dated May 21, 2003, the applicant confirmed the accessibility of all components with Alloy 690-type materials for inspection and confirmed that no Alloy 600 materials come in contact with the primary reactor coolant. The staff has determined, based on experience with operating reactors, that insulation can be removed for visual inspection, if necessary. Since removal of insulation makes these components accessible for inspection, and since any future redesign of insulation to facilitate more rapid inspection is not a major modification, the staff concludes that the applicant's response is acceptable and an additional ITAAC is not necessary. On this basis, Open Item 14.3.2-10 is resolved.

- <u>Open Item 14.3.2-11</u>: The staff reviewed Tier 2, Section 5.3.4, as it applies to pressurized thermal shock in accordance with SRP 5.3.2, "Pressure-Temperature Limits and Pressurized Thermal Shock." Section 50.61 of 10 CFR Part 50, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events," defines the fracture toughness requirements for protection against pressurized thermal shock (PTS) events. The requirements in 10 CFR 50.61 establish the PTS screening criteria below which no additional action is required for protection from PTS events. The screening criteria are given in terms of reference temperature (RT_{PTS}). These criteria are 148.0 °C (300 °F) for circumferential welds and 132.2 °C (270 °F) for plates, forgings, and axial welds. To verify that the design will be in accordance with the regulatory requirements associated with PTS, the staff requested that the applicant provide an appropriate ITAAC. The staff also suggested, as a design commitment for this ITAAC, that the amount of copper and nickel in the reactor vessel materials and the projected neutron fluences for the 40-year period of the COL will result in RT_{PTS} values lower than the screening criteria contained in 10 CFR 50.61. This was Open Item 14.3.2-11 in the DSER.

  By letter dated June 23, 2003, the applicant indicated that the DCD provides bounding values of nickel and copper in the reactor vessel materials. The applicant further indicated that the preliminary end-of-life RT_{PTS} values for the forging and beltline weld fall well below the screening criteria given in 10 CFR 50.61. These preliminary values are based on the bounding nickel and copper values and on the projected neutron fluences for the 40-year period of the COL. The staff concludes that an ITAAC in this area is not necessary because it is unlikely that future reactor vessels will contain unacceptable amounts of copper and nickel. On this basis, Open Item 14.3.2-11 is resolved.

- <u>Open Item 14.3.2-12</u>: In DCD Tier 1, Section 3.1, "Emergency Response Facilities," the staff found this ITAAC unacceptable because it did not address the radiological habitability or the ventilation system for the technical support center, both of which should be the same as, or comparable to, the MCR ITAAC. This was Open Item 14.3.2-12 in the DSER.

The applicant added Item #6 of DCD Tier 1, Section 3.1, “Emergency Response Facilities,” to state that the technical support center provides a habitable work space environment. The applicant also revised DCD Tier 1, Table 3.1-1, “Inspections, Tests, Analyses, and Acceptance Criteria,” to add this design commitment. Therefore, Open Item 14.3.2-12 is resolved.

- <u>Open Item 14.3.2-13</u>: In DCD Tier 1, Section 3.3, “Buildings,” Item 2.a of the design description and DCD Tier 1, Table 3.3-6 state that the NI structures, including the critical section listed in DCD Tier 1, Table 3.3-7, are seismic Category I and are designed and constructed to withstand design-basis loads (including seismic loads), as specified in the design description, without loss of structural integrity and their safety-related functions. However, as identified in Open Items 3.7.2.3-1, 3.7.2.3-3, and 3.8.5.4-1, the applicant did not demonstrate that the foundation mat will not lift up, and/or that the shear walls will not crack, during a postulated seismic event. The phenomena of the foundation mat uplifting and shear wall cracking will directly affect the design adequacy of the NI SSCs, including the thickness of structural elements listed in DCD Tier 1, Table 3.3-1 and safety-related piping systems. This was Open Item 14.3.2-13 in the DSER.

  As discussed in Sections 3.7.2 and 3.8.5 of this report, the applicant has properly (1) demonstrated that the uplifting of the foundation mat under an SSE is insignificant, and (2) considered the effects of shear wall cracking in the analysis and design of the NI structures. On the basis that the applicant has adequately resolved Open Items 3.7.2.3-1, 3.7.2.3-3, and 3.8.5.4-1. Therefore, Open Item 14.3.2-13 is resolved.

- <u>Open Item 14.3.2-14</u>: In Tier 1, Table 3.3-6, acceptance criteria 2.g states that the tolerance on the height of the containment vessel is +30.5 cm, - 15.2 cm (+12", -6") and the tolerance on the inside diameter is also +30.5 cm, - 15.2 cm (+12", -6"). The information included in Tier 2 related to the containment design does not address the +30.5 cm (+12") tolerance on the inside diameter. All of the applicant’s analyses, calculations, and responses to the RAIs related to the containment vessel use the nominal inside diameter of 39.62 m (130 ft) as a basis. From its review, it is the staff’s understanding that the inside diameter of the vessel wall, currently specified for 39.62m (130 ft), marginally meets ASME Code allowable tolerances. Adding 30.5 cm (12") to the vessel diameter will reduce the design margin. The staff request the applicant to justify the use of the proposed tolerances. This was Open Item 14.3.2-14 in the DSER.

  In its response dated July 7, 2003, the applicant stated that design commitment 2.c of Tier 1, Table 3.3-6, states that, “The containment and its penetrations are designed and constructed to ASME Code Section III, Class MC.” ASME Code, Section III, Division 1, Subsection NE requires that, “For components subjected to internal pressure, the inside diameter shall be taken as the nominal inner face.” The Code further states that, “The difference between the maximum and minimum inside diameters [of the fabricated vessel] at any cross section shall not exceed one (1) percent of the nominal diameter at the cross section under consideration." The Code then requires that a report be prepared as an addendum to the design report that compares the final as-built vessel to the design report. Differences must be justified or the design report must be revised. As a result, if the as-built inner diameter deviates from the design inner diameter, the difference must be addressed in the as-built reconciliation. The staff considers the applicant's response to be acceptable and, therefore, Open Item 14.3.2-14 is resolved.

- Open Item 14.3.2-15: In DCD Tier 1, Section 3.7, "Design Reliability Assurance Program," the staff found that the applicant did not update the list of risk-significant components in DCD Tier 1, Table 3.7-1 to include all risk-significant SSCs from the list of risk-significant SSCs identified in DCD Tier 2, Table 17.4-1, "Risk Significant SSCs within the Scope of D-RAP." Specifically, the list of risk-significant components should include the following:

  - compressed and instrument air system air compressor transmitter
  - passive containment cooling system diverse third motor-operated drain isolation valve function
  - IRWST vents
  - normal residual heat removal valve V055 function
  - feedwater isolation valves

  As discussed in Section 17.4 of this report, the staff determined that DCD Tier 2, Table 17.4-1 contained an acceptable list of risk-significant SSCs under the scope of D-RAP. In Table 17.4-1, the applicant also removed the safety-related passive core cooling condensate sump recirculation valves' automatic open function from the D-RAP for the AP1000 design, and DCD Tier 1, Table 3.7-1 should reflect this. This was Open Item 14.3.2-15 in the DSER.

