16. TECHNICAL SPECIFICATIONS

16.1 Introduction

The AP1000 technical specifications (TS) were modeled after Revision 2 of NUREG-1431, "Standard Technical Specifications: Westinghouse Plants" (STS). These STS were developed from the results of the TS improvement program, in accordance with SECY-93-067, "Final Policy Statement on TS Improvements for Nuclear Power Reactors," published on July 22, 1993, and Title 10, Section 50.36, of the Code of Federal Regulations (10 CFR 50.36), "Technical Specifications," as amended July 19, 1995. The applicant states that the AP1000 TS comply with 10 CFR 50.36(c)(2)(ii), which requires the TS to include a limiting condition for operation for each item meeting one or more of the following four criteria:

- Criterion 1—installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary

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

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

- Criterion 4—a structure, system, or component which operating experience or a probabilistic safety assessment has shown to be significant to public health and safety

The review of the AP1000 TS by the staff of the U.S. Nuclear Regulatory Commission (NRC) concentrated on the differences between that document and the STS. These differences result from the new passive systems design, structural differences from existing systems, and the advanced microprocessor-based instrumentation and control (I&C) system, as well as shutdown operations.

After its review, the staff forwarded its comments on the AP1000 TS to the applicant for resolution and incorporation into the final TS. The final AP1000 TS, included in Design Control Document (DCD) Tier 2, Section 16.1, provides resolution of the issues raised by the staff and are certified to be accurate by the applicant.

16.2 Evaluation

The staff evaluated the AP1000 TS to confirm that they will preserve the validity of the plant design, as described in the AP1000 DCD, by ensuring that the plant will be operated (1) within the required conditions bounded by the AP1000 DCD, and (2) with operable equipment that is essential to prevent accidents and to mitigate the consequences of accidents postulated in the AP1000 DCD. The staff also assessed the AP1000 TS to confirm that a limiting condition for operation (LCO) was established for any aspect of the design that met the criteria in 10 CFR 50.36(c)(2)(ii).

The AP1000 design includes safety systems that are both innovative and simplified. It employs passive safety-related systems that rely on gravity and natural processes, such as convection, evaporation, and condensation. Although the staff asked the applicant to model the AP1000 TS after NUREG-1431 to the maximum extent practical, it was necessary to develop TS beyond those in the STS to account for the advanced passive design features of the AP1000. However, in most cases, the AP1000 system design functions are similar to those of existing pressurized-water reactors (PWRs), even though the components and systems are new. The staff also requested that the applicant model the AP1000 TS after the equivalent STS safety functions. In those cases in which the staff believed deviation from the STS was appropriate to account for AP1000 design features, the required action completion times and surveillance requirement frequencies associated with the LCOs were maintained consistent with the STS provisions for the equivalent safety function.

In some instances, detailed design information, equipment selection, allowable values, or other information are needed to establish the information to be included in the TS. Locations for the addition of this information are signified by brackets to indicate that the combined license (COL) applicant must provide plant-specific values or alternative text. This is COL Action Item 16.2-1.

A comparison of the AP1000 TS with the STS, as well as an evaluation of the differences, is provided in the following sections.

16.2.1 AP1000 TS Section 1.0, “Use and Application”

Section 1.1 of the AP1000 TS provides definitions that correspond to those given in the STS. These definitions are acceptable to the staff because they are consistent with the STS and the AP1000 design features.

In addition to the STS definition of Dose Equivalent I-131, Section 1.1 of the AP1000 TS also includes a definition for Dose Equivalent Xe-133 not found in the STS. The source documents for the dose conversion factors for these two quantities differ from the STS, but are acceptable because they are consistent with the AP1000 dose analysis, which uses the total effective dose equivalent methodology, and Regulatory Guide (RG) 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.” AP1000 TS 3.4.10, “RCS Specific Activity,” places limits on these two quantities, in accordance with Criterion 2 of 10 CFR 50.36(c)(2)(ii). This will ensure that the doses resulting from a design-basis accident (DBA), such as a steam generator tube rupture (SGTR), will be within the bounding values of the AP1000 accident analysis. Therefore, specifying a definition for Dose Equivalent Xe-133 is appropriate and is acceptable as proposed.

Section 1.1 of the AP1000 TS omits STS definitions for $\bar{E}$—average disintegration energy, master relay test, and slave relay test; the AP1000 TS do not use these definitions.

Section 1.2 of the AP1000 TS (logical connectors), Section 1.3 (required action completion time rules), and Section 1.4 (surveillance requirement frequency rules) are consistent with the STS and are therefore acceptable.

16.2.2 AP1000 TS Section 2.0, "Safety Limits"

Section 2.0 of the AP1000 TS outlines the safety limit specifications. These are consistent with the STS and are therefore acceptable.

16.2.3 AP1000 TS Section 3.0, "Limiting Condition for Operation Applicability and Surveillance Requirement Applicability"

Section 3.0 of the AP1000 TS governs the general application of the LCOs and surveillance requirements (SRs). The specifications provided in Section 3.0, which correspond to the STS (LCOs 3.0.1 through 3.0.7 and SRs 3.0.1 through 3.0.4) are acceptable to the staff because they are consistent with the STS.

In addition, Section 3.0 includes LCO 3.0.8 to specify appropriate remedial actions in the event that an applicable shutdown LCO, and associated action requirements, cannot be met in Modes 5 and 6. This specification is a consequence of the AP1000 TS containing LCOs applicable during shutdown conditions that are in addition to those in the STS. The AP1000 TS LCOs 3.0.8 and 3.0.3 apply under similar conditions (i.e., when the action requirements of an LCO are not met and no other action is specified, or when none of the action requirements of an LCO address the plant condition). However, while LCO 3.0.3 only applies during operating conditions (Modes 1, 2, 3, and 4), LCO 3.0.8 also applies during shutdown conditions (Modes 5 and 6). This specification conforms to the format and usage rules of the STS and is acceptable because it specifies remedial actions that will maintain the plant in a safe condition in the event that a shutdown LCO is not met and the associated action requirements of the LCO are either not met or no associated action requirements are specified.

16.2.4 AP1000 TS Section 3.1, "Reactivity Control Systems"

Section 3.1 of the AP1000 TS governs reactivity control systems. The specifications in Section 3.1 which correspond to those given in STS 3.1.1 through 3.1.8 are acceptable to the staff because they are consistent with the STS.

In addition, Section 3.1 includes a specification, TS 3.1.9, to prevent an inadvertent reactor coolant system (RCS) boron dilution event. This TS requires two operable isolation valves capable of isolating the chemical and volume control system (CVS) from the demineralized water storage tank. The isolation condition required by TS 3.1.9 satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii). Further, the new demineralized water isolation valve specification conforms to the format and usage rules of the STS and is acceptable because it will prevent an inadvertent RCS boron dilution event.

16.2.5 AP1000 TS Section 3.2, "Power Distribution Limits"

Section 3.2 of the AP1000 TS governs core power distribution limits. The specifications in Section 3.2 which correspond to those given in STS 3.2.1 through 3.2.4 are acceptable to the staff because they are consistent with the STS.

