TECHNICAL EVALUATION REPORT
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THE ACCEPTABILITY OF FORT ST. VRAIN UPGRADED TECHNICAL SPECIFICATIONS FOR STRUCTURES, SYSTEMS, AND COMPONENTS WITH SAFETY-RELATED AND IMPORTANT-TO-SAFETY COOLING FUNCTIONS

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1.0 Summary

The proposed upgraded Technical Specifications[1-5,54,55] for Fort St. Vrain (FSV) structures, systems, and components (SSCs) that perform safety-related[6] or important-to-safety[7] cooling functions have been reviewed and evaluated by Oak Ridge National Laboratory (ORNL). The subject Technical Specifications have been found (1) to satisfy the FSV licensing basis as embodied in the FSV UPDATED FINAL SAFETY ANALYSIS REPORT (UFSAR)[8] and (2) to provide a functionally equivalent set of specifications for each of the cooling functions that are addressed in the Westinghouse Standard Technical Specifications (W-STS).[9] As used here, "functional equivalence" means that the FSV Specifications either implement the same or very similar provisions as the W-STS or accommodate a cooling function in an equivalent manner that is unique to the configuration of the FSV SSCs or to the FSV licensing basis.

The acceptability of the proposed upgraded Technical Specifications for the FSV cooling functions has been established using a methodology which is described in detail in this Technical Evaluation Report (TER). Previous effort by the staff of the U.S. Nuclear Regulatory Commission (NRC) had emphasized establishing the acceptability of the proposed upgraded Specifications based solely on showing the consistency of the proposed revisions with the FSV UFSAR and with the existing FSV Specifications while using the W-STS as general guidance especially with regard to format. However, the comprehensive review and evaluation methodology implemented by ORNL used the W-STS to establish a more logical and focused framework for assessing and evaluating the completeness and adequacy of the proposed FSV Specifications. The need for focus was necessitated in part because the FSV UFSAR (the licensing basis from which the Technical Specifications are drawn) often lacks precision and clarity as to SSC functional significance. This is because the original FSAR was written under early (1966) emerging guidelines for content. The early guidelines portend but do not specifically reflect the level of consistency currently required between technical specifications and the supporting safety analysis report. Thus, the W-STS was used as a guide first to identify generic cooling functions and then to assess and evaluate how the FSV UFSAR had addressed each function and whether the proposed Specifications were consistent

with the licensing basis in the FSV UFSAR. As discussed in Sections 2 and 3 of this TER, the ORNL methodology is judged to be consistent with the intent and objectives reflected in the U.S. Atomic Energy Commission's (AEC's)* statements of considerations that accompanied the rulemaking for the regulations that governed the initial FSV licensing and the development of the existing FSV Specifications. However, as also discussed in Sections 2 and 3 of this TER, the ORNL methodology executes the assessment using current regulatory guidelines while recognizing that the FSV license was, in most cases, formulated and approved prior to the development and implementation of the most current applicable regulations and regulatory guidelines. Key steps in the ORNL methodology are listed as follows:

- Identify a set of generic cooling functions that are cited as being important-to-safety in the General Design Criteria (GDC) for Nuclear Power Plants per Appendix A, Part 50 to Title 10 of the Code of Federal Regulations (that is, 10 CFR Part 50, Appendix A).
- Correlate the list of generic cooling functions with both:
  - the W-STS coverage of light water reactor (LWR) SSCs that are required to effect the generic cooling functions, and
  - the acceptance criteria for LWR SSCs that perform such cooling functions as discussed in the LWR *Standard Review Plan* (SRP).[10]
- Using the correlated list of generic cooling functions that are implemented in the W-STS, identify the proposed FSV Specifications that address the same cooling functions.
- Identify the similarities and the differences between the FSV Specifications and W-STS functional requirements including breadth and depth of coverage.
- Establish the technical and licensing basis for differences between the FSV Specifications and W-STS based on the FSV UFSAR.
- Review the FSV UFSAR against both the existing and the proposed FSV Technical Specifications to identify the licensing basis for unique specifications and the need for additional cooling function specifications due to unique functional requirements at FSV.

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* The AEC was the predecessor of the NRC for regulation of commercial nuclear power facilities.

- Compare and review both the existing and the proposed FSV Technical Specifications to assure completeness and correctness.

With the concurrence and oversight of the NRC staff, the above-cited methodology has been implemented in an iterative fashion that included consultation with and input from the licensee for FSV. Based upon the review and evaluation documented in this TER, the proposed Technical Specifications that are discussed in Section 4 below and listed in Table 2 of this TER are judged to be technically adequate and acceptable.

2.0 Introduction and Background

2.1 Regulatory and Licensing Bases for the Existing FSV Technical Specifications

The requirement for the correlation of the content of technical specifications with both the content of safety analysis reports and the use of principal design criteria to evaluate the acceptability of license applications was established as a fundamental basis for reactor plant licensing and regulation in the AEC's statements of considerations that accompanied the proposed and final rule changes that were issued respectively in August 1966 (Ref. 36) and December 1968 (Ref. 37) and that affected 10 CFR Parts 50.34, 50.36, and 50.59. Per the provisions of 10 CFR Part 50.36(d) as issued in December 1968, plants for which a construction permit had been issued prior to January 16, 1969, such as FSV,[38] had the option of developing technical specifications under the earlier 1962-issued regulations[39] although the commission retained the authority to require upgrading the content and scope of such plant technical specifications at any time. As evidenced by Attachment F to Ref. 48, the applicant for FSV chose to follow the 1968 regulations[37] in the development of the plant technical specifications.