  In a response dated July 1, 2003, the applicant provided the following information based on its review of DCD Tier 2, Table 17.4-1 and DCD Tier 1, Table 3.7-1:

  (1) The probabilistic risk assessment (PRA) importance of the compressed and instrument air system, air compressor pressure transmitter had been reevaluated. Based on the current AP1000 PRA, this instrument just meets the D-RAP selection criteria (risk achievement worth (RAW), risk reduction worth (RRW)) for large release frequency, although it does not meet the D-RAP selection criteria for core damage frequency. Furthermore, conservatisms in the PRA have resulted in the overestimation of RAW/RRW values for this instrument. These conservatisms result from not modeling some plant features that would have reduced the PRA importance of this instrument. Based on this

reevaluation, the D-RAP tables in the DCD and the ITAAC should no longer list this instrument. Therefore, the applicant removed it from DCD Tier 2, Table 17.4-1 and did not add it to DCD Tier 1, Table 3.7-1.

The staff requested that the applicant add information to this response concerning equipment that was not modeled in the PRA which would reduce the risk importance of the air compressor pressure transmitter. The applicant agreed to add information concerning instrument air bottles used to control air-operated valves in the feedwater system which would reduce the risk importance of the air compressor pressure transmitter.

(2) The applicant agreed to add the following equipment to DCD Tier 1, Table 3.7-1:

- IRWST vents
- main feedwater isolation valves

(3) The applicant stated that it need not add the third PCS water drain valve to DCD Tier 1, Table 3.7-1 because the component already exists in the table. The table lists three values under PCCWST drain isolation valves, including PCS-PL-V001A/B/C. The C valve is the diverse third drain valve.

(4) The applicant agreed that the table should also include the normal residual heat removal (RNS) valve 055. However, as indicated in DCD Tier 2, Table 17.4-1, other RNS MOVs are also required to allow the RNS to provide RCS makeup following ADS actuation, including the following:

- V011 RNS discharge containment isolation

- V022 RNS actuation containment isolation

- V055 RNS suction from the spent fuel pool cooling system cask loading pit

- V062 RNS suction from the IRWST

(5) The applicant agreed that it should remove the PXS containment recirculation MOVs (PXS-PL-V117A/B) from DCD Tier 1, Table 3.7-1, since they have been removed from DCD Tier 2, Table 17.4-1.

(6) The applicant's review also indicated that it should make the following additional changes to DCD Tier 1, Table 3.7-1:

- Add CVS makeup pump suction and discharge check valves.
- Add inverters and battery chargers for the 24-hour batteries.
- Add reactor vessel insulation water inlet and steam vent devices.
- Add reactor cavity door damper.

- Add service water cooling tower fans.
- Add low capacity chilled water subsystem.
- Add standby diesel generator room cooling fans.
- Add fuel assemblies.
- Remove PXS valves PCS-PL-V125A/B from the IRWST injection squib valve group. These valves are not squibs, and V123A/B and V125A/B lists the four squibs in these lines.

The staff finds that the applicant's response appropriately identifies all risk-significant SSCs that should be within the scope of D-RAP; however, the staff noted that the equipment identification nomenclature between DCD Tier 2, Table 17.4-1, and DCD Tier 1, Table 3.7-1, differs, making it difficult for the staff to identify like components in each table. The applicant stated that it would add the risk-significant component tag number for each component to DCD Tier 2, Table 17.4-1 to make the nomenclature between the two tables the same. The applicant revised DCD Tier 2, Table 17.4-1, to add the appropriate nomenclature to both tables. The staff finds this to be acceptable.

In addition, the staff requested that the applicant verify that the risk-significant SSCs identified in DCD Tier 2, Table 17.4-1, match the risk-significant components in DCD Tier 1, Table 3.7-1. In DCD Tier 2, Table 17.4-1, and DCD Tier 1, Table 3.7-1, the staff verified that the component lists in the two tables were identical; therefore, this part of Open Item 14.3.2-15 is resolved.

The NRC staff also noted that Westinghouse needed to add the uninterruptible power supply (UPS) Distribution Panels, EDS1-EA-1 and EDS2-EA-1, to the AP1000 D-RAP. The NRC staff determined that these components have RAW values equivalent to UPS Distribution Panels EDS1-EA-14 and EDS2-EA-14. Therefore, the AP1000 D-RAP must include EDS1-EA-1 and EDS2-EA-1. In Revision 9 to AP1000 DCD Tier 1, Table 3.7-1, "Risk Significant Components," and Tier 2, Table 17.4-1, "Risk Significant SSCs Within the Scope of D-RAP," Westinghouse added UPS Distribution Panels EDS1-EA-1 and EDS2-EA-1 to the two tables. Therefore, this part of Open Item 14.3.2-15 is resolved. Therefore, this part of Open Item 14.3.2-15 is resolved.

The NRC staff also noted that Westinghouse needed to add the uninterruptible power supply (UPS) Distribution panels, EDS1-EA-1 and EDS2-EA-1, to the AP1000 D-RAP. The NRC staff determined that these components have RAW values equivalent to UPS Distribution Panels EDS1-EA-14 and EDS2-EA-14. Therefore, the AP1000 D-RAP must include EDS1-EA-1 and EDS2-EA-1. In Revision 9 to AP1000 DCD Tier 1, Table 3.7-1, "Risk Significant Components," and Tier 2, Table 17.4-1, "Risk Significant SSCs Within the Scope of D-RAP," Westinghouse added UPS Distribution Panels EDS1-EA-1 and EDS2-EA-1 to the two tables. Therefore, this part of Open Item 14.3.2-15 is resolved. Therefore, Open Item 14.3.2-15 is resolved.

- <u>Electrical Cable Pulling</u>

In a public meeting on October 30, 2003, the staff stated that the NRC team developing the construction inspection program for new reactors identified a potential issue concerning cable pulling. The staff requested that the applicant consider verification of as-installed electrical cables be added to the AP1000 ITAAC.

The applicant stated in its response, dated November 17, 2003, that the cable pulling process will be governed by the construction procedures for the plant. In addition, an ITAAC for the cable pulling process was not included in any of the three designs previously certified. The applicant concluded that an additional ITAAC is not needed for AP1000.

The staff discussed this issue with the applicant in a conference call on January 29, 2004. The staff provided its position to the applicant prior to the call. This position is documented in the conference call summary dated March 11, 2004, and is repeated below.

