16 TECHNICAL SPECIFICATIONS

16.1 Introduction

The AP1000 technical specifications (TS) were modeled after Revision 2 of the "Standard Technical Specifications, Westinghouse Plants," NUREG-1431 (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 (58 FR 39132), and 10 CFR 50.36, "Technical Specifications," as amended July 19, 1995 (60 FR 36953). Westinghouse states that the AP1000 TS comply with 10 CFR 50.36(c)(2)(ii), which requires TS to include a limiting condition for operation for each item meeting one or more of the following 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 probabilistic safety assessment has shown to be significant to public health and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff's review of the AP1000 TS concentrated on differences from the STS. These differences are the result of the new passive systems design, structural differences from existing systems, advanced microprocessor-based instrumentation and control, and the results of the review of shutdown operations.

The staff forwarded Westinghouse comments from its review of the AP1000 TS for resolution and incorporation into the final TS. The final AP1000 TS, included in design control document (DCD) Tier 2 Section 16.2, provides resolution of issues raised by the staff and are certified to be accurate by Westinghouse.

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 assuring that the AP1000 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 which met the criteria in 10 CFR 50.36(c)(2)(ii).

The AP1000 design includes safety systems that are 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 requested that the AP1000 TS be modeled after NUREG-1431 to the maximum extent possible, it was necessary to develop TS beyond those in the STS to account for the AP1000 advanced, passive, design features. However, in most cases, the AP1000 system design functions are similar to existing pressurized-water reactor (PWRs) even though the components and systems are new. The staff requested that Westinghouse model the AP1000 TS based on the equivalent STS safety functions. Where 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 limiting conditions for operation were maintained, consistent with the STS provisions for the equivalent safety function.

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

A comparison of the AP1000 TS with STS and an evaluation of differences are as follows:

AP1000 TS “USE AND APPLICATION”

The AP1000 TS Section 1.1 definitions that correspond to those given in STS 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, AP1000 TS Section 1.1 contains a definition not found in the STS, i.e., for Dose Equivalent Xe-133. 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 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.” Limits are placed on these two quantities in AP1000 TS 3.4.10, “RCS Specific Activity,” in accordance with Criterion 2, to ensure that the doses resulting from a design-basis accident (DBA), e.g., 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.

TS Section 1.1 omits STS definitions of $\bar{E}$ - Average Disintegration Energy, Master Relay Test, and Slave Relay Test because AP1000 TS do not use these definitions.

The AP1000 TS Section 1.2 on logical connectors, Section 1.3 on required action completion time rules, and Section 1.4 on surveillance requirement frequency rules are consistent with those given in STS and are acceptable to the staff.

AP1000 TS “SAFETY LIMITS”

The AP1000 TS Section 2.0 safety limit specifications are consistent with those given in STS and are acceptable to the staff.

AP1000 TS “LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY AND SURVEILLANCE REQUIREMENT (SR) APPLICABILITY”

The AP1000 TS Section 3.0 governs the general application of LCOs and SRs. The Section 3.0 specifications corresponding to those given in STS (LCO 3.0.1 through LCO 3.0.7, SR 3.0.1 through SR 3.0.4) are acceptable to the staff because they are consistent with STS.

In addition, Section 3.0 includes LCO 3.0.8 to specify appropriate remedial actions in the event applicable shutdown LCOs 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 LCO 3.0.8 and LCO 3.0.3 apply under similar conditions (when an LCO’s action requirements are not met and no other action is specified, or none of the LCO’s action requirements 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 action that will maintain the plant in a safe condition in the event a shutdown LCO is not met and either the LCO’s associated action requirements are not met, or no associated action requirements are specified.

AP1000 TS “REACTIVITY CONTROL SYSTEMS”

The AP1000 TS Section 3.1 governs reactivity control systems. The Section 3.1 specifications corresponding to those given in STS 3.1.1-3.1.8 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. It requires two operable isolation valves capable of isolating the chemical and volume control system (CVS) from the demineralized water storage tank. The AP1000 TS contain this specification because this isolation condition satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii). 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.

AP1000 TS "POWER DISTRIBUTION LIMITS"

The AP1000 TS Section 3.2 governs core power distribution limits. The Section 3.2 specifications corresponding to those given in STS 3.2.1-3.2.4 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 power distribution parameters within the core via fixed incore detectors. It actuates alarms to alert control room staff in time to take corrective action when an OPDMS-monitored power distribution parameter is approaching the specified limit. The AP1000 TS contain this specification because the OPDMS satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii). The new OPDMS specification conforms to the format and usage rules of the STS, and is acceptable because it will preclude the core power distribution from exceeding the limits on initial conditions assumed in the safety analyses.