In addition, Section 3.2 includes a specification, TS 3.2.5, to govern the use of the on-line power distribution monitoring system (OPDMS). This system continuously monitors the power distribution parameters within the core via fixed, in-core detectors. It actuates alarms to alert control room staff to take timely corrective action when an OPDMS-monitored power distribution parameter is approaching the specified limit. The inclusion of the OPDMS in the AP1000 TS satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii). This new specification conforms to the format and usage rules of the STS and is acceptable because it will prevent the core power distribution from exceeding the limits on initial conditions assumed in the safety analyses.

16.2.6 AP1000 TS Section 3.3, "Instrumentation"

Section 3.3 of the AP1000 TS contains significant differences from the I&C provisions in the STS. The use of micro-processor (or digital)-based I&C systems in the AP1000 design is one source of the differences between the AP1000 TS and the STS. Another source of difference is the non-safety-related designation of a number of the active systems in the AP1000 design that correspond to safety-related systems in the STS. The applicant determined that the four criteria of 10 CFR 50.36(c)(2)(ii) do not require I&C TS LCOs for such non-safety-related systems.

Section 3.3 of the AP1000 TS contains four I&C specifications based on the corresponding specifications in the STS. These include TS 3.3.1 for the reactor trip system (RTS), TS 3.3.2 for the engineered safety features actuation system (ESFAS), TS 3.3.3 for the postaccident monitoring system (PAM), and TS 3.3.4 for the remote shutdown workstation system instrumentation. However, to account for the AP1000 design differences, the I&C functions contained in these four specifications vary significantly from the equivalent functions described in the STS, including STS 3.3.1 for the RTS, STS 3.3.2 for the ESFAS, STS 3.3.3 for the postaccident monitoring system, STS 3.3.4 for remote shutdown workstation system, STS 3.3.6 for containment purge and exhaust isolation, STS 3.3.7 for control room emergency filtration system actuation, and STS 3.3.9 for the boron dilution protection system instrumentation.

Section 3.3 of the AP1000 TS omits STS specifications for loss of power diesel generator start (STS 3.3.5) and fuel building air cleaning system actuation instrumentation (STS 3.3.8) because the associated systems are not safety-related in the AP1000 design. In addition, the I&C functions for containment purge and exhaust isolation, control room emergency filtration system actuation, and the boron dilution protection system are not presented in separate specifications. Rather, AP1000 TS 3.3.2 for ESFAS instrumentation includes these functions.

The staff requested that the applicant justify the use of WCAP-10271-P-A, "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System," Supplement 2, Revision 1, which is applicable to analog instrumentation systems, as a basis for certain required action completion times for the digitally-based instrumentation covered by TS 3.3.1 and TS 3.3.2. The applicant responded by bracketing the affected values, thus indicating that the final determination and justification of these time limits is the responsibility of the COL applicant. The staff finds this approach acceptable because the COL applicant would have to make such determinations and justifications, regardless of the applicability of WCAP-10271-P-A. The staff identifies this as part of COL Action Item 16.2-1.

Section 3.3 of the AP 1000 TS regarding safety-related instrumentation systems implements modified versions of the STS associated with the equivalent safety functions. These specifications conform to the format and usage rules of the STS and are functionally equivalent to the STS. As explained previously, the staff agrees that the AP1000 design differences justify not specifying LCOs for the STS instrumentation system functions noted above. The AP1000 TS 3.3.1, 3.3.2, 3.3.3, and 3.3.4 are acceptable because they will ensure that the specified instrumentation systems are capable of performing their intended safety functions, as assumed in the safety analyses, in the event of a DBA or transient.

Section 3.3 also includes a new specification, TS 3.3.5, to govern the diverse actuation system (DAS) manual controls. The DAS is a non-safety-related system that provides an anticipated transient without scram (ATWS) mitigation function (reactor trip, turbine trip, and passive residual heat removal heat exchanger actuation), as well as an ESFAS function for accident mitigation. The DAS automatic functions use equipment that is diverse from the safety-related I&C system (the protection and safety monitoring System (PMS)) from sensor output to the final actuated device. These functions automatically initiate a reactor trip and actuate designated safety-related equipment. The AP1000 DAS automatic and manual instrumentation functions are not credited in the DCD Tier 2, Chapter 15, safety analyses. Consequently, the DAS functions do not meet Criterion 1, 2, or 3 of 10 CFR 50.36(c)(2)(ii). In addition, the applicant determined that the automatic DAS functions do not meet Criterion 4.

However, as described in WCAP-15985, “AP1000 Implementation of the Regulatory Treatment of Non-Safety-Related Systems Process,” Revision 1, dated April 2003, the applicant determined that the regulatory treatment of non-safety systems (RTNSS) analysis for the automatic functions of the DAS demonstrates that they are important because they compensate for the accident mitigation uncertainty identified in the probabilistic risk assessment (PRA). In other words, the automatic functions of the DAS provide margin in the PRA sensitivity analysis (see Chapter 22 of this report). This analysis assumed no credit for non-safety-related systems, structures and components (SSCs) to mitigate at-power and shutdown events. However, the analysis did consider non-safety-related SSCs in the calculation of initiating event frequencies. Thus, DCD Tier 2, Section 16.3, establishes investment protection short-term availability controls (as defined in Section 22.5.9 of this report) for the automatic DAS ATWS mitigation and DAS ESFAS instrumentation. Should a COL be issued, the short-term availability controls would be maintained in a licensee-controlled document, as discussed in Section 22.5.9 of this report.

The DAS manual controls provide non-Class 1E backup controls in case of a common-mode failure of the PMS automatic and manual actuations, as evaluated in the AP1000 PRA. The applicant determined that crediting the DAS manual controls was necessary to meet the large release frequency safety goal identified in the focused PRA (see Sections 22.3.3 and 22.5.8 of this report). From this, the applicant concluded that the DAS manual controls satisfy Criterion 4 of 10 CFR 50.36(c)(2)(ii), and accordingly proposed TS 3.3.5 to comply with 10 CFR 50.36. In the event that one or more DAS manual control functions are inoperable for 30 days, the associated proposed action requirements specify more frequent performance of the RTS trip actuating device operational test for the reactor trip breakers and the ESFAS actuation logic test for the ESFAS instrumentation backed up by the DAS, as appropriate. These, and other associated action requirements, are acceptable because they provide a level of protection equivalent to that of the associated LCO. This acceptance is related to the resolution of Open Item 19.1.10.1-3 to confirm proper use of PRA results in determining the level of regulatory oversight (e.g., required action completion time and surveillance frequency). The NRC staff has determined that Open Item 19.1.10.1-3 is resolved because the applicant has properly used AP1000 PRA results. Therefore, the staff finds that the proposed TS 3.3.5, which conforms to the format and usage rules of the STS, is acceptable because it adequately compensates for the risk of a common-cause failure of the PMS.