> Operational experience has shown that inadequate cable installation procedures and cable pulling could cause safety-related as well as non safety-related cables (low voltage as well as medium) to fail and could challenge the performance of systems that are important to safety, and RTNSS important. Therefore, the staff has determined that ITAAC for systems important to safety should be added to verify that damage did not occur during storage, handling, and installation of all cables (power as well as instrumentation & control) whether they are Class 1E (safety), non-Class 1E, or RTNSS important. The following guidance should be used in preparing the ITAAC:
>
> IEEE Standard 422-1986 Section 10.2, “Installation,” provides information such as handling or pulling cables, cable pulling lubricants, pulling winches, cable reels, pulling tension and bends. This could cause damage to the cables’ sheathing, jacketing, or conductors. Section 11 of the standard provides guidance for the testing of cables after installation but before their connection to equipment, and includes cable terminations, and connections. The purpose of the tests is to verify that major cable damage did not occur during storage and installation. The following tests should be performed in conjunction with the cable manufacturer’s recommendation:
>
> 1) The insulation resistance tests for low-voltage power, instrumentation and control cables should measure the insulation resistance between the conductors in the same cable and between each conductor and station ground.
>
> 2) The insulation resistance tests should be performed for the shielded and unshielded medium-voltage cables.
>
> In addition to IEEE Standards 422 and 690, NRC Information Notices IN 87-08, IN 87-52, and IN 92-01, and EPRI Final Report NP-7485, "Practices to Assure Cable Operability," dated June 1992, should be reviewed for preparation of the electrical cable ITAAC.

In its response dated February 4, 2004, the applicant stated that it has reviewed the IEEE standards, Information Notices, and the EPRI report as they related to the AP1000 design. The applicant provided the following six conclusions in its response:

Verification Programs

1. Westinghouse agrees that inadequate cable installation and handling can cause cables to fail and could challenge the performance of systems that are important to safety.

2. Proper cable installation procedures should and will be followed. DCD Tier 2, Section 8.3.1.3.1 states that the installation of cables will comply with IEEE [Standard] 422.

3. As stated in EPRI NP-7485 (page 8-41), “A universally acceptable simple in-situ cable test or cable condition monitoring method that directly indicates the cable condition or its capability to withstand accident condition does not exist.”

4. Both IEEE Standards 422 and 690 allow a functional test at full voltage as an alternative to insulation resistance tests of low voltage cable. The existing DCD Tier 1 tests of instrumentation and electrical equipment provide functional tests that serve as alternatives to insulation resistance tests of low-voltage cables.

5. High potential testing of Class 1E medium-voltage cables is required by IEEE [Standard] 690; however, AP1000 does not have any Class 1E medium-voltage cables.

6. None of the non-Class 1E medium-voltage cables that have been identified as RTNSS important are in locations that will require them to withstand accident conditions.

The applicant further stated in its February 2, 2004, response:

> The cable pulling process will be governed by the construction procedures for the plant. The Quality Assurance program for procurement , fabrication, installation, construction, and testing of structures, and components in the facility will cover the cable process, as well as other installation processes...
>
> In summary, Westinghouse understands the concern regarding proper cable installation and handling; however, Westinghouse for the reasons stated above, does not believe that changes to DCD Tier 1 are needed.

The above rationale was provided by the applicant to conclude that an ITAAC does not address the needs of electrical (low and medium voltage) environmental qualification cables and connections which are important to safety, and RTNSS important. Damage during installation may void the equipment’s qualification to perform its intended safety function during and after a design basis accident. The staff believed confirmation is required that the cables have been installed in such a manner that does not negate the assumptions used in the equipment qualification type testing (i.e., the cable is installed in an as-new configuration).

On July 14, 2004, a conference call was held to discuss this issue further. The applicant agreed to consider appropriate acceptance criteria for cable installation. The applicant revised DCD Tier 1, Table 2.1.2-1, item 7a to state the following:

<u>Inspections, Test, Analyses</u>

ii) Inspections will be performed of the as-installed Class 1E equipment and the associated wiring, cables and terminations located in a harsh environment.

<u>Acceptance Criteria</u>

ii) A report exists and concludes that the as-installed Class 1E equipment and the associated wiring, cables, and terminations identified in [DCD Tier 1,] Table 2.1.2-1 as being qualified for a harsh environment are bounded by type test, analyses or a combination of type tests and analyses.

Similar changes were also made to the following DCD sections.

- DCD Tier 1, Table 2.1.3-2, item 9.a
- DCD Tier 1, Table 2.2.1-3, item 6.a
- DCD Tier 1, Table 2.2.2-3, item 6.a
- DCD Tier 1, Table 2.2.3-4, item 7.a
- DCD Tier 1, Table 2.2.4-4, item 7.a
- DCD Tier 1, Table 2.3.2-4, item 6.a
- DCD Tier 1, Table 2.3.6-4, item 7.a
- DCD Tier 1, Table 2.3.13-3, item 6.a
- DCD Tier 1, Table 2.5.5-2, item 3.a
- DCD Tier 1, Table 3.5-6, item 2

The staff has reviewed the changes to the ITAACs in the DCD sections referenced above and finds them to be acceptable.

- <u>Containment Sump</u>

  By letter dated January 13, 2004, Westinghouse changed the design of the containment recirculation screens and the IRWST screens by increasing the fine screen area by at least a factor of 2 to 13 m^2 (140 ft^2) or more by using a folded screen design. An increased screen area will allow the screen to tolerate more debris, while lowering the water velocity at the screen face. Westinghouse also added a cross-connection pipe between the two containment recirculation screens. This design change was incorporated in DCD Tier 1, Table 2.2.3-4, Item 8.c.

- <u>Confirmatory Items 14.3.2-1, 14.3.2-2, and 14.3.2-3</u>: In DCD Tier 1, Section 2.7.1, “Nuclear Island Nonradioactive Ventilation System,” DCD Tier 1, Table 2.7.1-1 lists the components, but neither DCD Tier 1, Figure 2.7.1-1 nor DCD Tier 2, Figure 9.4.1-1, shows them (see RAI 410.022). This was Confirmatory Item 14.3.2-1 in the DSER.

In DCD Tier 1, Section 2.7.3, “Annex/Auxiliary Building Nonradioactive Ventilation System.” DCD Tier 1, Table 2.7.3-1 lists the components, but neither DCD Tier 1, Figure 2.7.3-1 nor DCD Tier 2, Figure 9.4.2-1 shows them (see RAI 410.022). This was Confirmatory Item 14.3.2-2 in the DSER.

In DCD Tier 1, Section 2.7.5, “Radiologically Controlled Area Ventilation System.” DCD Tier 1, Table 2.7.5-1 lists the components, but DCD Tier 2, Figure 9.4.3-1 does not show them (see RAI 410.022). This was Confirmatory Item 14.3.2-3 in the DSER.