AP1000 TS "INSTRUMENTATION"

The AP1000 TS Section 3.3 contains significant differences from the instrumentation and control (I&C) provisions in the STS. One source of differences is the AP1000's use of micro-processor (or digital) based I&C systems. Another is the non-safety-related designation of a number of active systems in the AP1000 design that correspond to safety-related systems in the STS. Westinghouse 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.

The AP1000 TS Section 3.3 contains four I&C specifications based on corresponding specifications in the STS. These are 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, 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 in corresponding STS 3.3.1 for RTS, STS 3.3.2 for ESFAS, STS 3.3.3 for 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 boron dilution protection system instrumentation.

TS Section 3.3 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 boron dilution protection systems are not presented in separate specifications. Rather, AP1000 TS 3.3.2 for ESFAS instrumentation includes these functions.

The staff requested Westinghouse to justify the use of WCAP-10271-P-A Supplement 2, Revision 1, June 1990, 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. Westinghouse 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, in that 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.

TS Section 3.3 for the AP1000 safety-related instrumentation systems implement modified versions of STS for 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 above, the staff agrees that 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 specified instrumentation systems are capable of performing their intended safety functions as assumed in the safety analyses in the event of a design-basis accident 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 nonsafety-related system that has an anticipated transient without scram (ATWS) mitigation (reactor trip, turbine trip, and passive residual heat removal heat exchanger (PRHR HX) actuation) function and an ESFA function for accident mitigation. The DAS automatic functions use equipment that is diverse from the PMS, the safety-related I&C system, from sensor output to the final actuated device to automatically initiate a reactor trip, or 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, Westinghouse determined that automatic DAS functions also do not meet Criterion 4.

However, as described in WCAP-15985, Revision 1, dated April 2003, Westinghouse determined that the regulatory treatment of non-safety systems (RTNSS) analysis for DAS automatic functions shows that they are important because they compensate for probabilistic risk assessment (PRA) accident mitigation uncertainty; that is, they provide margin in the PRA sensitivity analysis (see Chapter 22 of this report). This analysis assumed no credit for nonsafety-related systems, structures and components (SSCs) to mitigate at-power and shutdown events, but did consider nonsafety-related SSCs in the calculation of initiating event frequencies. Thus, AP1000 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 ESFA 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 common-mode failure of the PMS automatic and manual actuations evaluated in the AP1000 PRA. Westinghouse determined that crediting the DAS manual controls was necessary to meet the large release frequency safety goal in the focused PRA (see Sections 22.3.3 and 22.5.8 of this report). From this, Westinghouse concluded that the DAS manual controls satisfy Criterion 4 of 10 CFR 50.36(c)(2)(ii), and accordingly proposed TS 3.3.5. In the event 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 conditional pending completion of the resolution of the open item associated with Section 19.1.7 of this report (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 staff finds that 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.

AP1000 TS “REACTOR COOLANT SYSTEM”

The AP1000 RCS specifications correspond to those in 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, on RCS operational leakage, differs from the STS by specifying an allowable unidentified leakage of 1.89 liters per minute (lpm) (0.5 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, on RCS leakage detection instrumentation, also differs from the STS to reflect the AP1000 design. These differences are acceptable because they are more restrictive than STS and accurately reflect differences in the AP1000 design related to reactor coolant leakage limitations and detection.

AP1000 TS 3.4.10, on 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 $\geq$ 48 hours. Although $\bar{E}$ is not used in the AP1000 TS, Westinghouse should explain why an equivalent surveillance using dose equivalent Iodine-131 is not proposed. This is identified as Open Item 16.2-1.

The AP1000 RCS TS section contains additional specifications to address (1) minimum RCS flow, (2) the ADS, (3) the 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 over pressurizing 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, and 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 shutdown 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 actions permit 6 hours to restore one flow path to operable status. This is acceptable, according to the proposed Bases, because of conservatisms in the coolant-addition transient analysis; Westinghouse has performed a more realistic analysis that shows overfilling does not occur. Assurance of operability of the four vent valves is provided by the valve stroke-open surveillance in accordance with the inservice testing program. 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 steam generator tube rupture accidents. The accident analyses of such events assumes that excessive addition of coolant to the RCS from the CVS makeup would increase the associated consequences, and thus assumes 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 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 TSs, 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.

