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NSD-NRC-97-5174
DCP/NRC0907
Docket No.: STN-52-003

June 11, 1997

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: WESTINGHOUSE RESPONSES TO NRC FOLLOWON QUESTIONS REGARDING THE AP600 INITIAL TEST PROGRAM (ITP)

Dear Mr. Quay:

Enclosed are the Westinghouse responses for additional information from the Containment Systems and Severe Accident Branch, relating to the AP600 Initial Test Program (ITP) as requested in your letter of May 14, 1997 from Mr. Joseph M. Sebrosky of your staff.

Enclosure 1 to this letter contains the followon RAI's related to ITP in your May 14, 1997 letter and Westinghouse's responses to close RAIs 260.118 through 260.137. (Responses to RAIs 260.138 and 260.139 are still being prepared.) Enclosure 2 contains the proposed SSAR changes to Chapter 14 resulting from these RAIs. Additions to the SSAR are shown in italics; deletions are shown with a strikeout line. Note that these proposed SSAR changes to Chapter 14 include testing related to design changes incorporated for post-72 hour functions in subsections 14.2.9.2.7, Spent Fuel Pool Cooling System Testing; 14.2.9.1.16, Long-Term Safety-Related System Support Testing; and 14.9.2.1.3, Passive Core Cooling System Testing. Enclosure 3 to this letter is subsection 14.2.9.2.4, Normal Residual Heat Removal System which has been revised to include testing to remove heat from the spent fuel pool; and subsection 14.2.9.1.4, Passive Core Cooling System Testing which has been revised to include testing of the IRWST gutter isolation valve controls.

Westinghouse requests the staff review these responses and inform Westinghouse of their status to be designated in the "NRC Status" column of the OITS. We suggest "Action N".

Westinghouse requests you provide any comments on these responses as soon as possible so that the milestones to SECY-97-051 can be met.

Please contact Eugene J. Piplica on (412) 374-5310 if you have any questions concerning this transmittal.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/ea

Enclosures 040102

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cc: W. C. Huffman, NRC (5E1, 5E2, 5E3)
N. J. Liparulo, Westinghouse (w/o Enclosures)

Enclosure 1

NSD-NRC-97-5174
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Question 260.118 (OITS 5296)

Re:

NRC Letter May 14, 1997 - The following is a general comment on Section 14.2.9.1.4. The purpose of the testing in this section is stated in terms of the safety-related function "to transfer heat from inside containment to the environment".

Additional testing objectives need to be incorporated into the Initial Test Program (ITP) to validate the expected PCS wetting characteristics. Additional testing objectives need to be incorporated into the ITP to validate the overall heat transfer characteristics used in the design basis accident evaluation model which are dependent on the as-built structures. (RAIs 260.119 through 260.130 are specific examples of the above general comment).

Response:

The response to RAIs 260.119 through 260.130 address the specific aspects of this general comment.

SSAR Revision: NONE

Question 260.119 (OITS 5297)

Re:

NRC Letter May 14, 1997 - The testing purpose needs to be expanded. It needs to be clear that there are distinct periods (three) of flow which need to be evaluated as well as the period of performance, 72 hours.

Response:

Item (c) has been clarified that testing will be conducted to cover the entire range of expected PCCS flow rates.

SSAR Revision: See attached Section 14.2.9.1.4, Passive Containment Cooling System Testing

Question 260.120 (OITS 5298)

Re:

NRC Letter May 14, 1997 - The passive containment cooling system water storage tank (PCCWST) is now also used as a safety-related makeup source for the spent fuel pool (see SSAR Section 6.2.2, Revision 11, February 28, 1997, page 6.2-21). This should be stated under Purpose, as is the fire protection function. Also, the description of the new, isolated fire protection tank within the PCCWST should be provided. Appropriate testing for the spent fuel pool makeup function needs to be developed and referenced in the Initial Test Program.

Response:

Testing of the passive containment cooling system, spent fuel pool cooling, and long-term safety system support has been modified to appropriately reflect the new NRC criteria regarding post-72 hour operations.

SSAR Revision:

See attached Sections 14.2.9.1.4, 14.2.9.2.7, and 14.2.9.1.16, Passive Containment Cooling System Testing, Spent Fuel Pool Cooling System Testing, and Long-Term Safety System Support Testing.

Question 260.121 (OITS 5299)

Re:

NRC Letter May 14, 1997 - Under prerequisites, the quantity of water available in the PCCWST needs to reflect an amount sufficient to demonstrate that at the minimum level (volume) specified in the technical specifications, the PCS will provide at least 72 hours of continuous cooling water.

Response:

The prerequisites state the requirements for the ability to fill the tank. Item (c) of the passive containment cooling system testing will be modified to include a test to show that the tank has sufficient capacity to last 72 hours.

SSAR Revision:

See attached Section 14.2.9.1.4, Passive Containment Cooling System Testing.

Question 260.122 (OITS 5300)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, the reference to Section 6.2 should be limited to Section 6.2.2, "Passive Containment Cooling System," only. This test does not cover the other sections.

Response:

The comment will be incorporated.