16.2.7 AP1000 TS Section 3.4, "Reactor Coolant System"

The AP1000 RCS specifications correspond to those in the STS, as follows:

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.4.1	3.4.1	RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling Limits (*same)
3.4.2	3.4.2	RCS Minimum Temperature for Criticality (*same)
3.4.3	3.4.3	RCS Pressure and Temperature (P/T) Limits (*same)
3.4.4*	3.4.4	RCS Loops (*RCS Loops - Modes 1 and 2)
3.4.5*	3.4.4	RCS Loops (*RCS Loops - Mode 3)
3.4.6*	3.4.4	RCS Loops (*RCS Loops - Mode 4)
3.4.7*	3.4.4	RCS Loops (*RCS Loops - Mode 5, loops filled)
3.4.8*	None	(*RCS Loops - Mode 5, loops not filled)
3.4.9	3.4.5	Pressurizer (*same)
3.4.10	3.4.6	Pressurizer Safety Valves (*same)
3.4.13	3.4.7	RCS Operational Leakage (*same)
None	3.4.8	Minimum RCS Flow
3.4.15	3.4.9	RCS Leakage Detection Instrumentation (*same)
3.4.16	3.4.10	RCS Specific Activity (*same)
None	3.4.11	Automatic Depressurization System (ADS) - Operating
None	3.4.12	ADS - Shutdown, RCS Intact

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
None	3.4.13	ADS - Shutdown, RCS Open
3.4.12*	3.4.14	Low-Temperature Overpressure Protection System (*same)
3.4.14*	3.4.15	RCS Pressure Isolation Valve (PIV) Integrity (*RCS PIV Leakage)
None	3.4.16	Reactor Vessel Head Vent (RVHV)
None	3.4.17	CVS Makeup Isolation Valves
3.4.11*	None	(*Pressurizer Power-Operated Relief Valves (PORVs))
3.4.17*	None	(*RCS Loop Isolation Valves)
3.4.18*	None	(*RCS Isolated Loop Startup (related to loop isolation valve LCO))
3.4.19*	None	(*RCS Loops - Test Exceptions)

AP1000 TS 3.4.7, regarding RCS operational leakage, differs from the STS by specifying an allowable, unidentified leakage of 1.89 liters per minute (lpm) (0.5 gallons per minute (gpm)), which is less than the STS value of 3.79 lpm (1 gpm). This difference is based on the AP1000 leak before break assumptions. AP1000 TS 3.4.9, regarding RCS and main steam leakage detection instrumentation, also differs from the STS to reflect the AP1000 design. These differences are acceptable because they are more restrictive than the STS and they accurately reflect differences in the AP1000 design related to reactor coolant and main steam leakage limitations and detection.

AP1000 TS 3.4.10, regarding RCS specific activity, omits STS SR 3.4.16.3. This surveillance requires, on a 184-day frequency, determining $\bar{E}$, the average disintegration energy, from a sample taken in Mode 1 after a minimum of 2 effective full-power days and 20 days of Mode 1 operation have elapsed since the reactor was last subcritical for less than or equal to 48 hours. Although $\bar{E}$ is not used in the AP1000 TS, the staff requested that the applicant explain why an equivalent surveillance using Dose Equivalent Xe-133 was not proposed. This was Open Item 16.2-1 in the DSER. The applicant adopted STS SR 3.4.16.3 as SR 3.4.10.3 in DCD Tier 2, Chapter 16.1, with the exception that the AP1000 surveillance determines Dose Equivalent Xe-133 instead of $\bar{E}$. This difference is consistent with the AP1000 design radiological consequence analyses and is acceptable. Therefore, Open Item 16.2-1 is resolved.

The AP1000 RCS TS Section contains additional specifications to address (1) minimum RCS flow, (2) the automatic depressurization system (ADS), (3) the reactor vessel head vent (RVHV) system, and (4) the CVS makeup isolation valves, in accordance with Criterion 3 of 10 CFR 50.36(c)(2)(ii). These specifications conform to the format and usage rules of the STS.

The purpose of TS 3.4.8 for minimum RCS flow is to maintain uniform RCS mixing as an initial condition for boron dilution transients. LCO 3.4.8 also specifies conditions for halting and restoring forced circulation in the RCS to ensure that the required shutdown margin and RCS subcooling margin are maintained. It also prevents the thermal transient associated with starting a reactor coolant pump from overpressurizing the RCS at low temperatures. In the event forced circulation is lost, the action requirements will ensure maintenance of the required shutdown margin. The requirements of this specification will maintain the validity of the analysis of the design basis RCS boron dilution transient. Therefore, TS 3.4.8 is acceptable.

The purpose of the ADS, which consists of four different stages of depressurization valves, is to depressurize the RCS to allow gravity injection of water from the in-containment refueling water storage tank (IRWST) or from the containment sump for long-term recirculation cooling. The proposed ADS required action 72-hour completion times are consistent with the repair time allowed for a loss of redundancy in the STS. Further, the proposed ADS SRs are adequate to assure operability of the ADS flow paths required by the associated LCOs. Thus, TS 3.4.11 and 3.4.12 will ensure that depressurization of the RCS will occur as assumed in the safety analysis in the event of a DBA (e.g., a loss-of-coolant accident (LOCA)). While the plant is shut down with the RCS open, TS 3.4.13 will ensure that sufficient vent area is available to support IRWST injection and containment recirculation to mitigate events in which core cooling, RCS makeup, or boration is needed. Therefore, the proposed ADS system specifications are acceptable.

The purpose of TS 3.4.16 is to ensure operability of the manually operated RVHVs so that the control room staff can open them to prevent overfilling of the pressurizer during RCS coolant-addition transients. Each of the two vent flow paths is capable of preventing overfill of the pressurizer. The 72-hour completion time for restoring one inoperable RCS vent flow path is consistent with the repair time allowed for a loss of redundancy in the STS. With both flow paths inoperable, the action requirements permit 6 hours to restore one flow path to operable status. This is acceptable, according to the proposed TS Bases, because of the conservatism in the coolant-addition transient analysis; the applicant has performed a more realistic analysis that demonstrates that overfilling will not occur. Periodic valve stroke-open surveillance, which is required by the inservice testing program, provides assurance of operability of the four vent valves. The RVHV specification will ensure that the RCS vent system will be available to the control room staff to prevent a coolant-addition transient from overfilling the pressurizer. Therefore, TS 3.4.16 is acceptable.

The purpose of TS 3.4.17 is to ensure operability of the redundant CVS makeup isolation valves to automatically prevent overfilling of the pressurizer during non-LOCA transients, and overfilling of the steam generators during SGTR accidents. The accident analyses of such events assume that excessive addition of coolant to the RCS from the CVS makeup would increase the associated consequences. The analyses thus assume that the CVS makeup is automatically isolated by a high water level in either the pressurizer or a steam generator. The 72-hour completion time for restoring one inoperable CVS makeup isolation valve is consistent with the repair time allowed for a loss of redundancy in the STS. With both valves inoperable, the makeup line must be isolated in 1 hour. The associated SRs provide assurance that these two isolation valves will automatically shut within the time interval assumed in the pertinent accident and transient analyses. The CVS makeup isolation valve specification will ensure that

RCS makeup will be isolated, as assumed in the accident analyses. Therefore, TS 3.4.17 is acceptable.

Omitting the STS specifications for RCS power-operated relief valves (PORVs) and loop isolation valves is acceptable because these features are not used in the AP1000 design.