As expressed by the AEC in 1966 and again in 1968 (Refs. 36 and 37), the intent was to "establish a revised system of technical specifications which focuses attention on items more directly related to public safety" with "emphasis... placed on two general classes of technical matters... related to prevention of accidents, and... related to the mitigation of the consequences of accidents." The "revised system" was to "provide for systematic documentation [and 'systematic analysis and evaluation'] of the technical and operational bases for specifications and [to] provide guidance as to the content of preliminary safety analysis report and [final] safety analysis reports required for permits to construct, and licenses to operate, production or utilization facilities." The AEC's 1968 statements of considerations[37] further clarified the AEC's intent that "the analysis and evaluation of the facility required under [10CFR Part] 50.34 must provide (1) the necessary information from which technical specifications will be selected, and (2) the detailed bases for the specifcations derived." To paraphrase the final revised regulations, "the technical specifications will be derived from the analyses and evaluations included in the safety analysis reports and amendments thereto," and the design description in the safety analysis reports is to include "the principal design criteria, the design bases and the relation of the design bases to the principal design criteria" and the "identification and justification for the selection of the variables, conditions or other items which are determined as the results of safety analysis and evaluation to be subjects of technical specifications, with special attention to those items which significantly influence the final design."* To carry out this revised system, the AEC issued guidelines for the content of technical specifications[40] and for the content and organization of safety analysis reports.[41] The AEC guidelines for the content of technical specifications further clarified the level of detailed analysis and evaluation expected in the safety analysis reports from which the specifications are to be derived (see pp. 11 and 26, Ref. 40).

In addition, the AEC statements of considerations cited successive sets of proposed principal design criteria that were issued by the AEC respectively in 1965 (Ref. 42) and 1967 (Ref. 43). Although subsequently subjected to other revisions, the final and current set of general design criteria (GDC) for nuclear power reactors was issued as Appendix A to 10 CFR Part 50 in February 1971 (Ref. 44), which was more than two years after the issuance of the revised technical specifications and safety analysis report rule and associated guidelines. As proposed in Attachment E to Amendment No. 10 of the FSV Preliminary Safety Analysis Report (PSAR)[45] and as accepted in Section 6 of the AEC's 1968 Safety Evaluation[46] supporting the FSV construction permit, the licensing basis at FSV is conditioned only on meeting "the intent of the applicable criteria" from the 1967-proposed set of GDC and not rigorous adherence to all of the 1967-proposed criteria, which were acknowledged as having been written based on experience with water-cooled reactors. This position was not altered by the AEC's 1972 Safety Evaluation[47] that supported the FSV operating license and that was issued after the 1971 regulation promulgating the current GDC.[44]

Both the originally proposed FSV Technical Specifications in Attachment F to Amendment No. 15 of the FSV PSAR[48] and the 1972-final proposal in Amendment No. 25 of the FSAR[49] followed the format given in the AEC's 1968 guide to technical specification content.[40] Per Section 7.0 of the AEC's 1972 Safety Evaluation,[47] the changes between the proposed Specifications in Amendment No. 15 of the PSAR[48]

* Per 10CFR Part 50.34(a)(5), the FSV preliminary safety analysis report was obviously exempted from this latter requirement since the construction permit was issued prior to January 16, 1969, but, per 10CFR Parts 50.34(a)(5) and 50.36(b) and (d), the FSV final safety analysis report supporting the operating license was not exempted from being made current consistent with the intent of 10CFR Part 50.34(b)(1) through (b)(6).

and those in Amendment No. 25 of the FSAR[49] were the result of a detailed review by the AEC and of "numerous meetings with the applicant to discuss their content;" however, the records of such meetings are not available in the NRC's Public Document Room and are not listed on the AEC's Chronological Sheets Index for Docket 50-267. With regard to safety-related cooling functions the major change that was made in the proposed Specifications during FSV licensing between PSAR Amendment No. 15 and FSAR Amendment No. 25 related to the deletion of reliance on the emergency condensate and associated systems for Class I cooling* and the institution of reliance instead on the firewater system for Class I cooling.

In addition, both the FSV PSAR and FSV FSAR adhered to the organization guidelines of the AEC's 1966 guide;[41] however, the content of the FSV FSAR, particularly with regard to establishing the detailed bases for the FSV Technical Specifications, is judged to have adhered less closely to the recommendations of either the 1966 or the 1968 guides.[40,41] Of course, the FSV FSAR both was written and submitted by the applicant and was reviewed substantially by the AEC prior to (1) the November 1970 issuance of the "Safety Guide" series, (2) the February 1971 issuance of the current GDC, (3) the November 1971 issuance of the "Information Guide" series, (4) the November 1972 combining of the Safety and Information Guides into the Regulatory Guide series and concurrent issuance of revised format and content guidance for safety analysis reports,[50] and (5) the subsequent development of the standard review plans that are based on using the 1971 set of GDC and the Regulatory Guides to derive acceptance criteria for plant licensing. Thus, current regulatory guidance for the content of FSARs to support the derivation of technical specifications was developed either during the latter part of or subsequent to the FSV licensing activity for the operating license.

Finally, in the statements of considerations[36,37] that accompanied the 1966-proposed and 1968 final rule changes affecting 10 CFR Part 50.36 with regard to the content of technical specifications, the AEC indicated the intent to make available sample or example technical specifications for applicants and licensees to follow in the development of plant specific specifications. The AEC's 1968 guide[40] to technical specification content cited three such example specifications which are very similar or identical to the format adopted in the FSV existing

* The initially envisioned Class I system per the initially proposed Technical Specifications included both small ($12\frac{1}{2}$% capacity) condensate pumps, both auxiliary boiler feed pumps, both condensate storage tanks, the decay heat removal exchanger, and the emergency condensate header. By inference drawn off the docket record, only the emergency condensate header out of this set of equipment was determined by AEC review to meet design requirements for the design basis earthquake and the maximum tornado. However, the FSV UFSAR still credits the use of this equipment as part of the primary success paths in response to nonseismically-induced anticipated transients.