SSAR Revision:

See attached Section 14.2.9.1.4, Passive Containment Cooling System Testing.

Question 260.123 (OITS 5301)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, the reference to "appropriate design specifications" is unacceptable. SSAR Section 6.2.2, specifically Section 6.2.2.2.4, "System Operation," needs to identify the relevant design specifications which are directly verified by test. At a minimum these include, for each flow phase:

a. The minimum acceptable flow rate for each flow phase, as measured just prior to the uncovery of each stand pipe.

b. The minimum acceptable water coverage area on the vessel side wall near the upper annulus drain elevation for each flow phase, and the uniformity of the coverage around the circumference of the vessel.

c. The time period for each flow phase, which considers the design objective of providing cooling water for a period of at least 72 hours in three flow phases to account for the reduction in the amount of heat to be removed during each phase.

Response:

As section 14.3 requires the AP600 design team to provide a scoping document that defines the applicable design requirements that must be validated, the use of "relevant" or "applicable" design specifications for a reference for more detailed design criteria for the acceptability of preoperational testing is warranted and has precedence in earlier standard submittals (i.e. CEESSAR System 80+ and GE ABWR).

a. SSAR section 6.2.2 has been modified to include these flow rates.

b. SSAR section 6.2.2 has been modified to specify the minimum acceptable coverage under the third phase of operation.

c. SSAR section 6.2.2 has been modified to include the flow profile for PCS operation which will provide the timing information requested.

SSAR Revision:

See Revision 13 of AP600 SSAR.

Question 260.124 (OITS 5302)

Re:

NRC Letter May 14, 1997 - Heat removal requires an adequate water film on the vessel exterior surface (sufficiently thick to assure stability based on the design basis accident evaluation model), as noted in SSAR Section 6.2.2.2.4. A non-invasive method for approximating the film thickness during each flow phase needs to be included in the Initial Test Program. Based on the known water delivery flow rate and the water coverage area, near the upper annulus drains, a method which measures the time for "a water particle" to travel from the vessel spring line to the upper annulus drain can be used to estimate the average film thickness over the covered vessel side wall.

Response:

The key parameters associated with proper PCS operation are total water flow and containment surface area coverage, which are thoroughly tested for as part of the ITP. Provided that these parameters can be verified, the actual water film thickness need not be tested.

SSAR Revision: NONE

Question 260.125 (OITS 5303)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, c), references to item a. and c. under RAI 260.123 need to be incorporated.

Response:

See the responses to items 260.119 and 260.123.

SSAR Revision: NONE

Question 260.126 (OITS 5304)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, c), the text refers to the PCCWST "drain" flowpath. SSAR Section 6.2.2 refers to the PCCWST "outlet" piping or "discharge" piping. In other descriptions, for example the technical specifications, references are made to the PCCWST "delivery" flowpath [piping]. There needs to be one term which is consistently used to identify the PCS piping which provides the cooling water to the distribution bucket.

Response:

This SSAR has been revised to use the term "delivery flowpath" to refer to the PCCWST discharge piping.

SSAR Revision:

See Revision 13 of AP600 SSAR and attached section 14.2.9.1.4, Passive Containment Cooling Water System Testing.

Question 260.127 (OITS 5305)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, d), reference to item b. under RAI 260.123 needs to be incorporated.

Response:

This comment will be incorporated, consistent with the response to RAI 260.123.

SSAR Revision: NONE

Question 260.128 (OITS 5306)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, d), in addition to verifying the uniformity of the wetted surface (proper operation of the water distribution bucket and weirs), an estimation of the water film thickness needs to be incorporated, as discussed in RAI 260.124.

Response:

See the response to RAI 260.124.

SSAR Revision: NONE

Question 260.129 (OITS 5307)

Re:

NRC Letter May 14, 1997 - Under General Test Acceptance Criteria and Methods, b), reference is made to features and equipment not identified in Section 6.2.2 of the SSAR. These features need to be included in the SSAR description:

a. Diverse actuation signals, those in addition to the Hi-2 containment pressure signal, need to be included in SSAR Section 6.2.2.1. Alternatively, the Initial Test Program description would have to specifically address SSAR Section 7.3 to identify the appropriate features of the PCS actuation system that are covered by the testing.

b. The shield plate which protects the distribution bucket.

Response:

a. Item (b) of test abstract 14.9.2.1.4 addresses the testing of system interlocks including PMS and DAS. References to these SSAR sections will be incorporated.

b. The shield plate does not perform a passive containment cooling system function and therefore is not discussed in Section 6.2. This plate serves as a shield for radiation from the containment and is shown in the generai arrangement drawings in Section 1.2 and will be shown in Figure 3.8.4-7 in the Rev. 14 issue of the SSAR.

SSAR Revision:

See attached Section 14.2.9.1.4, Passive Containment Cooling System Testing

Question 260.130 (OITS 5308)

Re:

NRC Letter May 14, 1997 - An additional test objective needs to be developed that will provide an estimate of the overall heat transfer process during the testing of the PCS. Consideration should be given to performing the test with a sufficient temperature difference between the PCCWST water temperature and the internal containment temperature to observe and measure containment cooldown. With no steam inside containment, this test will validate the overall thermal resistance of the vessel wall and its inorganic zinc coatings used in the design basis accident evaluation model. These data should, if practical, be obtained in conjunction with General Test Acceptance Criteria and Methods, f) which provides information on the exterior boundary of the PCS (air flow rates and temperatures).