The Bases for STS 3.4.19 state that its primary purpose is to provide an exception to LCO 3.4.4, “RCS Loops—Modes 1 and 2,” to permit reactor criticality under no flow conditions during certain physics tests, natural circulation demonstration, station blackout, and loss of offsite power to be performed while at low thermal power levels. A COL applicant may adopt this test exception LCO if it plans to conduct these kinds of tests. However, the AP1000 TS need not include this test exception because (1) these tests are not required, and (2) compliance with a test exception LCO is optional, in which case other specifications, such as STS 3.4.4, would apply. In addition, with the application of the other TS, including STS 3.4.4, this test exception LCO is not required by 10 CFR 50.36 because it does not meet any of the four criteria in 10 CFR 50.36(c)(2)(ii). Therefore, it is acceptable to omit a specification corresponding to STS 3.4.19 from the AP1000 TS.

Based on the above, the staff finds the AP1000 TS for the reactor coolant system acceptable.

16.2.8 AP1000 TS Section 3.5, “Passive Core Cooling System”

The AP1000 uses passive core cooling systems (PXS) rather than the pump-driven, active emergency core cooling systems (ECCS) of currently operating plants, upon which STS ECCS specifications are based. The safety-related PXS is designed to perform emergency core cooling and decay heat removal, reactor coolant emergency makeup and boration, and safety injection. The PXS is located inside the containment; it consists of several subsystems and associated components including the passive residual heat removal heat exchanger (PRHR HX) system, core makeup tanks (CMTs), IRWST, ADS, and accumulators. The AP1000 PXS specifications generally correspond to the STS for ECCS, as follows:

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.5.1*	3.5.1	Accumulators (*same)
3.5.2*	3.5.2	CMTs - Operating (*ECCS - Operating)
3.5.3*	3.5.3	CMTs - Shutdown, RCS Intact (*ECCS - Shutdown)
3.7.5*	3.5.4	PRHR HX - Operating (*Auxiliary Feedwater)
None	3.5.5	PRHR HX - Shutdown, RCS Intact
3.5.4*	3.5.6	IRWST - Operating (*RWST)
None	3.5.7	IRWST - Shutdown, Mode 5

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
None	3.5.8	IRWST - Shutdown, Mode 6
3.5.5*	None	(*Seal Injection Flow)
3.5.6*	None	(*Boron Injection Tank)

The PXS accumulators (1) supply water to the reactor vessel during the blowdown and refill phases of a large-break LOCA, (2) provide RCS makeup for a small-break LOCA, and (3) provide RCS boration for steam line breaks. These functions are essentially the same functions that the ECCS accumulators, which are also passive features, perform for currently operating Westinghouse PWRs. Thus, the proposed AP1000 TS 3.5.1 is very similar to STS 3.5.1. Other than appropriate design-based differences in SR acceptance criteria, AP1000 TS 3.5.1 specifies an 8-hour restoration required action completion time for the condition of one accumulator being inoperable for reasons other than boron concentration outside the specified limits. For this condition, the required action completion time is less restrictive than the 1-hour completion time found in the STS. The associated Bases for this completion time state that with one accumulator inoperable, the remaining accumulator is capable of providing the required safety function, except for one low-probability event (i.e., a large, cold-leg LOCA). The Bases also state that the incremental conditional core damage probability (ICCDP) for the 8-hour completion time is more than a factor of 10 less than the value indicated to have a small impact on plant risk (RG 1.177 gives this as an ICCDP value of 1E-7). This completion time is therefore acceptable. This acceptance is related to the resolution of Open Item 19.1.10.1-3 to confirm proper use of the PRA results. The NRC staff determined that Open Item 19.1.10.1-3 is resolved because the applicant had properly used AP1000 PRA results. Based on the above, TS 3.5.1 is, therefore, acceptable.

The CMTs are connected to and maintained within the RCS pressure boundary. This design allows the tanks to supply safety injection cooling and boration to the reactor via natural circulation and gravity injection at any RCS pressure. Thus, the CMTs are a passive means of supplying high-pressure safety injection in the AP1000 design.

The passive residual heat removal (PRHR) system transfers decay heat to the IRWST via natural circulation from the RCS whenever forced circulation cooling of the RCS is not available from the steam generators. The PRHR system provides decay heat removal for mitigation of non-LOCA events. The operation of the PRHR is functionally equivalent to the decay heat removal provided by the auxiliary feedwater system in currently operating Westinghouse PWRs.

The IRWST provides low-head safety injection cooling and boration via gravity injection through redundant direct vessel injection (DVI) flow paths after the RCS has been depressurized by the ADS (TS 3.4.11, 3.4.12, and 3.4.13) or an RCS break. Each IRWST DVI flow path contains redundant actuation valves, in parallel flow paths, so that the failure of one actuation valve to open will not prevent injection from the IRWST in the event of a break in the opposite DVI flow path. Operability of the IRWST also requires operability of the redundant containment sump recirculation flow paths to support long-term cooling of the core.

The TS action requirements for the CMT, PRHR, and IRWST PXS subsystems allow 72 hours for loss of a redundancy in one DVI flow path for each subsystem. This completion time is consistent with STS 3.5.2; however, the TS Bases for the PXS LCOs seem to indicate that only one subsystem at a time is affected. The AP1000 TS do not identify what the appropriate actions are in the event that the plant does not meet two or more PXS specifications (e.g., TS 3.5.1, 3.5.2, 3.5.4, and 3.5.6) concurrently. The TS Bases for the PXS LCOs also seem to indicate that DBA assumptions regarding ECCS functions may not be met in such cases. Pending clarification of the TS Bases, the staff's review of the PXS TS action requirements was considered incomplete. This was Open Item 16.2-2 in the DSER.

In a letter dated December 12, 2003, the applicant proposed several changes to the PXS specifications to resolve Open Item 16.2-2. The applicant determined that certain combinations of inoperable PXS subsystems, for which the proposed PXS TS action requirements would not require an immediate unit shutdown, may prevent adequate safety injection in response to a DVI line small-break LOCA. These combinations involve the following proposed AP1000 PXS TS actions conditions:

<u>Condition 3.5.1.B</u>

One accumulator inoperable for reasons other than Condition 3.5.1.A (boron concentration outside limits).

This actions condition corresponds to an accumulator that is inoperable due to one or more of the following reasons:

- nitrogen pressure not within limits
- water volume not within limits
- outlet isolation valve closed
- outlet isolation valve closed and will not open
- power not removed from outlet isolation valve operator

<u>Condition 3.5.2.C</u>

Two CMTs inoperable due to water temperature or boron concentration not within limits.

<u>Condition 3.5.2.E</u>

One CMT inoperable for reasons other than:

- Condition 3.5.2.A (one CMT outlet isolation valve inoperable (a redundant normally closed valve will not open));

- Condition 3.5.2.B (one or more parameters (water temperature, boron concentration) not within limits);
- Condition 3.5.2.C; or
- Condition 3.5.2.D (presence of noncondensible gases in the high point vent).

Actions Condition 3.5.2.E corresponds to a CMT that is inoperable due to one or more of the following reasons:

- both outlet isolation valves are inoperable (the normally closed valves will not open)
- the normally open return isolation valve is closed
- the normally open return isolation valve is closed and will not open
- water volume less than limit

The applicant proposed an additional 1-hour completion time to exit each of these action conditions, were another action condition entered concurrently, in the following two combinations: (1) Conditions 3.5.1.B and 3.5.2.C, and (2) Conditions 3.5.1.B and 3.5.2.E.