The staff requested in RAI 410.022 that the applicant explain why specific heating, ventilation, and air conditioning (HVAC) components are listed in the following ITAACs but are not discussed in DCD Tier 2, Section 9.4. The impacted ITAACs, which are listed in DCD Tier 1, Table 2.7.1-1, include (1) VBS-MA-11 and MA-12 instrumentation and control (I&C), Divisions B and C ancillary fans; (2) VXS-MS-04A through D MSIV, Compartments A, B, C, and D air handling units; (3) VXS-MS-08A and B valve piping penetration rooms, A and B air handling units; (4) VXS-MY-W01A, B and C annex building nonradioactive equipment room unit heaters; (5) VXS-MS-07A and B mechanical equipment area air handling units; and (6) VAS-030 fuel handling area differential pressure indicator, VAS-032 annex building differential pressure indicator, and VAS-033 auxiliary building differential pressure indicator.

In a letter dated April 24, 2003, the applicant provided a response stating that it had revised the following DCD Tier 2 sections to add the components listed above:

- Section 9.4.1.2.3.2, “Class 1E Electrical Room HVAC Subsystems” (Item 1)
- Section 9.4.2.2.1.4, “MSIV Compartment HVAC Subsystems” (Item 2)
- Section 9.4.2.2.1.6, “Valve/Piping Penetration Room HVAC Subsystems,” (Item 3)
- Section 9.4.2.2.1.3, “Equipment Room HVAC Subsystems,” (Item 4)
- Section 9.4.2.2.1.5, “Mechanical Equipment Areas HVAC Subsystems,” (Item 5)
- Section 9.4.3.5, “Instrumentation Applications,” (Item 6)

The staff reviewed the applicant’s response and revisions to the DCD Tier 2 sections listed above. Since these components are defense-in-depth-related and not safety-related, nor are they important to safety, the staff finds the applicant’s revisions to the DCD acceptable based on cross-component traceability between the DCD Tier 2 text description and the DCD Tier 1 table. Therefore, Confirmatory Items 14.3.2-1, 14.3.2-2, and 14.3.2-3 are resolved.

14.3.3 Design Acceptance Criteria

During the AP1000 preapplication review, the applicant requested the staff to review the acceptability of the proposed use of design acceptance criteria (DAC) to support the development of the design certification application for the AP1000 design (see Westinghouse letter dated August 28, 2000, as supplemented by its letter dated February 13, 2002, and SECY-02-0059, “Use of Design Acceptance Criteria for the AP1000 Standard Plant Design,” dated April 1, 2002). The applicant stated that the AP1000 design is based closely on the AP600 design, and that it maintained the AP600 design configuration, use of proven components, design basis and licensing basis by making as few changes as possible to the AP600 design.

In seeking certification of the AP1000 design, the applicant proposed to apply the DAC approach to the I&C and human factors engineering as it did for the AP600 design. However, the applicant also proposed to apply the DAC approach to the piping and structural design, and, to some extent, the seismic analysis, citing the precedents set in the use of DAC during certification of the ABWR and System 80+ designs. After discussions with the NRC regarding the requirements of 10 CFR 52.47(a)(2), the applicant stated, as detailed in its letter of February 13, 2002, that it would (1) limit the design certification to hardrock sites and provide a seismic analysis, and (2) perform specified structural design calculations. This would provide sufficient seismic and structural design information for the staff to reach a safety determination prior to granting design certification and to preclude the need for DAC in these areas. In the same letter, the applicant provided information supporting its proposed use of DAC in the piping area. Therefore, the staff’s evaluation of the AP1000 DAC approach contained herein is limited to the proposed use of DAC in the I&C, human factors engineering, and piping areas.

14.3.3.1 Instrumentation and Control System

The I&C system design uses digital computer technology for the reactor protection and control functions. Since the digital computer-based I&C systems are a rapidly changing technology, the NRC allowed the applicant to use design processes and DAC to develop, design, and evaluate the details of the design. The Tier 1 information should address the development and qualification processes for I&C equipment. Draft SRP Section 14.3.5, “Instrumentation and Controls (Tier 1),” states that for a computer-based I&C system, the Tier 1 information should include (1) design processes and acceptance criteria to be used for safety-related systems using programable microprocessor-based control equipment, (2) a program to assess and mitigate the effects of electromagnetic interference on I&C equipment, (3) a program to establish setpoints for safety-related instrument channels, and (4) a program to qualify safety-related I&C equipment for inservice environment conditions.

The Tier 1 information found in DCD Tier 1, Section 2.5.2, “Protection and Safety Monitoring System,” Item 11, addresses the hardware and software development process for the design, testing, and installation of I&C equipment. Tier 1 information includes the ITAAC that describes attributes of the process for developing the I&C system, as well as attributes of the final product. The ITAAC for software and hardware verifies the applicant’s implementation of the proposed design stages within the overall design process. Tier 2 information describes the various design stages in more detail. The staff has evaluated the I&C hardware and software development process addressed in Chapter 7 of this report. The staff finds that the information in Tier 1 is consistent with the information provided in Tier 2, including two references to topical reports, WCAP-15927, Revision 0, “Design Process for AP1000 Common Q Safety Systems,” and CE-CES-195, Revision 1, “Software Program Manual for Common Q Systems.” Therefore, the staff finds this information to be acceptable.

DCD Tier 1, Section 2.5.2, Item 3, addresses the AP1000 I&C system’s capability to withstand electrical surges and its compatibility with electromagnetic interference, radiofrequency interference, and electrostatic discharge conditions that would exist before, during, and following a design-basis accident. In particular, DCD Tier 1, Section 2.5.2, Item 3, addresses whether the system could experience such conditions without the loss of a safety function for the time required to perform the safety function. The staff finds that the information in Tier 1 is consistent with the information provided in Tier 2, including the reference to topical report, CENPD-396-P, Revision 1, “Common Qualified Platform.” Therefore, the staff finds this information to be acceptable.

DCD Tier 1, Section 2.5.2, Item 10, addresses the setpoint methodology, which accounts for loop inaccuracies, response time testing, and maintenance or replacement of instrumentation. The staff finds that the information in Tier 1 is consistent with the information provided in Tier 2, including the reference to WCAP-14605, “Westinghouse Setpoint Methodology for Protection Systems—AP600.” Therefore, the staff finds this information to be acceptable.

DCD Tier 1, Section 2.5.2, Item 4, addresses the I&C equipment qualification program, which qualifies the Class 1E equipment for the environment that would exist before, during, and following a design-basis accident. If qualified, equipment would experience such conditions without the loss of a safety function for the time required to perform the safety function. The staff finds that the information provided in Tier 1 is consistent with the information provided in Tier 2, including the reference to CENPD-396-P. Therefore, the staff finds this information to be acceptable.