Response:

An additional test will be incorporated to require sample coupons from the containment shell to be laboratory tested to determine its conductivity with and without an appropriate coating of paint.

SSAR Revision:

See attached Section 14.2.9.1.4, Passive Containment Cooling System Testing

Question 260.131 (OITS 5309)

Re:

NRC Letter May 14, 1997 - Is the preoperational test in 13.2.9.1.10 separate and distinct from the ASME Containment Structural Acceptance Test? Is it performed after the ASME Containment Structural Acceptance Test? If this is the case, it should be clarified in Section 14.2.9.1.10.

Response:

Section 14.2.9.1.10 will be clarified. The ASME Containment Structural Acceptance Test specified in Section 3.8.2.7 is a construction test and is separate from the testing specified in this section.

SSAR Revision:

See attached Section 14.2.9.1.10, Containment Isolation and Leak Rate Testing.

Question 260.132 (OITS 5310)

Re:

NRC Letter May 14, 1997 - A requirement to verify that isolation valve divisional assignments for instrumentation and actuation circuits are correct should be included. Also, instrumentation logic and remote manual operation capability should be verified.

Response:

Verification that isolation valve divisional assignments for instrumentation and actuation circuits are correct is included under Section 14.2.9.1.14 Class 1E DC Power and Uninterruptible Power Supply Testing

SSAR Revision: NONE

Question 260.133 (OITS 5311)

Re:

NRC Letter May 14, 1997 - Fail-open and fail-close valve motions should be verified.

Response:

This testing is performed under item (a). Inservice testing requirements include fail-safe testing of safety-related valves.

SSAR Revision: NONE

Question 260.134 (OITS 5312)

Re:

NRC Letter May 14, 1997 - Stroke-times should be verified.

Response:

This testing is performed under item (a). Inservice testing requirements include stroke testing of safety-related valves.

SSAR Revision: NONE

Question 260.135 (OITS 5313)

Re:

NRC Letter May 14, 1997 - Plants have used their Type C test procedures for preoperational testing. The test abstract references ANS-56.8-1994 for leakage testing methodology. The 1994 standard is permitted for Option B leakage testing programs to meet the requirements of Appendix J. Option A plants that want to use their Appendix J procedures and methods for preoperational testing have to use the 1972 standard.

Response:

This comment will be incorporated.

SSAR Revision:

See attached Section 14.2.9.1.10, Containment Isolation and Leak Rate Testing.

Question 260.136 (OITS 5314)

Re:

NRC Letter May 14, 1997 - The Purpose and the General Test Acceptance Criteria and Methods sections of 14.2.9.1.11 do not address the nonsafety-related functions described in Section 6.2.4. Specifically, those aspects of the system that have been incorporated to meet the requirements of 10 CFR 50.34(f)(2)(ix) need to be verified by testing. Therefore, this test abstract needs to be modified to include testing that verifies the operability of (1) all sixteen hydrogen sensors in their role of supporting proper actuation and operation of the hydrogen igniters, and (2) the alternative power supplies to the hydrogen igniters.

Response:

This comment will be incorporated.

SSAR Revision:

See attached Section 14.2.9.1.11, Containment Hydrogen Control System Testing.

Question 260.137 (OITS 5315)

Re:

NRC Letter May 14, 1997 - The SSAR does not appear to describe when the hydrogen igniters are to be actuated and how they are to be operated. This information is needed to support test c) under General Test Acceptance Criteria and Methods.

Response:

This comment will be incorporated. The SSAR will be revised accordingly.

SSAR Revision:

See Revision 13 of the AP600 SSAR and attached Section 14.2.9.1.11, Containment Hydrogen Control System

AP600

Enclosure 3

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14.2.9.1.3 Passive Core Cooling System Testing

Purpose

The purpose of the passive core cooling system testing is to verify that the as-installed components and their associated piping and valves properly perform the following safety functions, described in Section 6.3:

- Emergency core decay heat removal
- Reactor coolant system emergency makeup and boration
- Safety injection
- Containment pH control

Prerequisites

The construction testing of the passive core cooling system, or of a specific portion of the system to be tested, is successfully completed. The preoperational testing of the reactor coolant system, normal residual heat removal system, chemical and volume control system, the refueling cavity, the Class 1E dc and uninterruptable power supply, the ac electrical power and distribution systems, and other interfacing systems required for operation of the above systems is completed as needed to support the specified testing and system configurations. A source of water, of a quality acceptable for filling the passive core cooling system components and the reactor coolant system, is available.