With the unit in either of these combined conditions, the remaining safety injection capability may be less than assumed in the safety analysis for a DVI line, small-break LOCA. In the event of a break in the common DVI line associated with the operable accumulator (and possibly, an operable CMT), the water volume available from the inoperable CMT and inoperable accumulator for safety injection through the associated remaining DVI line would be less than assumed. In the worst case (both injection flow paths isolated), no safety injection would be available from the CMTs and accumulators. Therefore, in either of these combined conditions, the licensee must restore either the accumulator or the CMT to operable status within a short time, or initiate a unit shutdown. The 1-hour completion time permits sufficient time to take action for any problem that can be corrected quickly, such as remotely opening a shut valve or removing power to a valve operator. In such cases, this completion time may allow the unit to avoid an unnecessary shutdown, while also minimizing the time the unit is vulnerable to a DVI line break, if neither the accumulator nor the CMT can be made operable quickly.

The applicant did not propose similar conditional completion times for Condition 3.5.1.A and Conditions 3.5.2.A, 3.5.2.B, 3.5.2.C, and 3.5.2.D because the combination of Condition 3.5.1.A with any one of these CMT action conditions will not result in a significant reduction in the capability of the accumulators and CMTs to perform their safety injection and boration functions. Specifically, assuming no occurrence of an additional single failure concurrent with a DBA:

- Conditions 3.5.1.A and 3.5.2.B and Conditions 3.5.1.A and 3.5.2.C address boron concentration or temperature outside limits. The applicant stated that only slight deviations in these parameters are expected, considering the frequent surveillance to verify proper pressure, volume, and temperature, as well as the control room monitoring instrumentation for these parameters. The applicant stated in its response that an accumulator and a CMT with small deviations in these parameters remain capable of adequately performing their safety injection function. Therefore, these combinations of action conditions do not warrant a more restrictive completion time.

- Conditions 3.5.1.A and 3.5.2.A correspond to an accumulator with only a small deviation outside the boron concentration limits (as just noted) and a CMT that has lost just one redundant safety injection flow path associated with one DVI line. Both the affected accumulator and CMT remain capable of performing their safety functions. Therefore, this combination of action conditions does not warrant a more restrictive completion time.

- Conditions 3.5.1.A and 3.5.2.D correspond to an accumulator with only a small deviation outside the boron concentration limits and a CMT with more than the allowed volume of noncondensible gases in its high point vent collection line. The applicant stated in its response that voiding at the CMT high point has no impact on the performance of the CMT as a backup for the accumulator during a small-break LOCA because significant RCS voiding occurs as a consequence of the event. For other events, the operable redundant CMT will be available. Therefore, this combination of action conditions does not warrant a more restrictive completion time.

The applicant identified no DBA vulnerabilities in combined action conditions between the ADS and IRWST systems, or between these systems and the accumulators or CMTs. The staff concluded that the ADS and IRWST TS action requirements are sufficiently restrictive as currently proposed.

Along with the additional completion times for the accumulator and CMT action requirements, The applicant also proposed appropriate corresponding changes to the Bases, as well as changes to clarify the Bases discussions concerning the conditions in which the unit would be vulnerable to a DVI line, small-break LOCA. Therefore, based on the AP1000 TS changes proposed in the applicant’s response, Open Item 16.2-2 is resolved.

In addition, the applicant proposed to relax TS Condition 3.5.6.A to allow a 72-hour completion time to restore an inoperable IRWST injection valve to operable status. This is the same completion time specified to restore an inoperable containment sump recirculation valve. This completion time is appropriate because, even in the event of a DVI line, small-break LOCA in the opposite DVI flow path, the IRWST is still capable of supplying the required low-pressure safety injection through the remaining redundant injection path.

The AP1000 RCS uses canned rotor reactor coolant pumps which have no pump shaft seals. This design feature eliminates the possibility of an associated shaft seal failure LOCA. Consequently, the STS seal injection flow specification is not required for AP1000 and is therefore omitted.

The AP1000 TS omit a specification corresponding to STS 3.5.6 because the AP1000 design does not include a boron injection tank. The boron injection function to maintain the required shutdown margin after an accident is accomplished by the accumulators, CMTs, and IRWST.

The AP1000 specifications for the PXS implement modified versions of the STS for the ECCS. The staff finds that these specifications have been constructed to be essentially equivalent to the STS for the ECCS functions. The staff agrees that for those cases in which a TS corresponding to the STS has not been included, AP1000 design differences provide sufficient justification for such an omission. Therefore, the AP1000 PXS TS are acceptable.

16.2.9 AP1000 TS Section 3.6, "Containment Systems"

The AP1000 TS 3.6.1 through 3.6.5 are essentially identical to the corresponding atmospheric containment STS for containment operability, air locks, isolation valves, pressure, and temperature. The passive containment cooling system (PCS) is the major difference between the AP1000 atmospheric containment design and the atmospheric containment used by many currently operating Westinghouse PWRs. This is reflected in the AP1000 TS Section 3.6 specifications which correspond to the STS as follows:

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.6.1*	3.6.1	Containment (*same)
3.6.2*	3.6.2	Containment Air Locks (*same)
3.6.3*	3.6.3	Containment Isolation Valves (*same)
3.6.4A*	3.6.4	Containment Pressure (*same)
3.6.5A*	3.6.5	Containment Air Temperature (*same)
3.6.6A*	3.6.6	PCS - Operating (*Containment Spray and Cooling Systems)
None	3.6.7	PCS - Shutdown
None	3.6.8	Containment Penetrations
3.6.7*	3.6.9	pH Adjustment (*Spray Additive System)
3.6.8*	None	(*Hydrogen Recombiners)
3.6.9*	None	(*Hydrogen Mixing System)
3.6.11*	None	(*Iodine Cleanup System)
3.6.12*	None	(*Vacuum Relief Valves)

The PCS provides the containment safety-grade ultimate heat sink to prevent the containment shell from exceeding its design pressure of 508 kiloPascals (kPa) (59 pounds per square inch gauge (psig)). The PCS uses natural air circulation past the containment shell, enhanced by distribution of cooling water onto the containment shell, to achieve its design objectives. The water is gravity fed from an annular tank with a useable capacity of 2,864 cubic meters (m^3) (756,700 gallons). This tank is designed into the roof on the containment shield building. The tank has sufficient water to provide at least 3 days of cooling. The PCS TS 3.6.6 and 3.6.7 were modeled after STS 3.6.6A for containment cooling.

The AP1000 TS do not contain a containment spray specification because accident mitigation by the AP1000 containment spray system, which is designated as non-safety-related, is not credited in any DBA analysis.

The AP1000 design includes non-safety-related passive autocatalytic recombiners to limit hydrogen buildup inside containment. However, the applicant did not propose a specification similar to STS 3.6.8 for the passive autocatalytic recombiners for design-basis hydrogen control because it expected that such specifications would no longer be required before the staff could complete its review of the AP1000 application.

The NRC has proposed major changes to 10 CFR 50.44, “Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors,” and related changes to 10 CFR 50.34, “Contents of Applications; Technical Information,” and 10 CFR 52.47, “Contents of Applications,” along with the creation of a new rule, 10 CFR 50.46a, “Acceptance Criteria for Reactor Coolant System Venting Systems” (see volume 67, page 50374 of the Federal Register, August 2, 2002). These proposed changes are meant to risk-inform the combustible gas control requirements, and constitute significant relaxations of the requirements. Section 6.2.5 of this report contains the staff’s evaluation of combustible gas control. As set forth in this section, the staff identified the resolution of issues associated with combustible gas control as Open Item 6.2.5-1.