DCD Tier 1, Section 2.5.1, “Diverse Actuation System,” has addressed a concern with regard to software common mode failure. The diverse actuation system uses an operating system and programming language that are different from those used in the protection and safety monitoring system for performing comparable safety system actuation functions. The diverse actuation system implements manual initiation functions in a manner that bypasses the control room multiplexers and the signal processing equipment to ensure manual initiation capability in the event of loss of the multiplexers. The staff finds that the defense-in-depth and diversity provisions provided in Tier 1 are consistent with the information provided in Tier 2, including the reference to WCAP-15775, Revision 2, “AP1000 Instrumentation and Control Defense-in-Depth and Diversity Report.” Therefore, the staff finds this information to be acceptable.

The staff found that certain Tier 1 information was incomplete. The staff requested certain modifications for consistency with Tier 2 information. These requests were identified as open and confirmatory items in the DSER. The following describes the resolution of these open and confirmatory items:

- Open Item 14.3.3-1: The applicant should modify DCD Tier 1, Table 2.5.1-1, "Functions Automatically Actuated by the DAS," to include "actuate core makeup tanks, and trip the reactor coolant pumps on low wide-range steam generator water level." This comment resulted from the review of DCD Tier 2, Section 7.7.1.11, "Diverse Actuation System." This was Open Item 14.3.3-1 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.1-1, as suggested by the staff. The staff has verified that the information is included in the DCD. Therefore, Open Item 14.3.3-1 is resolved.

- Open Item 14.3.3-2: The applicant should modify DCD Tier 1, Section 2.5.1, design description Item 2.c, to include, "the DAS manual control bypasses the protection and safety monitoring system cabinets." This comment resulted from the review of DCD Tier 2, Section 7.7.1.11. This was Open Item 14.3.3-2 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.1-4, as suggested by the staff. The staff has verified that the information is included in the DCD. Therefore, Open Item 14.3.3-2 is resolved.

- Open Item 14.3.3-3: The applicant should modify DCD Tier 1, Section 2.5.1, design description Item 3.e to include, "the DAS uses sensors that are separate from those being used by the PMS [protection and safety monitoring system] and the plant control system." This comment resulted from the review of DCD Tier 2, Section 7.7.1.11. This was Open Item 14.3.3-3 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Section 2.5.1, Item 3.e and DCD Tier 1, Table 2.5.1-4, as suggested by the staff. The staff has verified that the information is included in the DCD. Therefore, Open Item 14.3.3-3 is resolved.

- Open Item 14.3.3-4: The applicant should modify DCD Tier 1, Section 2.5.2, "Protection and Safety Monitoring System," DCD Tier 1, Table 2.5.2-1 and DCD Tier 1, Figure 2.5.2-1, to include "two divisions of safety-related post-accident parameter displays" for consistency with the DCD Tier 1, Section 2.5.2, design description. This was Open Item 14.3.3-4 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.2-1, to include, "MCR safety-related displays, Division B and Division C." DCD Tier 1, Figure 2.5.2-1 does not require revision because the box labeled "Safety-Related Displays and Indications," already includes this information. The staff has verified that DCD Tier 1, Table 2.5.2-1 was revised to include the information. Therefore, Open Item 14.3.3-4 is resolved.

- Open Item 14.3.3-5: DCD Tier 1, Table 2.5.2-4, "PMS Manually Actuated Functions," is not consistent with the information provided in DCD Tier 2, Table 7.2-4, "System-Level Manual Inputs to the Reactor Trip Functions," and DCD Tier 2, Table 7.3-3, "System-Level Manual Inputs to the ESFAS." The applicant should modify DCD Tier 1, Section 2.5.2 design description Item 6.c to clarify that the functions listed in DCD Tier 1, Table 2.5.2-4 are based on minimum inventory requirements. This was Open Item 14.3.3-5 in the DSER.

  By letters dated June 23 and July 31, 2003, the applicant submitted responses to the above open item. The applicant noted that the functions listed in DCD Tier 1, Table 2.5.2-4, are not based on minimum inventory requirements. DCD Tier 2, Section 14.3.2.1, describes the Tier 1 selection (i.e., screening) criteria. Based on the criteria that "only the information from the Tier 2 material that is most significant to safety" are included in certified design descriptions, the PMS includes the manual actuation of safety functions as a top-level function. DCD Tier 1, Table 2.5.2-4 includes the specific manual actuation functions. The PMS block and interlock functions are also important, but somewhat less important than the manual actuation of the safety functions. Therefore, DCD Tier 1, Section 2.5.2 design description, Item 9, and DCD Tier 1, Tables 2.5.2-6 and 2.5.2-7 include the automatic features of these blocks and interlocks, but do not specify the details of the operator (manual) interface. Tier 1 does not discuss the reactor trip reset because the important aspect of the reactor trip function is how the reactor is tripped, not how it is reset. The staff agrees with the applicant's justification. The staff has verified that the applicant included this information in DCD Tier 1, Table 2.5.2-4. Therefore, Open Item 14.3.3-5 is resolved.

- Open Item 14.3.3-6: The applicant should modify DCD Tier 1, Section 2.5.2 design description Item 8.b to clarify that the multiple transfer switches implement the control transfer function. Each individual transfer switch is associated with only a single safety-related or single non-safety-related group. The ITAAC table should reflect this feature. This was Open Item 14.3.3-6 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Section 2.5.2 design description Item 8.b and DCD Tier 1, Table 2.5.2-8, as suggested by the staff. The staff has verified that the information is included in the DCD Tier 1, Section 2.5.2. Therefore, Open Item 14.3.3-6 is resolved.

- Open Item 14.3.3-7: The applicant should modify DCD Tier 1, Table 2.5.2-7, "PMS Interlocks," to include "Interlocks for the Accumulator Isolation Valves and IRWST Discharge Valve," for consistency with DCD Tier 2, Section 7.6.2.3, "Interlocks for the Accumulator Isolation Valve and IRWST Discharge Valve." This was Open Item 14.3.3-7 in the DSER.

  By letters dated June 23 and July 31, 2003, the applicant submitted responses to the above open item and noted that the interlocks for the accumulator isolation valve and IRWST discharge valve are not PMS functions. Therefore, the PMS ITAAC (DCD

Tier 1, Table 2.5.2-7) does not include them. DCD Tier 2, Section 7.6.2.3, describes this interlock. As stated in the last sentence of this section, the plant control system provides the confirmatory open and automatic open signals. This function should not be added to the Tier 1 requirements for the plant control system. AP1000 TS LCOs 3.5.1, 3.5.6, and 3.5.7 included in DCD Tier 2, Section 16.1, provide the function of assuring that these valves are open whenever these injection paths are required. The staff finds the above clarification acceptable; therefore, Open Item 14.3.3-7 is resolved.

- Open Item 14.3.3-8: The applicant should modify DCD Tier 1, Table 2.5.2-6, "PMS Blocks," to include (1) block automatic rod withdrawal (P-17), and (2) block automatic safeguards (P-4). This comment resulted from the review of the DCD Tier 2, Table 7.2-3, "Reactor Trip Permissives and Interlocks," and DCD Tier 2, Table 7.3-2, "Interlocks for Engineered Safety Features Actuation System." This was Open Item 14.3.3-8 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.2-6, as suggested by the staff. The staff has verified that the information is included in DCD Tier 1, Table 2.5.2-6. Therefore, Open Item 14.3.3-8 is resolved.