Specifications. Subsequently, as noted in the Foreward to ANSI/ANS-58.4-1979 (Ref. 51), the AEC's Standard Technical Specification (STS) Program was initiated in the spring of 1972, and, as noted in Section 16.0 of the *Standard Review Plan*,[10] the initial implementation of the STS program was made on the Donald C. Cook (Docket No. 50-135) operating license issued in October 1974 (Ref. 52). As also noted in the Foreward to ANSI/ANS-58.4-1979, the AEC and later the NRC approached the development of the STS with the intention of using them "as working documents" instead of providing "direct guidance on the methods and rationale used" in developing technical specifications and "criteria for their content." Thus, the AEC reportedly did not attempt to define the STS content criteria while FSV was still being licensed, and ANSI/ANS-58.4-1979 represents a retrospective attempt at developing such guidance from experience with the subsequent STS examples. In addition, the ANSI standard has not been endorsed formally by the NRC for universal application.

2.2 Base Objectives and Scope for the Specification Upgrade

Consistent with the provisions of 10 CFR Part 50.36(d)(3) and in accordance with the recommendations of the NRC's 1984 audit of FSV operations,[11] Public Service Company of Colorado (PSC) initiated a Technical Specification Upgrade Program (TSUP) to enhance the "clarity, completeness, and correctness" of the existing Technical Specifications.[12] PSC and NRC agreed upon both a scope[13,14] for implementing the TSUP and a set of guidelines[13] for applying to FSV the format and coverage of the current Standard Technical Specifications (STS)[9,15–17] that have been approved by the NRC for generic application to current generation LWRs. The W-STS[9] and ANSI/ANS-58.4-1979 were chosen as the standards for guidance in developing a complete set of specifications in the FSV TSUP, but these documents were not stipulated as providing acceptance criteria for the TSUP.

The items constituting the TSUP scope and the STS application guidelines are listed in Attachment 1. As indicated in Attachment 1, these items are designated respectively as P-1 through P-14 for the TSUP scope committed to by PSC (Attachment 1 to Ref. 13), as N-1 through N-7 for the additional scope items imposed on TSUP by the NRC (Enclosure to Ref. 14), and as G-1 through G-7 for the STS application guidelines recommended by PSC (Attachment 2 to Ref. 13). In particular, the PSC guideline G-7 stipulated the position that the FSV Specification requirements are only to be justified against the FSV licensing basis embodied in the FSV UFSAR, and PSC guidelines G-2 and G-7 stipulate that no STS requirements will be considered or utilized which open up the FSV licensing basis to further analysis, justification or backfitting of LWR requirements. Similarly, the NRC has interpreted that scope items P-3, P-11, N-2 and N-4 are not meant to require additional analysis at this time as part of the TSUP although the provisions of

10CFR Parts 50.34(a)(5) and (b), 50.36(b) and 50.71(e) have not been categorically waived as applicable to the bases of the upgraded Technical Specifications.

2.3 Reviews Performed Prior to ORNL Involvement

Prior to the inception of the ORNL review and evaluation of the proposed cooling function Technical Specifications in March 1986, PSC had previously submitted proposals[1,18] for technical specifications to address SSCs used in accomplishing safety-related cooling functions. The NRC staff reviewed these proposals and proposed in turn an alternatively worded set of specifications[19] to address the subset of SSCs comprised by the helium circulators, the steam generators, and the liner cooling system (LCS) for the prestressed concrete reactor vessel (PCRV). In February 1986, the licensee responded with a counter proposal[20] for specifications for the helium circulators, the steam generators and the PCRV LCS.

2.4 Summary of ORNL Review Activity

In March 1986, under the direction of the NRC Lead Engineer, G. L. Plumlee, III, the ORNL review of the proposed Technical Specifications[1,18–20] was initiated. With the concurrence of the NRC Lead Engineer, this review expanded in scope to address the cooling functions in a comprehensive and consistent manner. The approach used in the ORNL review is outlined below in Section 3.0 of the TER and the results of the review are discussed in Section 4.0.

Based upon the ORNL review, a draft set of comments and a markup of the affected draft specifications were provided to the NRC Lead Engineer in August 1986. After revision based on consultation with the staff, a final draft was provided to NRC in November 1986 with further minor changes submitted in January 1987. These comments were accepted by the NRC Project Manager and forwarded as NRC comments to the licensee in April 1987 (Ref. 21).

During the initial review period, additional changes to the existing Technical Specifications were proposed as new licensing actions to address both the need to prevent core channel flow instabilities under low flow conditions[22–24] and the recent changes in FSV SSC configurations due to Environmental Qualification under 10 CFR Part 50.59 (Ref. 25). In May 1987, to account for the impact of these changes to the existing Specifications, the proposed upgraded Specifications[1,2,20] were reviewed again by ORNL at the request of the NRC Lead Engineer (Dr. K. L. Heitner). Based on this review, additional comments and markups were prepared by ORNL in June 1987, and these were forwarded by NRC as part of a request for additional information that was sent to the licensee in July 1987 (Enclosure 3, Ref. 26).