AP1000 TS “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, and 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 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)
None	3.5.2	CMTs - Operating
None	3.5.3	CMTs - Shutdown, RCS Intact
3.5.2*	None	(*ECCS - Operating)
3.5.3*	None	(*ECCS - Shutdown)
None	3.5.4	PRHR HX - Operating
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
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 supply water to the reactor vessel during the blowdown and refill phases of a large break LOCA, provide RCS makeup for a small break LOCA, and 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 accumulator specification is very similar to corresponding 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 limits, which is less restrictive than the STS's 1-hour completion time. 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 (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 ten less than the value indicated to have a small impact on plant risk (Regulatory Guide 1.177 gives this as an ICCDP value of 1E-7). This completion time is therefore acceptable. This acceptance is conditional pending completion of the resolution of the open item associated with Section 19.1.7 of this report (Open Item 19.1.10.1-3) to confirm proper use of the PRA results. Based on the above, TS 3.5.1 is 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 PRHR system transfers decay heat to the IRWST via natural circulation from the RCS whenever forced circulation cooling of the RCS is not available via the steam generators.

The IRWST provides low-head safety injection cooling and boration via gravity injection after the RCS has been depressurized via the ADS (TS 3.4.11, 3.4.12, and 3.4.13) or from an RCS break. Operability of the IRWST includes operability of the 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, which is consistent with STS 3.5.2; however, the 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 the plant does not meet two or more PXS specifications (e.g., 3.5.1, 3.5.2, 3.5.4 and 3.5.6) concurrently. The 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 Bases, the staff's review of the PXS TS action requirements is considered incomplete. This is Open Item 16.2-2.

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 omitted.

The AP1000 TSs 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 required shutdown margin after an accident is accomplished by the accumulators, CMTs, and IRWST.

The AP1000 specifications for the PXS implement modified versions of STS for ECCS. The staff finds that they have been constructed to be essentially equivalent to the STS for the ECCS functions. The staff agrees that where TS corresponding to the STS have not been included, AP1000 design differences provide sufficient justification for such omissions. Therefore, the AP1000 PXS TS are acceptable.

AP1000 TS “CONTAINMENT SYSTEMS”

The AP1000 TS 3.6.1-3.6.5 are essentially identical to the corresponding atmospheric containment STS for containment operability, air locks, isolation valves, pressure, and temperature. The major difference between the AP1000 atmospheric containment design and the atmospheric containment used by many currently operating Westinghouse PWRs is the passive containment cooling system (PCS). This is reflected in 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 kPa (59 psig). The PCS uses natural air circulation past the containment shell enhanced by distribution of cooling water onto the containment shell. The water is gravity fed from a 2864 m^3 (756,700 gallon) (useable capacity) annular tank designed into the roof on the containment shield building. This tank has sufficient water to provide at least three 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.

Westinghouse did not propose a specification for the passive autocatalytic recombiners for design basis hydrogen control; hence the AP1000 DCD for the control of combustible gas in containment during accidents does not comply with current regulations.

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 and 10 CFR 52.47, along with the creation of a new rule, 10 CFR 50.46a (see 67 FR 50374, August 2, 2002). These proposed changes are meant to risk-inform the combustible gas control requirements, and constitute significant relaxations of the requirements. The staff's evaluation of combustible gas control is contained in Section 6.2.5 of this report. 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 is written in anticipation of these rule changes. As such, it is not in compliance with the current, more-restrictive regulations. Furthermore, until the proposed rule changes are final and effective, the staff cannot know for certain if the DCD will comply with the revised rule. Therefore, the issue of containment combustible gas control, including omission of a corresponding TS, must remain open at this time. This issue is identified in Section 6.2.5 of this report as Open Item 6.2.5-1.

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 postaccident 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 which only applies during movement of irradiated fuel assemblies in containment. STS Section 3.6 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).

AP1000 TS Section 3.6 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 they have been constructed to be essentially equivalent to the STS for the containment cooling and isolation functions. The staff agrees that where 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.

AP1000 TS "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))
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))

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
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 MSSV specification only differs from the STS to account for the AP1000 design, which has two steam generators (SGs) each with six MSSVs, instead of four SGs each with up to five MSSVs. The AP1000 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 MFIV and MFCV specification differs from the STS only to account for the fewer number of valves in the AP1000 design and in the required actions, which contain the option of placing the plant in Mode 5 instead of isolating the flow path with the inoperable valve(s). Accordingly, the differences from the STS in these three specifications 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. They are, therefore, 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, and during transients in the event of main feedwater system unavailability. The safety related decay heat removal system for the AP1000 is, however, provided by the PRHR system (TS 3.5.4 and 3.5.5), instead of by AFW flow from the CST via a turbine-driven AFW pump to an SG expelling decay heat through release of steam through an ADV. Consequently, specifications corresponding to the STS specifications for the AFW system and CST are not required, and are 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; see discussion of TS 3.7.10 below. Omission of these STS requirements is acceptable because of differences in the AP1000 design compared to currently operating plants, upon which STS are based.