- Open Item 14.3.3-9: In DCD Tier 1, Table 2.5.2-8, Item 7.c columns do not have sufficient criteria to verify that they meet the design commitment. Removal of power of non-safety components and review of gateway filtering is not enough. The language should be consistent with the acceptance criteria for other ITAACs in this section, such as Items 7.a and 7.b. The applicant should prepare a report about the major design considerations, such as quality of components, performance requirements, reliability, control access, single-failure criterion, independence, failure modes, testing, and electromagnetic interference/radio frequency interference (EMI/RFI) susceptibility. SRP Section 7.9 (data communications) may be used as guidance. This was Open Item 14.3.3-9 in the DSER.

  By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.2-8, Item 7.c to be consistent with Items 7.a and 7.b. The applicant appropriately identified sufficient criteria to verify that the data communication between safety and non-safety systems does not inhibit the performance of the safety function. The staff finds DCD Tier 1, Table 2.5.2-8, Item 7.c, as revised, to be acceptable. Therefore, Open Item 14.3.3-9 is resolved.

- Open Item 14.3.3-10: The DCD Tier 1, Table 2.5.2-8, ITAAC Item 7.d columns may not be sufficient to verify the design commitment, especially the terminology "non-Class 1E controls" in the performance of the operational tests. The language should be similar to other ITAACs in DCD Tier 1, Section 2.5.2, such as Items 7.a and 7.b. The applicant should prepare a report about the verification process to ensure that no potential signal from the non-safety system will prevent the PMS from performing its safety function. This was Open Item 14.3.3-10 in the DSER.

By letter dated June 23, 2003, the applicant submitted a response to the above open item and agreed to revise DCD Tier 1, Table 2.5.2-8, Item 7.d, to be consistent with Items 7.a and 7.b. The applicant appropriately identified sufficient criteria to verify that the Class 1E manual controls and automatic safety functions both have priority over non-Class 1E soft controls. The staff finds DCD Tier 1, Table 2.5.2-8, Item 7.d, as revised, to be acceptable. Therefore, Open Item 14.3.3-10 is resolved.

14.3.3.2 Human Factors Engineering

The applicant used DAC for human factors engineering (HFE) of the MCR and remote shutdown room (RSR), which is similar to its approach for the AP600 design. As discussed in Section 18.1.3 of this report, the staff reviewed the applicant's HFE elements at programmatic, implementation plan, and complete element review levels. Each level of review is associated with different DAC commitments. At the programmatic level, the DAC should include a commitment to (1) develop a detailed implementation plan and (2) complete the implementation plan and provide results to the NRC. At the implementation plan level, the DAC should include a commitment to complete the implementation plan and provide results to the staff. The staff has completed its review of DCD Tier 1, Section 3.2, "Human Factors Engineering." In its review, several issues were identified as open and confirmatory items in the DSER. The following describes the resolution of these open and confirmatory items

- Open Item 14.3.3-11: DCD Tier 1, Table 3.2-1, Item 3, acceptance criteria should include "man-in-the loop engineering test reports" as a last criterion and one of the documents to indicate that the design of the operation and control centers system conforms with the implementation plan. This was Open Item 14.3.3-11 in the DSER.

  The applicant satisfactorily addressed this open item in the DCD by including this criterion. Therefore, Open Item 14.3.3-11 is resolved.

- Open Item 14.3.3-12: The applicant should modify DCD Tier 1, Table 3.2-1, Item 4, acceptance criteria to indicate that the verification and validation implementation plan includes the following activities (terminology to be consistent with NUREG-0711, Revision 1):

  - operational conditions sampling
  - design verification (HSI task support verification and HFE design verification)
  - integrated system validation
  - human engineering discrepancy resolution
  - plant HFE/HSI (as designed at the time of plant startup) verification

  This was Open Item 14.3.3-12 in the DSER.

  In its July 1, 2003, response to open items, the applicant indicated that it would revise WCAP-15860, Section 4.6, to address the above open item. The applicant submitted WCAP-15860, Revision 1, dated August 25, 2003, but it did not address this open item. By letter dated October 16, 2003, the applicant submitted WCAP-15860, Revision 2, which revised Section 4.6, “Criteria for Selection of Test Scenarios for Dynamic Evaluations,” to address this open item. WCAP-15860, Revision 2, satisfactorily addressed the NUREG-0711 criteria. Therefore, Open Item 14.3.3-12 is resolved.

- Open Item 14.3.3-13: DCD Tier 1, Table 3.2-1, Item 5, design commitment should be changed to indicate that the verification and validation implementation plan includes the following activities (terminology to be consistent with NUREG-0711, Revision 1):

  - operational conditions sampling
  - design verification (HSI task support verification and HFE design verification)
  - integrated system validation
  - human engineering discrepancy resolution
  - plant HFE/HSI (as designed at the time of plant startup) verification

  This was Open Item 14.3.3-13 in the DSER.

  In its July 1, 2003, response, the applicant satisfactorily addressed this open item by explaining that although DCD Tier 1, Table 3.2-1, “Design Commitment,” statement 5, terminology differs from the terminology in NUREG-0711, Revision 1, the content and meaning remain the same and the current terminology is used to maintain consistency within the AP1000 DCD. The staff agrees with the applicant’s response. Therefore, Open Item 14.3.3-13 is resolved.

- Open Item 14.3.3-14: The applicant should modify the acceptance criteria in DCD Tier 1, Table 3.2-1, Item 5, to include a new Item (a) to indicate that, “(a) Operational Conditions Sampling was conducted in accordance with the implementation plan,” and re-letter the remaining criteria. This was Open Item 14.3.3-14 in the DSER.

  In its July 1, 2003, response to open items, the applicant satisfactorily addressed part of this open item by explaining that although DCD Tier 1, Table 3.2-1, Item 5, terminology differs from the terminology in NUREG-0711, Revision 1, the content and meaning remain the same and the current terminology is used to maintain consistency within the AP1000 DCD. However, the applicant did not revise WCAP-15860 to address this open item as indicated in its July 1, 2003, response. Therefore, Open Item 14.3.3-14 remained open.

  By letter dated October 16, 2003, the applicant submitted WCAP-15860, Revision 2, which revised Section 4.6, “Criteria for Selection of Test Scenarios for Dynamic Evaluations,” to address this open item. WCAP-15860, Revision 2, satisfactorily addressed the NUREG-0711 criteria. Therefore, Open Item 14.3.3-14 is resolved.

- Open Item 14.3.3-15: The applicant should modify the inspections, tests and analyses of DCD Tier 1, Table 3.2-1, Item (d), to replace “design issues resolution” with “human engineering discrepancy resolution.” This was Open Item 14.3.3-15 in the DSER.