General Test Method and Acceptance Criteria

The performance of the passive core cooling system is observed and recorded during a series of individual component testing and testing with the reactor coolant system. The following testing demonstrates that the passive core cooling system operates as described in Section 6.3 and appropriate design specifications.

a) Proper operation of safety-related valves is verified by the performance of baseline in-service tests as described in subsection 3.9.6. Also, the proper operation of non-safety-related valves is verified including manual valve locking devices. This testing does not include actuation of the squib valves, which is discussed in Item t, below.

b) Proper calibration and operation of safety-related instrumentation, controls, actuation signals, and *safety related* interlocks *as specified in section 7.6,* is verified. This testing includes the following:

   - Passive residual heat removal heat exchanger flow
   - Core makeup tank level
   - In-containment refueling water storage tank level
   - Containment floodup level

- Core makeup tank inlet/outlet valve controls
- Passive residual heat removal heat exchanger inlet/outlet valve controls
- In-containment refueling water storage tank outlet valve controls
- Containment recirculation valve controls
- Automatic depressurization valve controls
- *In-containment refueling water storage tank gutter isolation valve controls*

This testing includes demonstration of proper actuation of safety-related functions from the main control room.

c) Proper calibration and operation of instrumentation, controls, and interlocks required to demonstrate readiness of a safety-related component is verified. This testing includes the following:

- Accumulator pressure and level and alarms
- Passive residual heat removal heat exchanger temperatures
- Passive residual heat removal heat exchanger high point vent level
- Core makeup tank inlet line temperatures
- Core makeup tank inlet line high point levels
- Direct vessel injection line temperatures
- In-containment refueling water storage tank *level and* temperatures

d) Proper calibration and operation of temporary instrumentation and data recording devices used in this testing is verified. This testing includes the following:

- CMT level
- CMT flow and balance line temperatures
- PRHR supply line temperatures
- Accumulator wide range level
- In-containment refueling water storage tank and sump-recirculation flow
- ADS piping differential pressure

The passive core cooling system emergency core decay heat removal function is verified by the following testing of the passive residual heat removal heat exchanger.

e) During hot functional testing of the reactor coolant system, the heat exchanger supply and return line piping water temperatures are recorded to verify that natural circulation flow initiates.

f) The heat transfer capability of the passive residual heat removal heat exchanger is verified by measuring natural circulation flow rate and the heat exchanger inlet and outlet temperatures while the reactor coolant system is cooled to ≤ 400°F. This testing is performed during hot functional testing with the reactor coolant system initial temperature ≥ 540°F and the reactor coolant pumps not running.

g) The proper operation of the passive residual heat removal heat exchanger and its heat transfer capability with forced flow is verified by initiating and operating the heat exchanger with all four reactor coolant pumps running. This testing is performed during hot functional testing with the reactor coolant system at an elevated initial temperature between 350°F. and 400°F. The heat exchanger heat transfer is determined by measuring the heat exchanger flow rate and its inlet and outlet temperatures while the reactor coolant system is cooled down.

h) The heatup characteristics of the in-containment refueling water storage tank water are verified by measuring the vertical water temperature gradient that occurs in the in-containment refueling water storage tank water at the passive residual heat removal heat exchanger tube bundle and at several distances from the tube bundle, during testing in Item e), above. **Note that this verification is required only for the first plant.**

The passive core cooling system emergency makeup and boration function is verified by the following testing of the core makeup tanks.

i) The resistance of the core makeup tank cold leg balance lines is determined by filling the core makeup tanks with flow from the cold legs. This testing is performed by filling the cold, depressurized reactor coolant system using a constant, measured discharge flow from the normal residual heat removal pumps. The reactor coolant system is maintained at a constant level above the top of the cold leg balance line(s). The normal residual heat removal system flow rate and the differential pressure across the cold leg balance lines are used to determine the resistance of the balance lines.

j) During hot functional testing of the reactor coolant system, the core makeup tank cold leg balance line piping water temperature at various locations is recorded to verify that the water in this line is sufficiently heated to initiate recirculation flow through the CMTs.

k) Proper operation of the core makeup tanks to perform their reactor water makeup and boration function is verified by initiating recirculation flow through the tanks during hot functional testing with the reactor coolant system at ≥ 530°F. This testing is initiated by simulating a safety signal which opens the tank discharge isolation valves, and stops reactor coolant pumps after the appropriate time delay. The proper tank recirculation flow after the pumps have coasted down is verified. Based on the cold leg temperature, CMT discharge temperature, and temporary CMT flow instrumentation, the net mass injection rate into the reactor is verified. **Note that this verification is required only for the first plant.**

The passive core cooling system safety injection function is verified by the following testing of the core makeup tanks, accumulators, in-containment refueling water storage tank, containment sump, automatic depressurization, and their associated piping and valves.

l) Proper flow resistance of each of the core makeup tank injection lines is verified by gravity draining each tank filled with cold water through the empty direct vessel injection flow path, while measuring the CMT level (driving head) and discharge flow rate. Air enters the top

of the draining tank from the reactor coolant system cold leg via the cold leg balance line. If necessary, the flow limiting orifice in the core makeup tank discharge line is to be resized, and the core makeup tank retested to obtain the required line resistance.

m) The proper flow resistance of each of the accumulator injection lines is verified by performing a blowdown from a partially pressurized accumulator through the empty direct vessel injection flow path, while measuring the change in accumulator level and pressure. If necessary, the flow orifice in the accumulator discharge line is to be resized and the accumulator retested to obtain the required discharge line resistance.