The NRC and NRC contractors (including ORNL) held a meeting[27] with the licensee on August 25 and 26, 1987, at which time the licensee's responses to Refs. 21 and 26 were discussed in detail. Based on the August 1987 meeting, the licensee forwarded a submittal[28] to NRC on November 19, 1987, that included proposed revisions to the cooling function Technical Specifications and responses both to the initial set of NRC comments[21] and to the subsequent NRC request for additional information.[26] On December 2 and 3, 1987, the NRC and NRC contractors (including ORNL) held another meeting[29] with the licensee to discuss the proposed revisions and responses to comments. Based on the concurrence reached in the December 1987 meeting, the licensee forwarded a second submittal[3] on December 23, 1987, that included final drafts of the cooling function upgraded Technical Specifications and revised responses both to the NRC comments[21] and to the NRC request for additional information.[26] Further minor revisions have been submitted subsequently.[4,5,54]

3.0 Approach

This TER documents a review and evaluation of the set of PSC proposed draft upgraded Technical Specifications[1–5,54,55] that are to apply to those FSV structures, systems, and components (SSCs) that execute safety-related and important-to-safety cooling functions. For FSV, safety-related SSC configurations (UFSAR Appendix B.5.2.7 and UFSAR Tables 1.4-1, 1.4-2, and 8.2-8) are defined to be those that constitute the primary or backup success paths that mitigate the consequences of accidents, transients, malfunctions, and other challenges to the integrity of fission product barriers as described in the UFSAR. At FSV, safety-related SSCs are required to be and are seismically and environmentally qualified, with the sole exceptions being a few components of the Alternate Cooling Method (ACM) configuration (UFSAR Section 8.2.8.2 and Table 8.2-8) that is relied upon to mitigate the consequences of disruptive faults or events, such a major fire, in the congested cable areas. Important-to-safety SSC configurations are defined herein to be those that constitute preferred primary success paths that provide "reasonable assurance" of public health and safety by mitigating the consequences or effects of accidents, transients, malfunctions, and other challenges as described in the UFSAR but that have not been required to be seismically and environmentally qualified as part of the FSV licensing basis. At FSV, each important-to-safety SSC configuration is redundantly backed up by a safety-related SSC configuration. Since the failure of any nonsafety-related portions of the important-to-safety SSC configurations that are defined herein for FSV has been determined not to adversely affect the function of safety-related SSCs, the provisions of 10CFR Part 50.49(b)(2) do not apply to the nonsafety-related electric equipment that is associated with important-to-safety SSC configurations as defined and discussed in this TER.

To conduct the review and evaluation in a logical manner, the first step was to define a set of safety-related and important-to-safety cooling functions and subfunctions that would be expected either to be executed or otherwise to be accommodated by the FSV SSCs. To conduct the TSUP evaluation in a consistent and readily auditable manner, a generic set of cooling functions and subfunctions was defined based on identifying the set of cooling functions that are implemented in the W-STS consistent with the cooling functions defined in the GDC per 10 CFR Part 50, Appendix A. The 1967-proposed GDC,[43] against which FSV was licensed as meeting "the intent of the applicable criteria" as documented in UFSAR Appendix C, were also reviewed for identifying a generic set of cooling functions; however, the functions implied by the 1967-proposed GDC were found to be incomplete and inconsistent similar to the AEC's findings based on public comments on the 1967-proposed GDC as expressed in the statements of considerations that accompanied the issuance of the current GDC (Ref. 44). It is further noted that, although the 1967-proposed GDC lack specificity and clarity with regard to such functions as cooling water, residual heat removal, and the temperature-reduction function of the containment heat removal system, this lack of specificity did not preclude the AEC from including these functions as part of the initial STS implementation[52] at Donald C. Cook (Docket No. 50-315). Per Section 1.4 of the Cook UFSAR and per Appendix H of the original Cook FSAR, Donald C. Cook was also licensed as meeting "the intent of" the 1967-proposed GDC as was FSV. Also, the Donald C. Cook Technical Specifications were not approved until October 1974 which is nearly four years after the current GDC were made part of the regulations. Thus, there is precedent for interpreting functional analogies based on later regulations without requiring strict adherence to the later regulations as part of the licensing basis. Further, this precedent stems from the STS program itself, which is being used here as guidance for the FSV TSUP. In addition, the NRC staff has performed at least one recent safety evaluation for a FSV license amendment invoking the current GDC as guidance rather than the 1967-proposed GDC (see Ref. 53).

By addressing generic cooling "functions," the evaluation of the FSV TSUP draft against guidance of the LWR STS is performed in this TER based on "functional analogies" as opposed to "SSC (equipment) analogies." Equipment analogies are inappropriate because equipment can vary with different reactor types, but functional analogies should be more consistent among different reactor types and should be independent of specific SSCs that may be used to accomplish a given function in a given reactor type. Further, by addressing "functions," the evaluation focused on the "intent of" the GDC as opposed to specific equipment-related requirements; thus, the evaluation utilized the current GDC in a manner analogous to and consistent with the way in which the 1967-proposed GDC were factored into the initial FSV licensing. As discussed in Section 2.1 of this TER, the licensing basis for FSV is that FSV has been held to meeting the intent of but not a rigorous adherence to specific GDC.

The consistency between the generic cooling functions of the current GDC and the W-STS was further established by correlating the GDC with the acceptance criteria for the respective W-STS SSCs as documented in the applicable sections of the NRC's *Standard Review Plan*[10] for Safety Analysis Reports (SARs). As required by the provisions of 10 CFR Part 50.36(b) under which FSV was initially licensed, "technical specifications will be derived from the analyses and evaluations included in the safety analysis reports and amendments thereto." Thus, the set of generic cooling functions was identified consistent with current regulations (that is, the GDC), with the W-STS, and with the acceptance criteria that are used to review the analyses and evaluations of SSC performance that are required to be documented in the SARs from which technical specifications are to be derived. As described in Section 2.1 of this TER, this approach is interpreted to be consistent with the AEC's original intent with regard to developing technical specifications but is updated here to be consistent with current regulatory guidance. However, as discussed below, care has been exercised to assure that FSV Technical Specification requirements were only defined against the FSV licensing basis and not against non-applicable W-STS requirements nor LWR-specific regulatory guidance that would be inappropriate for FSV.