In its July 1, 2003, response to open items, the applicant indicated that it would revise WCAP-15860 to address this open item. However, WCAP-15860, Revision 1, dated August 25, 2003, did not address this open item. Therefore, Open Item 14.3.3-15 remained open.

By letter dated October 16, 2003, the applicant submitted WCAP-15860, Revision 2, which revised Section 5, "Issue Resolution Verification," to address this open item by clarifying that human engineering discrepancies (HEDs) would be tracked and resolved as part of the issue resolution verification process. WCAP-15860, Revision 2, satisfactorily addressed the NUREG-0711 criteria. Therefore, Open Item 14.3.3-15 is resolved.

- Open Item 14.3.3-16: The applicant should modify the acceptance criteria in DCD Tier 1, Table 3.2-1, Item (d) to, "human engineering discrepancy resolution verification was conducted in accordance with the implementation plan and includes verification that human factors issues that were documented in the design issues tracking system and human engineering discrepancies that were identified in the design process have been addressed in the final design." This was Open Item 14.3.3-16 in the DSER.

  In its July 1, 2003, response to open items, the applicant satisfactorily addressed part of this open item by explaining that although DCD Tier 1, Table 3.2-1, Item 5, terminology differs from the terminology in NUREG-0711, Revision 1, the content and meaning remain the same and the current terminology is used to maintain consistency within the AP1000 DCD. However, the applicant did not revise WCAP-15860 to address this open item as indicated in its July 1, 2003, response. Therefore, Open Item 14.3.3-16 remained open.

  By letter dated October 16, 2003, the applicant submitted WCAP-15860, Revision 2, which revised Section 5, "Issue Resolution Verification," to address this open item by clarifying that HEDs would be tracked and resolved as part of the issue resolution verification process. WCAP-15860, Revision 2, satisfactorily addressed the NUREG-0711 criteria. Therefore, Open Item 14.3.3-16 is resolved.

- Open Item 14.3.3-17: DCD Tier 1, Table 3.2-1, Items 7.iii and 7.iv acceptance criteria do not relate to the provision of a suitable work space environment for MCR operators. Nothing in DCD Tier 1, Section 2.6.3, evaluates the adequacy/effectiveness/suitability of illumination levels for the facility or the workstations in the facilities. As part of evaluating a suitable work space environment for the MCR and RSR, the applicant should assess auditory levels (noise) as well. This comment also applies to Table 3.2-1, Item 10.ii acceptance criterion. This was Open Item 14.3.3-17 in the DSER.

  The applicant satisfactorily addressed this open item by making changes to DCD Tier 1, Section 2.6.5, and DCD Tier 2, Sections 9.4.1.1.2, 9.5.3.2.1, and 9.5.3.2.2. Therefore, Open Item 14.3.3-17 is resolved.

- <u>Open Item 14.3.3-18</u>: With regard to DCD Tier 1, Table 3.2-1, Item 10.i, DCD Tier 1, Section 2.7.1 does not have ITAAC related to RSR. In addition, there is no ITAAC that requires inspection, test, and analyses for the RSR and ventilation. The staff asked the applicant for clarification. This was Open Item 14.3.3-18 in the DSER.

  The applicant satisfactorily address this open item by making changes to DCD Tier 1, Section 2.7.1 and DCD Tier 1, Figure 2.7.1-1. Therefore, Open Item 14.3.3-18 is resolved.

- <u>Confirmatory Item 14.3.3-1</u>: The staff found typographical errors throughout the ITAAC. For example, the abbreviation, “HIS” should be replaced with “HSI.” This was Confirmatory Item 14.3.3-1 in the DSER.

  The applicant satisfactorily addressed this confirmatory item by making the appropriate abbreviation changes. Therefore, Confirmatory Item 14.3.3-1 is resolved.

14.3.3.3 <u>Piping Design</u>

In the piping design area, the applicant used a different approach for AP1000 than it used in AP600. In AP600, the applicant essentially completed the piping design. The applicant developed the ITAAC for the AP600 design to provide reasonable assurance that the as-installed piping would meet its certified design requirements. Each AP600 system-based design description involving safety-related piping incorporated the ITAAC. However, for the AP1000, the applicant does not plan to complete the piping design prior to design certification. Instead, the applicant proposes to use DAC for piping design similar to their use in the evolutionary plants (i.e., ABWR and System 80+).

While piping DAC are established as a part of the certified plant design, the COL applicant will complete, in conjunction with its COL application, the overall piping design, including piping stress analyses, pipe support design, the effects of high-energy line breaks, and the application of leak-before-break (LBB). The COL applicant will also verify the piping design using ITAAC during plant construction. The as-built piping system is required, through the piping ITAAC, to be reconciled with the AP1000 design commitments. The applicant designated the supporting information for the piping DAC as Tier 2* information in the AP1000 Tier 2, information. Section 3.12 of this report discusses in detail the acceptability of the piping DAC, including the analysis methods and design criteria to be used by a COL applicant or licensee to complete the AP1000 piping design.

In SECY-02-0059, the staff identified an issue to the Commission regarding the applicant’s proposed use of piping DAC, which differs from the approach used in previous design certification applications. The applicant proposed to provide, as part of a COL application that references the AP1000 design, its analyses for piping design using an LBB approach. In previous design certification reviews, the applicants provided, as a part of design certification, their bounding piping analyses in which an LBB approach was used. However, the applicant proposes to establish bounding curves at the design certification phase, and will provide an evaluation of LBB piping at the COL phase. This approach is not consistent with Commission policy. Without performing an evaluation of the LBB bounding curves using preliminary analysis results at the design certification stage, the question of whether sufficient margin exists in the piping to demonstrate that the probability of pipe rupture is extremely low would remain unresolved. Thus, the design certification review might not assure the finality of design. This was Open Item 14.3.3-19 in the DSER.

In Section 3.6.3.5 of this report, the staff discusses the applicant’s revised approach that would provide reasonable assurance at the design certification stage that the LBB piping systems will have sufficient margin to meet the LBB bounding analysis curves (BACs) and, thus, ensure successful completion of the ITAAC at the COL stage. As discussed in Section 3.6.3.5 of this report, the applicant completed an LBB evaluation for a candidate AP1000 LBB piping system using AP1000 piping stress analysis results. The applicant also provided the staff with an assessment of the other LBB candidate piping subsystems that provided reasonable assurance that these other LBB candidate piping subsystems will be able to meet their respective BACs when the final piping design and stress analyses are completed by the COL applicant. The staff evaluated the preliminary piping design and LBB analyses performed by the applicant to address Open Item 3.6.3.4-2. The staff concludes, on the basis of these analyses and assessments, that the LBB piping systems contained sufficient margin to demonstrate that the ITAAC associated with LBB can be met at the COL stage. Thus, the probability of pipe ruptures for the AP1000 LBB candidate piping subsystems is extremely low under conditions consistent with the design bases for these piping subsystems (see Section 3.6.3.5 of this report). Therefore, as Open Item 3.6.3.4-2, which encompassed the staff's concern with the applicant's LBB approach, is resolved, Open Item 14.3.3-19, is also resolved.