n) The proper flow resistance of each of the in-containment refueling water storage tank injection lines is verified by gravity draining water from the tank through the empty direct vessel injection flow path, while measuring the water level (driving head) and discharge flow rate using temporary instrumentation. If necessary, the flow orifice in the in-containment refueling water storage tank injection line is resized and retested, until the required line resistance is achieved

o) The flow resistance of each of the flow paths from the in-containment refueling water storage tank to each containment sump, and from each containment sump to the reactor is verified by a series of tests. These tests gravity drain water from the in-containment refueling water storage tank to the containment sump, and from the sump through the empty direct vessel injection flow path, while measuring the storage tank water level (driving head) and injection flow rate using temporary instrumentation. This testing is performed using temporary piping to prevent flooding of the containment. A spool piece with prototypical resistance may be used to simulate the squib valves in the flow paths tested.

p) The resistance of each automatic depressurization stage 1, 2, and 3 flowpath and flowpath combination is verified by pumping cold water from the in-containment refueling water storage tank into the cold, depressurized, water-filled reactor coolant system; and back to the in-containment refueling water storage tank using the normal residual heat removal pump(s). The resistances are determined by measuring the residual heat removal pump flow rate and the pressure drop across the flow paths tested using temporary instrumentation.

q) The resistance of each automatic depressurization stage 4 flowpath and their flowpath combinations is verified by pumping cold water from the in-containment refueling water storage tank into the cold, depressurized, water-filled reactor coolant system using the normal residual heat removal pump(s). The resistances are determined by measuring the residual heat removal pump flow rate and the pressure drop across the flow paths tested using temporary instrumentation. The automatic depressurization stage 4 squib valves are not required to be included in this test.

r) The proper operation of the vacuum breakers in the automatic depressurization discharge lines is verified.

s) During hot functional testing of the reactor coolant system, proper operation of automatic depressurization is verified by blowing down the reactor coolant system. This testing verifies proper operation of the stage 1, 2, and 3 components including the ability of the spargers to limit loads imposed on the in-containment refueling water storage tank by the blowdown. Proper operation of the stage 1, 2 and 3 valves is demonstrated during blowdown conditions. **Note that this verification is required only for the first plant.**

t) The proper operation of at least one of each squib valve size and type including a containment recirculation, in-containment refueling water storage tank injection, and a stage 4 automatic depressurization squib valve is demonstrated. The squib valve performance and the flow resistance of the actuated squib valves is compared to the squib valve qualification testing results.

u) The proper operation of the containment sump instrumentation is demonstrated by simulating the containment flood-up water levels.

v) The proper operation of the CMT level instrumentation is demonstrated during the draindown testing of the CMTs, specified in Item l) above.

w) In conjunction with the verification of the core makeup tanks to perform their reactor water makeup function and boration function described in item k) above, the proper operation of the core makeup tanks to transition from their recirculation mode of operation to their draindown mode of operation after heatup will be verified. This testing will also verify the proper operation of the core makeup tank level instrumentation to operate during draining of the heated tank fluid. The in-containment refueling water storage tank initial level is reduced to at least 3 ft. below the spillway level as a prerequisite condition for this testing in order to provide sufficient ullage to accept the mass discharged from the reactor coolant system via the automatic depressurization stage 1.

The recirculation operation in Item k) above, should be continued until the core makeup tank fluid has been heated to ≥ 350°F. The core makeup tank isolation valves are then closed, the reactor coolant pumps are started, and the reactor coolant system is reheated up to hot functional testing conditions. This testing is initiated by shutting off the reactor coolant pumps, opening the core makeup tank isolation valves, and by opening one of the automatic depressurization stage 1 flow paths to the in-containment refueling water storage tank. This will initiate a large loss of mass from the reactor coolant system, depressurization of the reactor coolant system to the bulk fluid saturation pressure, and additional recirculation through the core makeup tank. Core makeup tank draindown initiates in response to the continued depressurization and mass loss from the reactor coolant system. The automatic depressurization stage 1 flow path is closed after the core makeup tank level has decreased below the level at which stage 4 actuation occurs. Note that this verification is required only for the first plant.

14.2.9.2.4 Normal Residual Heat Removal System Testing

Purpose

The purpose of the normal residual heat removal system testing is to verify that the as-installed components and associated piping, valves, and instrumentation properly perform the following defense-in-depth functions, as discussed in Section 5.4:

- Remove reactor core decay heat and cool the reactor coolant system during shutdown operations at low pressure and temperature
- Remove reactor core decay heat from the reactor coolant system during reduced reactor coolant inventory operations in Modes 5 and 6
- Following actuation of the automatic depressurization system, provide makeup to the reactor coolant system at low pressure
- Circulate and cool water from the containment after draindown of the in-containment water storage tank
- Provide low temperature overpressure protection for the reactor coolant system
- *Remove reactor core decay heat and cool the spent fuel pool during refueling operations when the core is off-loaded from the reactor vessel to the spent fuel pool.*

Prerequisites

The construction testing of the normal residual heat removal system is completed. The required preoperational testing of the in-containment refueling water storage tank, reactor coolant system, passive core cooling system, component cooling water system, service water system, ac electrical power and distribution systems, and other interfacing systems required for operation of the above systems and data collection is available as needed to support the specified testing and system configurations. The reactor coolant system and the in-containment refueling water storage tank have an adequate water inventory to support testing.