The resulting list and correlation of generic safety-related and important-to-safety cooling functions are provided in Table 1. Having identified the correlated list of generic cooling functions that are both performed by LWR SSCs and subjected to technical specification requirements, the next step was to review the proposed FSV Technical Specifications against the FSV UFSAR and to correlate these proposals and their licensing basis as given in the FSV UFSAR with the list of generic cooling functions. This correlation procedure has actually been accomplished in an interative manner as discussions have proceeded in NRC meetings with the licensee. Much of this discussion has focused on clarifying the FSV licensing basis due to the lack of clarity in the FSV UFSAR. The NRC comments given in Enclosure 1 to Ref. 21 reflect the results of the initial attempt to correlate the proposed FSV upgraded Technical Specifications and licensing basis with the cooling functions listed in Table 1 with the sole exception of spent fuel cooling which was not included in that iteration. Table 2 reflects the final correlation of cooling functions with the proposed final draft of the affected Technical Specifications as submitted in Refs. 3 through 5.

In the process of correlating the proposed Specifications with the generic cooling functions identified in Table 1, the provisions of the proposed FSV Specifications were also compared both with the provisions of the existing FSV Technical Specifications and, as indicated previously, with the licensing basis embodied in the FSV UFSAR. The results of this correlation are also recorded in Table 2. Further, relevant portions of UFSAR Chapters 3 through 10 and Chapter 14 were reviewed in detail to establish the existence of any potential cooling function requirements that might warrant Technical Specifications. The results of these reviews are documented in the following section of this TER.

4.0 <u>Results of Functional Analysis</u>

4.1 Top-Level Differences Between the FSV TSUP Draft and the W-STS

The manner in which the FSV proposed upgraded Technical Specifications accommodate the generic cooling functions has been illustrated in Table 2 and is discussed in detail below. However, there are several top-level differences between the proposed FSV Technical Specifications and the W-STS that should be noted first with regard to cooling functions. These differences arise primarily from the inherent differences between the thermal and structural characteristics of the High-Temperature Gas-Cooled Reactor (HTGR) and those of the pressurized water reactor (PWR).

These differences relate principally to the following areas:

- The use of operational modes to define redundancy requirements for the safety-related SSCs in the W-STS.

  Impact: Operational modes are not used for this purpose at FSV; another mechanism is employed based on a calculated parameter with the calculation controlled by a Technical Specification.

- The manner in which the Specifications address incore power peaking.

  Impact: FSV lacks incore flux-mapping monitors but uses (1) thermocouples to monitor core regionwise outlet gas-flow temperature per Technical Specification requirements and (2) Technical Specification Design Features and Administrative Controls on neutronic calculations to assure acceptable power peaking.

- The use of safety-related SSCs to assure coolant circulation at FSV versus coolant injection in PWRs in accommodating the emergency core cooling function.

  Impact: The equivalent emergency core cooling function and the equivalent emergency feedwater subfunction at FSV are accomplished using a combination of both diverse and common subsets of SSCs to effect "emergency" forced circulation of primary and secondary coolant.

- Long thermal response times and relatively large thermal margins to fuel damage in the FSV core.

  Impact: Safety-related cooling functions are normally manually actuated at FSV. There are no requirements for automatic actuation that further require Specifications on associated instrumentation as at PWRs.

- The combination at FSV of the primary coolant pressure boundary function (GDC 14) and the containment function (GDC 16 and 50) in the Prestressed Concrete Reactor Vessel (PCRV).

  Impact: The structural and thermal ruggedness of the PCRV has been shown in Appendix D to the FSV UFSAR accident analysis to preclude exceeding the dose guidelines of 10 CFR Part 100 under extreme conditions. Because of the PCRV, the licensing history at FSV allows in some cases less restrictive ACTION times for achieving SHUTDOWN due to redundant SSC inoperabilities than for that of equivalent-function SSCs in the W-STS. However, in regard to the containment function, the FSV TSUP draft Specifications require more restrictive ACTION times than for equivalent-function SSCs in the W-STS.

Each of these principal differences is discussed as follows. Where judged appropriate in these discussions, the LWR specification requirements are addressed first to establish the context for comparison and to facilitate review by auditors who are presumed to be more familiar with LWR requirements. This ordering does not imply that LWR requirements are to be used to define FSV requirements but that unique and yet functionally analogous requirements are to be found in the FSV licensing basis.

Operational Modes. The operational mode definitions in Table 1.2 of the W-STS are delineated based on the relative value of the average coolant temperature as well as on the reactivity condition and the rated thermal power level excluding decay heat. Since the PWR reactor coolant must be maintained as a liquid, particularly at reduced pressures during shutdown and refueling, the operational mode definitions in the W-STS are used to demarcate thermodynamic and thermal-hydraulic limits on the allowed core conditions. Within the W-STS, this implicit demarcation is utilized via the APPLICABILITY statement in the Specification LIMITING CONDITION FOR OPERATION (LCO) to impose thermal limits on the redundancy requirements for SSCs with safety-related cooling functions.