AP1000 TS do not contain specifications for the component cooling water system (CCS), the SWS, or the UHS. The CCS and 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 during normal reactor shutdown and cooldown through the normal residual heat removal system heat exchangers (RNS HXs). The PXS and the PCS provide safety related heat removal in the event of a DBA; and these systems do not rely on the CCS and SWS. Omission of specifications for CCS, SWS, and UHS (cooling tower) is acceptable because these systems perform no 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 standpoint, as described in WCAP-15985, Revision 1. These three systems are thus 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, which characterize the STS CREFS and CREATCS, respectively. If radiation monitors in the normal control room 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 inleakage. In addition, the thermal design of the control room boundary along with the VES air supply will maintain temperature in the control room 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 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 to within General Design Criteria-19, “Control Room,” criteria.

The AP1000 TS 3.7.7 for the startup feedwater system’s isolation and control valves 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 in the event of an inside-containment feedwater line break or steam line break. 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 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, and 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 design basis accident. Accordingly, this limit does not satisfy any of the criteria in 10 CFR 50.36(c)(2)(ii), but is included in TS for defense in depth. Therefore, TS 3.7.8 is acceptable.

AP1000 TS 3.7.9 was added to require 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 water lost through boiling of pool water in the event of a loss of normal cooling by the nonsafety spent fuel pool cooling system for an extended period. The required water sources are the PCS water storage tank and the cask washdown pit. 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 TS for defense in depth. This specification is consistent with the format and usage rules of the STS, and will ensure a makeup water source is available in the event 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 power operated relief valve (PORV) flowpaths (both the PORV (functions as an atmospheric dump valve) and 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 and also following 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 AP1000 PRA insights. These completion times are acceptable pending completion of the AP1000 PRA review by the staff. Other than this, TS 3.7.10 is acceptable.

The AP1000 TS Section 3.7 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 where TS corresponding to STS have not been included, AP1000 design differences provide sufficient justification for such omissions. Therefore, the staff finds the AP1000 plant system specifications acceptable.

AP1000 TS “ELECTRICAL POWER SYSTEMS”

The AP1000 does not rely on ac power to mitigate design-basis accidents or attain safe shutdown (except for instrumentation and control which is ultimately powered from the dc system). Thus, STS 3.8.1 for ac sources-operating; 3.8.2 for ac sources-shutdown; and 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 includes 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 from the STS. The completion time for one dc subsystem inoperable was extended from 2 hours to 6 hours on the basis of 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 still reach safe-shutdown with two subsystems inoperable and the ability to mitigate most DBAs. Other specifications on inverters, distribution subsystems, and battery cell parameters are either consistent with 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 where TS corresponding to STS have not been included, AP1000 design differences provide sufficient justification for such omissions. Therefore, the staff finds the AP1000 electrical power system TS acceptable.

AP1000 TS “REFUELING OPERATIONS”

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

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
3.9.1*	3.9.1	Boron Concentration (*same)

STS	AP1000 TS	AP1000 TS TITLE (*STS TITLE)
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)

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 VFS system 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 these two differences are appropriate for the AP1000 design because containment closure and VFS system 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.

The AP1000 TS Section 3.9 includes a separate specification for the VFS, which is 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 shows 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 AP1000 TS for defense in depth. Therefore, TS 3.9.6 is acceptable.

The AP1000 TS do not include a specification for the nonsafety-related RNS, which corresponds to the STS residual heat removal system. The AP1000 safety-related methods of removing decay heat when the plant is in the refueling mode are passive. One 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 the RNS to function in a loss of cooling event during refueling shutdown conditions, the AP1000 RNS does not satisfy any of 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 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 AP1000 design basis fuel handling accident analysis dose consequence estimates, and 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. Westinghouse did not propose a decay time specification in the AP1000 TS. This is Open Item 16.2-3.

AP1000 Shutdown Operations

Westinghouse 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. 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 and assessed to be conservative or improved compared to STS provisions during shutdown operations. Therefore, the staff finds the AP1000 shutdown operations TS acceptable.

AP1000 TS “DESIGN FEATURES”

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

AP1000 TS “ADMINISTRATIVE CONTROLS”

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

16.3 Conclusion

Based on the staff’s review of the AP1000 TS, as discussed above, 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 pending resolution of Open Items 16.2-1, 16.2-2, and 16.2-3.