General Test Acceptance Criteria and Methods

Normal residual heat removal system performance is observed and recorded during a series of individual component and system testing, that characterizes system operation. The following testing verifies that the normal residual heat removal system performs its defense-in-depth functions as described in subsection 5.4.7 and appropriate design specifications:

a) Operation of valves to open, to close, or to control flow as required to perform the above defense-in-depth functions is verified.

b) Operation of system controls, alarms, instrumentation, and interlocks associated with performing the above defense-in-depth functions is verified. *In addition, the proper operation of the normal residual heat removal system/reactor coolant system isolation valve interlocks specified in Section 7.6 is verified.*

c) The normal residual heat removal system pumps testing includes verification that the pump flow rate corresponds to the expected system alignment, proper pump miniflow operation, and verification that adequate net positive suction head is available for the configurations tested. The following system configurations are tested with each pump operating individually and with two pumps operating:

- Recirculation from and to the reactor coolant system with the reactor coolant system at mid-loop hot leg water level and atmospheric pressure

- Makeup to the reactor from the in-containment refueling water storage tank with approximately 4 feet of water in the tank

- *Recirculation from and to the spent fuel pool with the pool at normal minimum level.*

d) During the verifications of normal residual heat removal system flow to the reactor coolant system, verify that the pumped flow provides sufficient back pressure to maintain a water level in the CMT.

e) The capability of the normal residual heat removal heat exchangers to provide the required heat removal rate from the reactor coolant system is verified by testing performed with flow from and to the heated reactor coolant system, with each normal residual heat removal pump/heat exchanger operating individually.

f) The capability of the normal residual heat removal heat exchangers to provide the required heat removal rate from the spent fuel pool is verified. Since the spent fuel pool is not heated during pre-operational testing, this verification can be made based on the flowrate from Item c and heat removal capability from Item e, above.

g ~~f~~) Operation of the normal residual heat removal system relief valve which provides low temperature overpressure protection for the reactor coolant system is verified by the performance of baseline in-service testing, as specified in subsection 3.9.6.

h ~~g~~) Operation of the system to facilitate draining the reactor coolant system water level to near the centerline of the hot leg for reduced inventory operations is verified. This test is performed in conjunction with the chemical and volume control system, and is used to demonstrate the performance of the reactor coolant system hot leg level instruments as discussed in subsection 14.2.9.1.1.

Enclosure 2

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14.2.9.1.4 Passive Containment Cooling System Testing

Purpose

The purpose of the passive containment cooling system testing is to verify that the as-installed components perform properly to accomplish their safety-related functions to transfer heat from inside the containment to the environment, as described in ~~Section 6.2. The passive containment cooling water storage tank also provides a seismically qualified source of water for the fire protection system. Testing of this function is discussed in subsection 14.2.9.2.8.~~ *Section 6.2.2. The passive containment cooling water storage tank also provides a safety-related source of makeup water for the spent fuel pool, and provides a seismically qualified source of water for the fire protection system. Testing of these functions are discussed in subsections 14.2.9.1.16 Long Term Safety System Support Testing, and 14.2.9.2.8. Fire Protection System Testing.*

Prerequisites

The construction testing of the passive containment cooling system is successfully completed. The preoperational testing of the Class 1E dc electrical power and uninterruptable power supply systems, the non-Class 1E electrical power supply system, the compressed and instrument air system, and other interfacing systems required for operation of the above systems is available as needed to support the specified testing and system configurations. Additionally, a sufficient quantity of acceptable quality water for filling the passive containment cooling water storage tank and draining onto the containment is available, and a means of filling the tank is available.

General Test Acceptance Criteria and Methods

Passive containment cooling system performance is observed and recorded during a series of individual component testing that characterizes passive containment cooling system operation. The following testing demonstrates that the passive containment cooling system operates as described in Section 6.2 and appropriate design specifications:

a) Proper operation of safety-related valves is verified by the performance of baseline in-service tests as described in subsection 3.9.6.

b) Proper calibration and operation of safety-related, defense-in-depth, and system readiness instrumentation, controls, actuation signals and interlocks *as discussed in SSAR sections 7.3 and 7.5* are verified. This testing includes the following:

- Normal range containment pressure
- High range containment pressure
- Passive containment cooling water flow rate
- Passive containment cooling water storage tank level
- Passive containment cooling water isolation valve instrumentation and controls
- Diverse actuation system passive containment cooling initiation

- Passive containment cooling water storage tank water temperature
- Air inlet *and* shield plate, ~~and exhaust~~ *freeze protection* heater controls

This testing includes demonstration of proper actuation of these functions from the main control room.

c) ~~The resistance of each passive containment cooling water storage tank drain flowpath and flowpath combinations is verified by draining water from the water storage tank onto the containment surface, with the storage tank water initially at the different water levels just above and below each drain standpipe.~~