Unlike the W-STS, the FSV operational mode definitions in Table 1.1 of the proposed upgraded Technical Specifications are delineated based primarily on operator-controlled switch positions that activate or deactivate interlocks in selected systems as well as on rated thermal power excluding decay heat. In particular, for the TSUP conditions of SHUTDOWN and REFUELING, the operational mode definitions used at FSV impose no specific thermodynamic or thermal-hydraulic limits on core conditions. Thus, instead of an implied thermal limit via the operational mode as in the W-STS, the required redundancy in SSCs with safety-related cooling functions is established by the use of the CALCULATED BULK CORE TEMPERATURE as a thermal limit criterion that is implemented and controlled per proposed FSV Specification LCO 3.0.5. Proposed LCO 3.0.5 (Ref. 4) is a direct carry-over of existing FSV Specification LCO 4.0.4 which was reviewed and approved by NRC in FSV License Amendment No. 57 (Ref. 24). The SSC redundancy criterion is relaxed in STARTUP (<5% rated thermal power excluding decay heat), SHUTDOWN and REFUELING whenever the CALCULATED BULK CORE TEMPERATURE is determined to be less than 760°F. The 760°F limit corresponds to the operational limit of 760°F imposed on core inlet coolant temperature. Having a core average temperature less than 760°F provides margin to the temperature at which damage to components in the primary coolant system can occur and substantial margin to the temperature at which fuel damage can occur.

Incore Power Peaking. Because of the high operating temperature of the graphite core structure in FSV, the technology for neutron or gamma flux detectors that could operate effectively incore was not available at the time that FSV was licensed. Thus, incore power maps during core operation are precluded in the FSV design and are not used to assess power peaking limits as is done in the PWR per SURVEILLANCE REQUIREMENTS (SRs) in W-STS Section 3/4.2. However, because of the high temperature capability of the FSV fuel particles in retaining fission products, the high heat capacity of the large graphite core structure, and the single phase of the helium gas coolant, the power peaking parameters that are subjected to LCOs/SRs in the W-STS, such as departure from nucleate boiling and core peak heat flux limits, are not relevant to the potential challenges to thermal limits in FSV. On the other hand, because of the individual coolant channels through the large, down-flow graphite core in FSV, coolant flow, pressure, and temperatures must be controlled under decay heat loads to preclude channel flow stagnation or flow reversal and the resulting potential for local undercooling of the fuel. Thus, incore power peaking is a concern primarily only at power in the up-flow open-lattice PWR core, but controlling local power-to-flow ratio is also required during shutdown in the HTGR until decay heat loads become insignificant in comparison to the capability of the solid core to conduct heat away from local hot spots.

Because of the licensing history at FSV, the calculation of axial and local neutron power peaking effects during operation is controlled per TSUP draft Specification DESIGN FEATURE (DF) 5.3.4. The allowable control rod withdrawal sequence, which directly affects axial and radial power peaking, is established for each fuel cycle by the calculations performed under TSUP draft Specification 5.3.4. Anomalies in unmonitored axial power peaking due to long-term burnup effects should be evidenced as an observed reactivity deviation that is monitored per TSUP draft Specification 3/4.1.7. The neutronic calculations performed under TSUP draft Specification 5.3.4 and for generating the base reactivity curve under TSUP draft Specification 3/4.1.7 are subject to internal review as safety significant design changes per 10 CFR Part 50.59 through TSUP draft Specification ADMINISTRATIVE CONTROLS (AC) 6.5.2.9 that is imposed upon and implemented by the FSV Nuclear Facility Safety Committee (NFSC).* Gross radial power peaking is controlled in two ways: (1) by limits placed on critical rod positions directly per TSUP draft Specification 3/4.1.4.1, as well as indirectly per draft Specifications 3/4.1.7 and 5.3.4 cited above, and (2) by limits placed on regionwise coolant flow rate and/or temperature rise (that is, indices of regionwise power-to-flow ratio) by TSUP draft Specifications 3/4.2.2 through 3/4.2.4. A core integral limit on power-to-flow ratio is also maintained per TSUP draft Specification 3/4.2.6.

Coolant Circulation vs. Coolant Injection. The PWR core requires cooling for both normal operation and decay heat removal by using liquid water to wet the surface of the fuel clad. During accidents from powered operation and involving either loss of coolant or loss of flow, the PWR requires rapid replenishment of cold water entering the core. Therefore, the PWR emergency core cooling system (ECCS) is designed to provide high pressure and low pressure coolant injection to rapidly replenish coolant, and the PWR auxiliary feedwater system (AFWS) is designed to provide a seismically qualified source of water to the steam generators to rapidly provide backup cooling capability if primary coolant flow can be maintained or restored following accident initiation. For certain cases of the small break loss of coolant accident or of loss of heat sink, the PWR ECCS can provide injection for bleed-and-feed cooling that is functionally redundant to the emergency feedwater subfunction of the PWR AFWS.

On the other hand, FSV cannot suffer a loss of coolant accident in the same since as the PWR because the FSV coolant is a gas, and the graphite core has high

* Related issues, such as the lack of a quality-assured, documented licensing basis against which the NFSC would be expected to perform its review, audit, and approval functions and to maintain records of the same for inspection, were classified by NRC as being outside the TSUP scope but subject to potential future requests for additional information. The TSUP draft is judged to provide an adequate framework for quality control and quality assurance for safety-related design activities that can affect power distributions and the margins to core thermal limits; however, the licensing history at FSV indicates that NRC allowed the lice· ·ee to accept internal cognizance over these aspects under 10 CFR Part 50.59 without requiring a documented licensing basis with regard to the use of quality-assured analytical methods, models and data.