The use of DAC for piping in the AP1000 does not affect the application of piping ITAAC because in either case (whether DAC is or is not used), completion of the piping design must occur prior to construction of the standard plant. The application of the piping ITAAC will occur after the piping design is completed. Each system-based design description involving safety-related piping also includes the piping ITAAC for the AP1000. The piping ITAAC for the AP1000 are the same as the piping ITAAC for the AP600. For the AP1000, Tier 1 piping DAC are described and repeated in each system where piping ITAAC apply. The first column of the ITAAC (i.e., design commitment) provides the Tier 1 piping DAC. The design commitments related to piping design include the following:

- The components identified in Table [w.x.y-z] as ASME Code Section III are designed and constructed in accordance with ASME Code Section III requirements.

- Pressure boundary welds in piping identified in Table [w.x.y-z] as ASME Code Section III meet ASME Code Section III requirements.

- The components identified in Table [w.x.y-z] as ASME Code Section III retain their pressure boundary integrity at their design pressure.

- Each of the lines identified in Table [w.x.y-z] for which functional capability is necessary is designed to withstand combined normal and seismic design basis loads without a loss of functional capability.

- Each of the as-built lines identified in Table [w.x.y-z] as designed for LBB meets the LBB criteria, or an evaluation is performed of the protection from the dynamic effects of a rupture of the line.

The above items are the piping design criteria appropriate as Tier 1 design commitments. The Tier 1 piping DAC address the piping design requirements in 10 CFR 50.55a and GDC 2 and 4 of Appendix A to 10 CFR Part 50. The acceptability of piping DAC is evaluated in Section 3.12 of this report.

14.3.4 Other Tier 1 Information

The applicant provided other Tier 1 information, such as definitions, general provisions, interface requirements, and site parameters. The evolutionary designs used similar information except for the basic configuration inspection (see discussion below). The applicant did not identify any significant interface requirements for the AP1000 design because of design features in the standard plant.

Both evolutionary designs used “verifications for basic configuration for systems.” This verification process consisted of an inspection of the system functional arrangement in its final as-built condition at the plant site and included four other elements (e.g., dynamic and environmental qualification). The applicant adopted a “functional arrangement” inspection but assigned verification of the other four elements to individual ITAAC, as appropriate. For the evolutionary and AP600 designs, this functional arrangement inspection verifies that the as-built facility conforms to the approved design and applicable regulations by using as-built drawings, design documentation, and in situ plant walkdowns. The applicant’s approach meets the intent of the basic configuration ITAAC, as described in Appendix D to draft SRP 14.3, because the four elements are verified in the individual ITAAC. Therefore, the staff finds it to be acceptable.

Many of the acceptance criteria in the ITAAC tables use the phrase “A report exists and concludes that ...” When this phrase was used for the evolutionary designs, a description of the report was provided in the Tier 2 information. Westinghouse has adopted a broader usage of this phrase and agreed, in a public meeting on July 10, 2003, to provide an explanation of its usage in the General Provisions section of Tier 1. Also, many entries in the inspections, tests, analyses column of the ITAAC tables use the phrase “Inspection will be performed for the existence of a report ... “In a telephone conference call held on August 19, 2003, Westinghouse agreed to provide an explanation of this phrase in the General Provisions section of Tier 1. Finally, during the same conference call, the NRC staff stated that “many ITAAC are only a reference to another Tier 1 location.” The applicant agreed to provide an explanation of the phrase “See Tier 1 Material ... “in the General Provisions section of Tier 1. The staff has reviewed all of the additional explanations provided in a revision to the General Provisions section of DCD Tier 1, found that they adequately explain how to use the AP1000 ITAAC and are, therefore, acceptable.

Initially, control room relative concentration (χ/Q) values were not provided in DCD Tier 1, Table 5.0-1. As noted in Section 2.3.4 of this report, the COL applicant would have to assess the impact of design-specific information on the control room χ/Q values. This was Open Item 14.3.4-1 in the DSER.

Following discussions between the NRC staff and the AP1000 applicant, the control room χ/Q values were provided in DCD Tier 2, Tables 2-1 and 15A-6, and DCD Tier 1, Table 5.0-1, as well as design-specific information in DCD Tier 2, Table 15A-7 and Figure 15A-1. The information provided by the applicant addresses the issues raised by the staff. Therefore, Open Item 14.3.4-1 is resolved.

14.4 Combined License Applicant Responsibilities

In DCD Tier 2, Section 14.4, "Combined License Applicant Responsibilities," Westinghouse describes the following COL action items (note that the NRC staff action item number follows each Westinghouse item):

- The specific staff, staff responsibilities, authorities and personnel qualifications for performing the AP1000 initial test program are the responsibility of the Combined License applicant. This test organization is responsible for the planning, executing, and documenting of the plant initial testing and related activities that occur between the completion of plant/system/component construction and commencement of plant commercial operation. Transfer and retention of experience and knowledge gained during initial testing for the subsequent commercial operation of the plant is an objective of the test program. [This is COL Action Item 14.4-1.]

- The Combined License applicant is responsible for providing test specifications and test procedures for the preoperational and startup tests, as identified in [DCD Tier 2, Section] 14.2.3, for review by the NRC. [This is COL Action Item 14.4-2.]

- The Combined License application is responsible for a startup administration manual (procedure) which contains the administration procedures and requirements that govern the activities associated with the plant initial test program, as identified in [DCD Tier 2, Section] 14.2.3. [This is COL Action Item 14.4-3.]

- The Combined License applicant or holder is responsible for review and evaluation of individual test results. Test exceptions or results which do not meet acceptance criteria are identified to the affected and responsible design organizations, and corrective actions and retests, as required, are performed. [This is COL Action Item 14.4-4.]

- The Combined License applicant is responsible for testing that may be required of structures and systems which are outside the scope of the design certification. The interfacing systems to be considered for testing are taken from [DCD Tier 2,] Table 1.8-1 and include as a minimum, the following:

- storm drains
- site specific seismic monitors
- offsite ac power systems
- circulating water heat sink
- raw and sanitary water systems
- individual equipment associated with the fire brigade
- portable personnel monitors and radiation survey instruments
- equipment associated with the physical security plan

[This is COL Action Item 14.4-5.]

- [*The COL applicant or holder for the first plant and the first three plants will perform the tests listed in [DCD Tier 2, Section] 14.2.5. For subsequent plants, the COL applicant or licensee shall either perform the tests listed in [DCD Tier 2, Section] 14.2.5, or shall provide a justification that the results of the first-plant-only tests or first-three-plant tests are applicable to the subsequent plant*.]* [This is COL Action Item 14.4-6.]