Flow testing is performed to demonstrate proper system flow rates by draining the passive containment cooling system water storage tank. This testing demonstrates the proper resistance of the four passive containment cooling water storage tank delivery flowpaths. This testing also demonstrates that water is supplied at the specified flow rates and times for 72 hours consistent with the design basis analyses presented in Section 6.2.1.

d) The proper operation of the passive containment cooling water distribution bucket and weirs is verified and proper wetting of the containment is observed and recorded during draindown testing in Item c, above.

e) The proper operation of the drains in the upper containment/shield building annulus to each drain of the containment cooling water from the annulus floor is verified.

f) The resistance of the passive containment cooling air flowpath is verified by measuring the wind induced driving head developed from the air inlet plenum region of the shield building to the air exhaust at several locations along the flow path and at several circumferential locations, and measurement of the induced air flow velocity. Temporary instrumentation is used for this testing.

g) Sample coupons from the containment shell with and without an appropriate coating of paint are laboratory tested to determine their conductivity.

h) The proper operation of each of the PCS water storage tank recirculation/makeup pumps to perform their recirculation function is verified.

14.2.9.1.10 Containment Isolation and Leak Rate Testing

Purpose

The purpose of the containment isolation and leak rate testing is to demonstrate that the as-installed containment isolation valves, piping and electrical containment penetrations, and hatches, and the containment vessel properly perform the following safety functions as described in Section 6.2:

- Automatic isolation of the piping penetrating containment required to assure containment integrity
- The containment vessel, penetration, and isolation valve leakage is less than the design basis leakage at or near the containment design pressure *consistent with 10 CFR 50, Appendix J pressure test requirements.*
- The containment vessel and penetrations can withstand elevated internal pressure consistent with 10 CFR 50, Appendix J pressure test requirements

Prerequisites

The construction testing of the containment, containment hatches/airlocks and containment penetrations, *including the containment pressure test as specified in Section 3.8.2.7 has been completed.* , plus tThe *construction testing of the* piping and isolation valves or electrical wiring through the penetrations, has been completed. The instrumentation to be used in performing the Type A, B, and C testing is calibrated and available, including their associated data processing equipment. The required preoperational testing of the protection and safety monitoring system, plant control system, the Class 1E electrical power uninterruptable power supply, and other interfacing systems required for operation of the containment isolation devices and data collection is available.

General Test Acceptance Criteria and Methods

Containment isolation functions, leak rate, and structural integrity performance are observed and recorded during a series of individual component and integrated system testing. The following testing demonstrates that the containment functions as described in Section 6.2 and the appropriate design specifications are achieved. The testing is in accordance with the American National Standard *combined license applicant's* Containment System Leakage Testing Requirements *Program, which meets the requirements of* ANSI/ANS-56.8-1994 *or ANSI/ANS-N45.4-1972, as appropriate.*

a) Proper operation of safety-related containment isolation valves, listed in Table 6.2.3-1, is verified by the performance of baseline in-service tests as specified in subsection 3.9.6.

b) Proper calibration and operation of safety-related containment isolation instrumentation, controls, actuation signals and interlocks is verified. This testing includes actuation of the containment isolation valves from the main control room, and upon receipt of a containment isolation signal.

c) The appropriate Type C leakage testing is performed for each piping path penetrating the containment boundary, verifying the leakage for each containment isolation valve (listed in Table 6.2.3-1) or set of isolation valves. This testing for individual isolation valves may be performed in conjunction with the associated system test.

d) The appropriate Type B leakage testing is performed for each containment penetration whose design incorporates seals, gaskets, sealants, or bellows. This testing includes door or hatch operating mechanisms and seals.

e) A baseline in-service test/inspection of the accessible interior and exterior surfaces of the containment structure and components is performed as specified in subsection 3.8.2.

~~f) The structural integrity of the containment, including penetrations, is verified by pressurizing the containment to the pressure required by 10 CFR 50 Appendix J to verify their function at design pressure.~~

f ~~g~~) A Type A integrated leak rate test is performed to verify that the actual containment leak rate does not exceed the design basis leak rate specified in the Technical Specifications.

14.2.9.1.11 Containment Hydrogen Control System Testing

Purpose

The purpose of the containment hydrogen control system ~~safety-related~~ testing is to verify that the system properly performs the following safety-related *and non-safety defense-in-depth* functions described in Section 6.2:

- Prevent the concentration of hydrogen in containment from reaching the flammability limit
- *Prevent the concentration of hydrogen in containment from reaching the detonation limit.*
- Monitor the containment hydrogen concentration as required by Regulatory Guide 1.97

Prerequisites

The construction testing of the containment hydrogen control system is completed. The Class 1E dc electrical power and uninterruptable power supply systems, the non-Class 1E electrical supply system, and other interfacing systems required for operation of the above systems and calibrated data collection instrumentation are available as needed to support the specified testing.