The AP1000 DCD was written in anticipation of these rule changes. The proposed rule changes became effective on October 16, 2003. Therefore, Open Item 6.2.5-1 is resolved, and omission of a specification corresponding to STS 3.6.8 is acceptable.

AP1000 TS 3.6.7 was developed for the pH adjustment of the containment sump water for controlling release of radionuclides from water in the containment following a LOCA with fuel damage. The containment sump water pH control is actually a part of the PXS system. Control of the pH in the containment sump water after an accident is achieved through the use of pH adjustment baskets containing granulated trisodium phosphate (TSP) in the containment sump. Maintaining a proper alkaline pH range reduces offsite doses by decreasing the radiolytic formation of elemental iodine in the containment sump, the resulting formation of organic iodine, and subsequent production of airborne iodine. This feature accomplishes the same purpose as the sodium hydroxide chemical additive in the containment spray system, upon which STS 3.6.6A and 3.6.7 are based. This pH adjustment function satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

The AP1000 TS 3.6.8 for containment penetrations in Modes 5 and 6 is in addition to the containment penetration specification, TS 3.9.5, which is based on STS 3.9.4 and only applies during movement of irradiated fuel assemblies in containment. Section 3.6 of the STS does not contain this specification. The purpose of TS 3.6.8 is to ensure that in the event of a loss of normal cooling in Modes 5 and 6, the containment can be closed before reactor coolant steaming occurs. This in turn will maintain the cooling water inventory within containment necessary to support either PRHR or IRWST injection and containment sump recirculation for postulated shutdown events in Modes 5 and 6. The capability to close containment prior to steaming satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

Section 3.6 of the AP1000 TS does not contain specifications corresponding to STS 3.6.9 for hydrogen mixing, 3.6.11 for iodine cleanup, or 3.6.12 for containment vacuum relief valves because the AP1000 design either does not contain these features or does not credit them in the safety analyses.

The AP1000 specifications associated with containment systems implement modified versions of the STS for containment systems. The staff finds that these specifications have been constructed to be essentially equivalent to the STS for the containment cooling and isolation functions. The staff agrees that for those cases in which the corresponding STS have not been included, AP1000 design differences provide sufficient justification for such omissions. Therefore, the staff finds the AP1000 containment system specifications acceptable.

16.2.10 AP1000 TS Section 3.7, "Plant Systems"

The AP1000 TS for plant systems correspond to the STS as follows:

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.7.1*	3.7.1	Main Steam Safety Valves (MSSVs) (*Main Steam Safety Valves)
3.7.2*	3.7.2	Main Steam Isolation Valves (MSIVs) (*Main Steam Isolation Valves)
3.7.3*	3.7.3	Main Feedwater Isolation and Control Valves (MFIVs and MFCVs) (*MFIVs and Main Feedwater Regulation Valves (MFRVs))
3.7.5*	None	(*Auxiliary Feedwater (AFW) System)
3.7.6*	None	(*Condensate Storage Tank (CST))
3.7.7*	None	(*Component Cooling Water (CCW) System)
3.7.8*	None	(*Service Water System (SWS))
3.7.9*	None	(*Ultimate Heat Sink (UHS))

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.7.18*	3.7.4	Secondary Specific Activity (*same)
3.7.15*	3.7.5	Spent Fuel Pool Water Level (*Fuel Storage Pool Water Level)
3.7.10*	3.7.6	Main Control Room Habitability System (VES) (*Control Room Emergency Filtration System (CREFS))
3.7.11*	None	(*Control Room Emergency Air Temperature Control System (CREATCS))
None	3.7.7	Startup Feedwater Isolation and Control Valves
None	3.7.8	Main Steam Line Leakage
None	3.7.9	Fuel Storage Pool Makeup Water Sources
3.7.4*	3.7.10	Steam Generator Isolation Valves (*Atmospheric Dump Valves (ADVs))
3.7.12*	None	(*ECCS Pump Room Exhaust Air Cleanup System (PREACS))
3.7.13*	None	(*Fuel Building Air Cleanup System (FBACS))
3.7.14*	None	(*Penetration Room PREACS)
3.7.16*	None	(*Fuel Storage Pool Boron Concentration)
3.7.17*	None	(*Spent Fuel Pool Storage)

The AP1000 main steam safety valve (MSSV) specification differs from the STS because the AP1000 design has two steam generators (SGs), each with six MSSVs, rather than four SGs, each with up to five MSSVs. The AP1000 main steam isolation valve (MSIV) specification differs from that of the STS primarily to account for reliance on the non-safety-related turbine stop or control valves, in combination with the turbine bypass and moisture separator reheat supply steam control valves, as a backup to isolating the steam flow path, given a single failure of an MSIV in response to a steam line break. The AP1000 main feedwater isolation valve (MFIV) and main feedwater control valve (MFCV) specifications differ from the STS because of the fewer number of valves in the AP1000 design and in the required actions, which include the option of placing the plant in Mode 5 instead of isolating the flow path with the inoperable valve(s). Accordingly, the difference between these three specifications and the STS reflect the AP1000 design. Therefore TS 3.7.1, 3.7.2, and 3.7.3 are acceptable.

AP1000 TS 3.7.4 for secondary specific activity and TS 3.7.5 for spent fuel pool water level are essentially the same as the corresponding STS specifications. Therefore, they are acceptable.

The AP1000 uses the non-safety-related startup feedwater system to perform the non-safety functions that the safety-related auxiliary feedwater system performs for an operating PWR. These functions include supplying the SGs with feedwater during conditions of plant startup, hot standby, and shutdown, as well as during transients in the event the main feedwater system is unavailable. In the AP1000, the PRHR system (TS 3.4.5 and 3.5.5) provides the safety-related decay heat removal system instead of auxiliary feedwater (AFW) flow from the CST via a turbine-driven AFW pump to an SG expelling decay heat through release of steam by an atmospheric dump valve (ADV). Consequently, AP1000 TS which correspond to the STS specifications for the AFW system and CST are not required and are therefore omitted. A specification for the energy release function of the ADVs is also omitted because the AP1000 design does not rely on the ADVs as a safety-related method of emergency RCS heat removal. However, the SG isolation function of the ADVs is included as discussed in the evaluation of AP1000 TS 3.7.10. Omission of these STS requirements is acceptable because of design differences between the AP1000 and currently operating plants, which are the basis for the STS.

The AP1000 TS do not contain specifications for the component cooling water system (CCS), the service water system (SWS), or the ultimate heat sink (UHS). The CCS and the SWS are not safety-related in the AP1000 design. The SWS supports the CCS by supplying cooling water to remove heat from the CCS heat exchangers. The SWS rejects the heat to a heat sink, such as a cooling tower system. The CCS is a closed system that removes heat from various components needed for plant operation. The CCS also removes core decay heat and sensible heat through the normal residual heat removal system heat exchangers (RNS HXs) during normal reactor shutdown and cooldown. The PXS and the PCS provide safety-related heat removal in the event of a DBA; these systems do not rely on the CCS and SWS. Omission of specifications for the CCS, SWS, and UHS (cooling tower) is acceptable because these systems do not perform safety-related functions and do not satisfy any of the criteria in 10 CFR 50.36(c)(2)(ii).