heat capacity that precludes the need for the immediate continuation of forced circulation cooling as long as shutdown is achieved. FSV can potentially experience either a significant decrease in the coolant gas density due to primary system depressurization to atmospheric pressure and/or an extended loss of the normal forced cooling function before cooling is restored. In either case, the response is essentially the same: namely, to continue or to restore forced circulation of the primary coolant coupled with the provision of secondary cooling water flow to the steam generator. It should be noted that both the equivalent emergency core cooling function and the equivalent emergency feedwater subfunction are accomplished in essentially the same way at FSV, that is, by assuring primary and secondary coolant flow by the use of the combination of diverse and, in some cases, common SSCs. The distinction that is made here is that the primary success path for accomplishing the equivalent emergency core cooling function at FSV is a set of Class I SSCs which constitute the SAFE SHUTDOWN COOLING SYSTEM and that the primary success paths for accomplishing the equivalent emergency feedwater subfunction at FSV are, depending upon the initiating event, the combination of other non-Class I SSCs operating in conjunction with a subset of the Class I SSCs. Although FSV Class I and non-Class I SSCs are operated in conjunction with each other to provide primary success paths to accommodate certain events, as described in FSV UFSAR Sections 1.4, 8.2 and 10.3.10, separation and independence are maintained; however, this TER does not specifically review such SSC configurations against the provisions of current GDC 1 through 5, 22 through 24, or 29 with regard to issues of separation and independence. Per Ref. 46, FSV has been found to comply with the intent of the AEC's 1967-proposed GDC as documented in UFSAR Appendix C, and the FSV licensing basis for separation and independence can be found in Appendix C with regard to FSV meeting the intent of the 1967-proposed GDC 1 through 5, 19 through 26, and 40 through 43.

In general, the non-Class I SSCs that are utilized in accomplishing the equivalent emergency feedwater subfunction at FSV are selected portions of the normal secondary cooling flowpaths that are upstream of the emergency condensate header and the emergency feedwater header and that are downstream of the main and reheat steam bypass valves. Thus, at FSV, the circulator water turbine drives, the circulator auxiliaries and the steam generators make up a common set of seismically and environmentally qualified SSCs that are used to accomplish both the equivalent emergency core cooling (or safe shutdown cooling) function and the equivalent emergency feedwater subfunction. In both cases, the results of accident analysis are presented in Chapters 10 and 14 of the UFSAR.

<u>Thermal Response Times and Margins</u>. As illustrated in Specification 3/4.3.2 of the W-STS and as discussed in Section 7.2 and Chapter 15 of the *Standard Review Plan*, the PWR engineered safety features including safety injection are required to be actuated automatically by instrumentation that is subject to Technical

Specification requirements. Because of longer thermal response times and larger thermal margin inherent in the coated fuel particles and ceramic core structure of FSV, emergency cooling of the FSV core can be accommodated as described in UFSAR Section 6.3 by manual restoration of redundant sets of SSCs that can provide for forced circulation cooling or, in the worst case, by manual actuation of the seismically and environmentally qualified Safe Shutdown Cooling System within 90 minutes after the interruption of forced cooling. If forced cooling cannot be restored within 2 hours, the PCRV is depressurized, and the containment function is assured by operation of the PCRV liner cooling system using, if necessary, the minimum set of equipment constituting the Alternate Cooling Method (ACM) System that is described in UFSAR Section 8.2.8. Actuation of the ACM system components to maintain containment is also manual. Thus, there is no separate FSV Technical Specification for Engineered Safety Features Actuation System Instrumentation as there is in the W-STS.

The actuation of some of the FSV "engineered safeguards" does rely on inputs from instrumentation. The balance of these FSV "engineered safeguards" is normally operating equipment. As described in FSV UFSAR Sections 6.4 and 7.1, the steam/water dump system, which is an engineered safeguard, relies on inputs from instrumentation in the Plant Protection System (PPS). PPS instrumentation is covered by TSUP draft Specification 3/4.3.1 and is to be reviewed in a separate TER. None of the other FSV engineered safeguards rely on unique sets of instrumentation for automatic actuation, but several components described in UFSAR Chapter 6 are on the emergency diesel generator automatic load and start sequences which are surveilled per TSUP draft Specification SR 4.8.1.1.2.d.5.

PCRV Containment and TSUP ACTION Times. In the W-STS, Specifications 3.0.3, 3/4.5.1, 3/4.5.2, 3/4.5.4, 3/4.7.1.2, 3/4.7.1.3, 3/4.7.3, 3/4.7.4, and 3/4.7.5 stipulate that the PWR must be in HOT STANDBY within the next 6 hours and in HOT SHUTDOWN within the following 6 hours whenever redundant trains that effect or support emergency core cooling or auxiliary feedwater become inoperable. In Section 3/4.6 of the W-STS, ACTION times for inoperabilities of redundant trains of the containment depressurization and cooling systems are generally more liberal than for the ECCS and AFWS with the exception of those spray systems that are credited for iodine removal. Also, in the W-STS, the specifications for PWR containment pressure control systems, including hydrogen control, are more liberal than those for the PWR ECCS and AFWS for inoperabilities of single trains but revert to the more restrictive limits of W-STS Specification 3.0.3 for inoperabilities of redundant trains. The PWR containment challenges are primarily pressure-driven.

At FSV, the PCRV liner cooling system provides heat removal to assure the integrity of the reactor coolant pressure boundary per GDC 14 as well as the integrity of containment per GDC 16 and 50. Because of this dual role, the loss of the FSV liner cooling system function requires immediate (that is, within 15 minutes) shutdown of the reactor as provided in TSUP draft Specification 3/4.6.2.1. Because of the efficacy of the containment function with respect to the dose guidelines of 10 CFR Part 100 when the liner cooling system is operable, even with a 30-hour delay in the initiation of operation per the analysis in FSV UFSAR Appendix D.2.3, the licensing history at FSV has allowed a 24-hour ACTION time to be in SHUTDOWN when redundant Safe Shutdown Cooling System trains become inoperable. However, for the TSUP when the CALCULATED BULK CORE TEMPERATURE is greater than 760°F, the W-STS restoration time of 72 hours for a single train inoperability with at least two required to be OPERABLE has been adopted for the Safe Shutdown Cooling System while retaining the additional 24-hour ACTION time to be in SHUTDOWN if restoration is not accomplished with 72 hours. This approach is judged to be reasonable and consistent with the FSV licensing basis. When the CALCULATED BULK CORE TEMPERATURE is less than 760°F, the inoperability of any single critical component in the single required OPERABLE train of the Safe Shutdown Cooling System either must be corrected or requires the reactor to be in at least SHUTDOWN within 12 hours. This approach is conservative with respect to both the 24 hours of the existing FSV Specification and the 21 hours of the equivalent W-STS Specification 3/4.5.3.