General Test Acceptance Criteria and Methods

Performance of the containment hydrogen control system is observed and recorded during a series of individual component testing. The following testing verifies that the system operates as described in Section 6.2.4 and as specified in the appropriate design specifications:

a) Proper operation of *both the Class 1E* ~~the~~ safety-related *and non Class 1E* containment hydrogen concentration instrumentation and alarms is verified.

b) The ability of the passive autocatalytic recombiners to achieve their specified plate temperature when exposed to a specified atmosphere containing hydrogen is verified by testing a portion of the installed recombiner plates ex-containment. *This testing may include certified manufacturing tests of the plates performed in accordance with the recombiner qualification requirements.*

c) The ~~proper~~ *manual* actuation and operation of the hydrogen igniters *confirm that the igniters are supplied by two power groups from two subsystems of the non-class 1E dc and uninterruptible power supply system* ~~is verified~~ .

14.2.9.1.16 Long-Term Safety-Related System Support Testing

Purpose

The purpose of this testing is verify the capability to perform the following functions for maintaining the extended operation of the safety-related systems and components as described in Section 1.9:

- Supply makeup water to the passive containment cooling system
- ~~Supply makeup water to the inside of containment~~
- Supply makeup water to the spent fuel pool
- Provide electrical power for post-accident instrumentation, *control room lighting and ventilation, division B and C and I&C room ventilation, passive containment cooling system pumps, ancillary generator room lights, ancillary generator fuel tank heaters.*
- ~~Supply air to~~ *Provide ventilation cooling to* the main control room
- Provide *ventilation* cooling to the Class 1E cabinets for post-accident instrumentation

Prerequisites

The construction tests of the safety-related systems and/or components designed for long-term actions have been successfully completed. The preoperational testing of these systems and/or components, including instrument calibrations, has been completed as required for the specified testing, system configurations, and operations. Equipment required for data collection is available and operable. Water used in this testing should be of a quality suitable for filling the specified components. Equipment used to provide the required long-term actions is available.

General Test Method and Acceptance Criteria

The ability to perform the required long-term actions is observed and recorded during a series of individual component and integrated system testing. The following testing verifies that the long-term actions can be performed as discussed in Section 1.9 and as specified in appropriate design specifications:

~~a) The ability to provide makeup water to containment via the piping connection on the normal residual heat removal system as described in Section 6.3 and subsection 5.4.7 is verified.~~

a ~~b~~) The ability to provide makeup water to the passive containment cooling water storage tank as described in subsection 6.2.2 is verified.

b ~~c~~) The ability to provide electrical power to the post-accident monitoring instrumentation, *control room lighting and ventilation, division B and C I&C room ventilation, passive containment cooling system pumps, ancillary generator room lights, ancillary generator tank heaters,* ~~by~~ using ~~a portable, engine driven ac~~ *the ancillary diesel* generators as described in Section 8.3 is verified.

~~d) The ability to provide breathable, compressed air for the main control room air supply and pressurization system using portable compressed air bottles as described in Section 6.4 is verified.~~

c ~~e~~) The ability to provide main control room ~~and air recirculation~~ *ventilation cooling* using ~~a portable~~ *ancillary* fans as described in ~~S~~*subs*ection ~~6.4~~ *9.4.1* is verified.

d ~~f~~) The ability to provide ventilation cooling to post-accident monitoring instrumentation equipment rooms using ~~portable~~ *ancillary* fans as described in ~~S~~*subs*ection ~~6.4~~ *9.4.1* is verified.

e ~~g~~) The ability to provide makeup water to the spent fuel pool via the safety-related makeup connection *from the passive containment cooling system water storage tank,* as described in subsection 9.1.3, is verified.

14.2.9.2.7 Spent Fuel Pool Cooling System Testing

Purpose

The purpose of the spent fuel pool cooling system testing is to verify that the system properly performs the following defense-in-depth function described in subsection 9.1.3:

- Remove heat from the spent fuel stored in the spent fuel pool

Prerequisites

The construction testing of the spent fuel pool cooling system has been completed. The spent fuel pool is filled with water of acceptable quality and chemistry. The ac electrical power and distribution systems and other interfacing systems required for operation of the pumps and for data collection are available as needed to support the specified testing and system configurations.

General Test Acceptance Criteria and Methods

Spent fuel pool cooling system performance is observed and recorded during a series of individual component and integrated system testing. The following testing demonstrates that the system properly performs its defense-in-depth function as described in subsection 9.1.3 and appropriate design specifications:

a) Proper operation of the spent fuel pool cooling pumps, valves, and strainers is verified.

b) Proper operation of the instrumentation, controls, actuation signals and interlocks is verified, including:

   - Automatic pump actuation if an operating pump stops
   - Pump flow rate
   - Pump discharge pressure
   - Spent fuel pool water level and control
   - Spent fuel pool water temperature
   - Water return temperature

   This testing includes operation of the system pumps from the main control room.

c) The capability of the pumps to provide the expected cooling flow rates to and from the pool is verified; with both pumps operating, with either individual pump operating, and with either heat exchanger operating.

d) In conjunction with Item c above, the pump(s) runout flow rate is verified to be properly limited, and adequate net positive suction head is verified to be available during the appropriate operating modes.

e) The proper operation of the spent fuel pool siphon breakers is verified.

f) The proper operation of the spent fuel pool gravity drain makeup flowpath from the cask washdown pit is verified.