The residual heat removal function of the RNS, CCS, and SWS during Modes 5 and 6 with the RCS open was determined to be significant from a RTNSS perspective. This is discussed in WCAP-15985, Revision 1. Thus, these three systems are included in the short-term availability controls.

AP1000 TS 3.7.6 contains requirements for the main control room habitability system (VES) which provides safety-related control room ventilation and radiation protection. To maintain a safe environment in the control room in the event of a DBA, the VES does not rely on ventilation filtering of outside air, which may contain radioactivity, or on air conditioning units for temperature control, as described in the STS for the control room emergency filtration system (CREFS) and the control room emergency air temperature control system (CREATCS), respectively. If radiation monitors in the nuclear island nonradioactive ventilation system (VBS) actuate, the VBS is automatically isolated and the VES will initiate to supply breathable air from compressed air storage tanks for 72 hours. The VES also maintains the control room pressurized with respect to the environment outside the control room boundary to minimize outside air in-leakage. In addition, the thermal design of the control room boundary, along with the VES air supply, will maintain the control room temperature within limits. This specification is consistent with the format and usage rules of the STS and will ensure that the VES system will be able to perform its intended function. The VES satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii). Therefore, TS 3.7.6 is acceptable. In addition, requirements corresponding to the STS for the CREFS and CREATCS are not required in the AP1000 TS because the VBS is not assumed to function to limit doses to control room personnel in accordance with General Design Criteria 19, “Control Room.”

The AP1000 TS 3.7.7 for the isolation and control valves of the startup feedwater system is a new specification to ensure isolation of feedwater flow to the SGs from the startup feedwater system in the event of a break in a feedwater or steam line, a SGTR, or other secondary side event. Isolation is necessary to limit the mass and energy added to containment from a feedwater line break or a steam line break event inside containment. Isolation also prevents SG overfill in the event of a SGTR. This specification is consistent with the format and usage rules of the STS and will ensure isolation of the startup feedwater system when required. Therefore, TS 3.7.7 is acceptable.

The AP1000 applies leak-before-break technology to the main steam line and the primary coolant system, while currently operating PWRs only apply this technology to the primary coolant system. A new specification, TS 3.7.8 for main steam line leakage, is provided to account for these differences. The STS do not contain a corresponding specification. This specification is consistent with the format and usage rules of the STS and will ensure that degradation of the integrity of main steam system lines inside containment will be detected before the leak before break leak rate criterion is reached. This specification will also ensure that the plant is brought to Mode 5 to preclude the leak from causing further degradation which could lead to a steam line break. The main steam line leakage limit does not affect a fission product barrier and is not an initial condition of a DBA. Accordingly, this limit does not satisfy any of the criteria in 10 CFR 50.36(c)(2)(ii), but is included in the TS for defense in depth. Therefore, TS 3.7.8 is acceptable.

AP1000 TS 3.7.9 was added to require the availability of a spent fuel pool makeup water source under certain spent fuel pool decay heat loads. The STS do not contain a corresponding specification. The makeup water replaces the water lost through pool water boiling in the event of a loss of normal cooling by the non-safety spent fuel pool cooling system for an extended period. The PCS water storage tank and the cask wash down pit serve as the required water sources. The spent fuel pool makeup function is not an initial condition of any DBA and does not mitigate any DBA that assumes the failure of or presents a challenge to the integrity of a fission product barrier. Accordingly, this function does not satisfy any of the criteria in 10 CFR 50.36(c)(2)(ii), but is included in the TS for defense in depth. This specification is consistent with the format and usage rules of the STS and will ensure the availability of a makeup water source in the event that normal pool cooling is lost and boiling occurs in the pool. Therefore, TS 3.7.9 is acceptable.

The AP1000 TS add a specification for SG isolation valves, TS 3.7.10. This specification ensures the capability to automatically isolate the SG PORV flow paths (both the PORV, which functions as an ADV, and the associated block valve) following a SGTR to minimize radiological releases from the affected SG. It also ensures the capability to automatically isolate the SG blowdown line from each SG following a loss of feedwater or a feedwater line break in order to retain SG water inventory for RCS heat removal using the SGs.

TS 3.7.10 is consistent with the format and usage rules of the STS and satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii). Conditions C and D of the action requirements specify an 8-hour completion time to correct a loss of SG automatic isolation capability. The Bases justify the 8-hour interval using insights from the AP1000 PRA. These completion times are related to the staff review of the AP1000 PRA. The NRC staff determined that Open Item 19.1.10.1-3 was resolved because the applicant had properly used AP1000 PRA results. Therefore, TS 3.7.10 is acceptable.

Section 3.7 of the AP1000 TS implements modified versions of the STS plant system specifications. The staff finds that these specifications have been constructed to be essentially equivalent to the STS for plant systems. The staff agrees that for those cases in which a TS corresponding to the STS has not been included, AP1000 design differences provide sufficient justification for such an omission. Therefore, the staff finds the AP1000 plant system specifications acceptable.

16.2.11 AP1000 TS Section 3.8, “Electrical Power Systems”

The AP1000 does not rely on alternating current (ac) power to mitigate DBAs or to attain safe shutdown (except for I&C which is ultimately powered from the direct current (dc) system). Thus, STS 3.8.1 for ac sources-operating, STS 3.8.2 for ac sources-shutdown, and STS 3.8.3 for diesel fuel oil, lube oil, and starting air are not required. Therefore, omitting specifications for the corresponding AP1000 non-safety systems is acceptable. However, ac power sources have been determined to be important from a RTNSS perspective and are consequently included in the short-term availability controls.

The AP1000 TS for electrical power systems include specifications corresponding to STS 3.8.4 and 3.8.5 for dc sources - both operating and shutdown (TS 3.8.1 and TS 3.8.2); STS 3.8.6 for battery parameters (TS 3.8.7); STS 3.8.7 and 3.8.8 for inverters - both operating and shutdown (TS 3.8.3 and 3.8.4); and STS 3.8.9 and 3.8.10 for distribution systems - both operating and shutdown (TS 3.8.5 and 3.8.6). The staff finds these electrical power system specifications acceptable, but notes the following difference between the AP1000 TS and the STS. The completion time for one dc subsystem inoperable was extended from 2 hours to 6 hours based on the continued capability of the AP1000 to reach safe shutdown and mitigate all DBAs with the capacity of the remaining dc subsystems. A 2-hour completion time was added for two dc subsystems inoperable to permit limited time to assess and restore an inoperable dc subsystem on the basis of the AP1000 capability to reach safe shutdown with two subsystems inoperable, as well as its ability to mitigate most DBAs. Other specifications on inverters, distribution subsystems, and battery cell parameters are either consistent with the STS or have only minor, acceptable variations.

The AP1000 TS associated with the electrical power system implement modified versions of the STS for the dc electrical power systems. The staff finds that these specifications have been constructed to be essentially equivalent to the STS for the corresponding electrical power system functions. The staff agrees that for those cases in which a TS corresponding to the STS has not been included, AP1000 design differences provide sufficient justification for such an omission. Therefore, the staff finds the AP1000 electrical power system TS acceptable.

16.2.12 AP1000 TS Section 3.9, "Refueling Operations"

The AP1000 TS for refueling operations compare closely to the corresponding STS provisions, with only a few exceptions. The correspondence between Section 3.9 of the AP1000 TS and Section 3.9 of the STS is as follows:

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.9.1*	3.9.1	Boron Concentration (*same)
3.9.2*	3.9.2	Unborated Water Source Flow Paths (*Unborated Water Source Isolation Valves)
3.9.3*	3.9.3	Nuclear Instrumentation (*same)
3.9.7*	3.9.4	Refueling Cavity Water Level (*same)
3.9.4*	3.9.5	Containment Penetrations (*same)
None	3.9.6	Containment Air Filtration System (VFS)
3.9.5*	None	(*Residual Heat Removal and Coolant Circulation - High Water Level)
3.9.6*	None	(*Residual Heat Removal and Coolant Circulation - Low Water Level)
None	3.9.7	Decay Time

The AP1000 specifications for boron concentration, unborated water sources, nuclear instrumentation, and refueling cavity water level contain no significant differences from the corresponding STS specifications. Therefore, TS 3.9.1, 3.9.2, 3.9.3, and 3.9.4 are acceptable.

AP1000 TS 3.9.5 for containment penetrations during movement of irradiated fuel assemblies within containment differs from the STS in two respects. Unlike the STS, maintaining closure of the containment penetrations during fuel movement does not satisfy the criteria of 10 CFR 50.36(c)(2)(ii). Rather, TS 3.9.5 is provided as an additional level of defense for the in-containment fuel handling accident (FHA). The design-basis, in-containment FHA safety analysis shows acceptable dose consequences without crediting containment closure or filtration of containment ventilation exhaust. In addition, LCO 3.9.5 specifies the option of placing the non-safety-related containment air filtration system (VFS) in operation in lieu of satisfying the closure provision for the equipment hatch, the personnel airlock, and the containment spare penetrations. This option for meeting the LCO will ensure filtration of containment ventilation exhaust in the event of a FHA involving fuel damage. The staff finds that these two differences are appropriate for the AP1000 design because containment closure and VFS operation are not credited in the inside-containment FHA analysis. Also, specifying two options for meeting the LCO provides operational flexibility during fuel movement inside containment. Therefore, TS 3.9.5 is acceptable.

Section 3.9 of the AP1000 TS includes a separate specification for the VFS, applicable during irradiated fuel movement in the fuel building, to establish the LCO, required action, and surveillance requirements for this FHA defense in depth feature. This specification is consistent with the format and usage rules of the STS. The design-basis, fuel building FHA safety analysis demonstrates acceptable dose consequences without crediting filtration of fuel building ventilation exhaust by the VFS. Accordingly, mitigation of a fuel building FHA by the VFS does not satisfy the criteria of 10 CFR 50.36(c)(2)(ii). This function is included in the AP1000 TS for defense in depth. Therefore, TS 3.9.6 is acceptable.

The AP1000 TS do not include a specification for the non-safety-related normal residual heat removal system (RNS), which corresponds to the residual heat removal system in the STS. The AP1000 employs passive safety-related methods for removing decay heat when the plant is in the refueling mode. One such method is feed-and-bleed from the IRWST if water remains available in the IRWST. If not, then decay heat may be removed by refueling cavity boiling if the refueling canal is full and the reactor pressure vessel upper internals are removed. To retain sufficient coolant inventory using this method, the containment must be closed. Because the accident analyses do not assume that the RNS will function in a loss of cooling event during refueling shutdown conditions, the AP1000 RNS does not satisfy the criteria of 10 CFR 50.36(c)(2)(ii). However, RNS short-term availability controls have been established for plant conditions during which the RNS has been determined to be important from a RTNSS perspective. Therefore, omitting specifications corresponding to the STS residual heat removal requirements during refueling operations is acceptable.

The time interval between the time the reactor was last critical and the initial movement of an irradiated fuel assembly from the reactor core is a key assumption in the dose consequence estimates of an AP1000 design-basis FHA analysis, as well as in the spent fuel pool cooling requirements. As such, this decay time satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii) and is required to be included in an LCO in AP1000 TS, preferably in TS Section 3.9. The applicant did not propose a decay time specification in the AP1000 TS. This was Open Item 16.2-3 in the DSER.

In its response to Open Item 16.2-3, the applicant proposed to add TS 3.9.7, “Decay Time,” and the associated Bases. This specification provides a decay time limit and associated action and surveillance requirements consistent with the AP1000 FHA analysis, STS format, and requirements of 10 CFR 50.36. Therefore, TS 3.9.7 is acceptable and Open Item 16.2-3 is resolved.

The AP1000 TS associated with refueling operations implement modified versions of the STS for refueling operations. The staff finds that these specifications have been constructed to be essentially equivalent to the STS for the corresponding refueling constraints. The staff agrees that for those cases in which a TS corresponding to the STS has not been included, AP1000 design differences provide sufficient justification for such an omission. Therefore, the staff finds the AP1000 refueling operations TS acceptable.

16.2.13 AP1000 Shutdown Operations

The applicant proposed new TS to control the availability of portions of the PXS, PCS, containment closure, and related systems during shutdown operations (Modes 5 and 6). These new specifications are intended to maintain the capability of passively cooling the core and maintaining cooling water inventory inside the containment following loss of the RNS during shutdown operations. If the RCS boundary is closed, the PRHR system will eventually be able to remove core decay heat following heatup of the RCS. If the RCS is open, the loss of residual heat removal results in steam being released to the containment. Core cooling can be maintained via a feed-and-bleed-type injection from the IRWST and eventually long-term containment sump recirculation, if necessary. In either case (RCS open or closed), as long as the containment is closed and sufficient cooling is provided through the containment shell to condense the steam, the condensate will eventually drain back to the RCS, providing long-term decay heat removal. The TS for the ADS, PRHR, PCS, and containment penetrations provide assurance that portions of these systems and components will be maintained for shutdown conditions. In addition, a number of I&C ESFAS signals have been added to ensure the ability to actuate these systems during Modes 5 and 6.

The AP1000 TS associated with shutdown operations do not have equivalent STS versions. The staff finds that the shutdown operation TS have been constructed to be essentially equivalent to the STS format and usage rules. In addition, the staff finds these TS to be conservative or improved compared to the STS shutdown operations provisions. Therefore, the staff finds the AP1000 TS for shutdown operations to be acceptable.

16.2.14 AP1000 TS Section 4.0, “Design Features”

The AP1000 design features correspond to, and are consistent with, those specified in the STS. Therefore, Section 4.0 of the TS acceptable.

16.2.15 AP1000 TS Section 5.0, “Administrative Controls”

The AP1000 administrative controls correspond to, and are consistent with, those specified in the STS. Therefore, Section 5.0 of the TS is acceptable.

16.3 Conclusions

Based on the staff’s review of the AP1000 TS, the staff concludes that the proposed AP1000 TS are consistent with the regulatory guidance contained in the STS. The proposed TS contain design-specific parameters and additional TS requirements considered appropriate by the staff. The staff concludes that the AP1000 TS comply with 10 CFR 50.34 and 10 CFR 50.36 and are, therefore, acceptable.