For depressurized core cooling using at least two helium circulators driven by high pressure feedwater supplied by at least one boiler feed pump, a 72-hour restoration time and a 24-hour ACTION time to be in SHUTDOWN are allowed for the inoperability of both trains per TSUP draft Specification 3/4.7.1.1. These time allowances are reasonable since (1) the plant cannot operate at power levels exceeding about 33% of rated without two operating boiler feed pumps,* (2) the inoperability of the water turbine drives falls under a more restrictive Specification, and (3) the rapid depressurization has been determined to be a low probability event that, for equilibrium operation below 82% of rated reactor power, can be accommodated with less than 1% of fuel damage by providing forced circulation cooling with the Safe Shutdown Cooling System.[30]

For essential cooling following loss of offsite power, a 72-hour restoration time and a 24-hour ACTION time to be in SHUTDOWN are also allowed per TSUP draft Specification 3/4.7.1.7 for the inoperability of both $12\frac{1}{2}\%$ capacity condensate pumps where only one is required to be operable. The essential cooling flow provided by the small condensate pumps, which are part of the automatic load and start

* For operation below an equilibrium level of 35% of rated power, FSV UFSAR, Appendix D.4, and independent analyses[31] have shown little or no fuel damage occurs when the only means of decay heat removal is through the PCRV liner cooling system.

sequence of the emergency diesel generators, is diversely and redundantly backed up by the two trains of the seismically and environmentally qualified Safe Shutdown Cooling System. The immediate operation of the essential cooling loads upon loss of offsite power conservatively assures substantial margin to fuel damage (UFSAR Figures 10.3-2 and 14.4-2), but this event is well bounded by operation of the Safe Shutdown Cooling System after 90 minutes delay in startup (UFSAR Figure 14.4-7). Neither the two small condensate pumps nor their redundant supplies of cooling water (namely, the condenser hot well, the decay heat removal exchanger, and the condensate storage tanks) are seismically or environmentally qualified SSCs.

4.2 Normal Process Cooling Function

Table 2 lists those portions of the TSUP proposed draft Specifications that relate to assuring adequate cooling of the core during normal operation. The top-level differences between the W-STS and the TSUP draft Specifications with regard to limits and surveillances on incore power peaking and power-to-flow ratio are addressed above in Section 4.1 of this TER. The Specifications in TSUP draft Sections 3/4.1 and 3/4.2 are also to be addressed in a separate TER since these Specifications control other parameters besides those parameters that are listed in Table 2 and that are directly related to accommodating the normal process cooling function without exceeding core thermal design limits.

In addition, with the exception of TSUP draft Specification 3/4.4.1, the other draft Specifications listed under normal process cooling in Table 2 represent equivalent carry-over Specifications from the existing Specifications in the NRC-approved FSV license. As noted above, some of these Specifications lack a documented licensing basis and a referenceable quality-assured design basis, but this issue was determined by NRC to be outside the TSUP scope and subject to future potential requests for additional information (see Table 3 of Ref. 21). Since the absence of a detailed licensing basis relates directly to FSV UFSAR content, particularly with respect to licensing actions taken after the issuance of the original FSAR, resolution of discrepancies in the licensing basis falls under the provisions of 10 CFR Part 50.71(e) with regard to requirements for UFSAR updates.

TSUP draft Specification 3/4.4.1, Primary Coolant Loops and Coolant Circulation, is a new Specification that has been recommended by the licensee in response to NRC suggestions and comments as documented in Refs. 19 and 21. This Specification provides a functional equivalent to W-STS Specification 3/4.4.1.1 that assures the continuation of the normal cooling configuration in a manner that is diverse and redundant to the Specifications in Section 3/4.2 for the surveillance of parameters that are indicative of core thermal margin. However, TSUP draft Specification 3/4.4.1 is tailored to the allowable FSV primary flow configurations as described in FSV UFSAR Section 4.3. Most importantly, TSUP draft Specifications 3/4.4.1.1 and 3/4.4.1.2, as compared to the TSUP draft Specifications in Section 3/4.5, Safe Shutdown Cooling System, allow the distinction to be made between (1) the "in-operation" status of the helium circulators and steam generators using the respective motive power and cooling water supply sources that effect normal process cooling and (2) the OPERABLE status of the helium circulators, circulator auxiliaries and steam generators using the respective motive power and cooling water supply sources that constitute the environmentally and seismically qualified Safe Shutdown Cooling System. Clarifying the distinction in SSC functional requirements between the normal cooling function and the Safe Shutdown Cooling function (that is, the equivalent emergency core cooling function at FSV) was the basic need that generated the NRC suggestions and comments documented in Refs. 19 and 21.

TSUP draft Specification 3/4.4.1.1 implements the required primary system cooling configuration for normal operation at POWER and LOW POWER and is thus applicable to operation at greater than 5% of rated thermal power. The draft Specification does not stipulate the motive power source for the helium circulator drive as being either reactor-generated steam, auxiliary boiler steam or high-pressure feedwater. This selection of diverse sources is at the option of the operators and depends upon the capability inherent in each source. Above about 25% power, reactor-generated steam is the only practical and economic source to assure adequate primary coolant flow and feedwater supply.* The draft Specification also does not address directly the operability or operating status of the helium circulator auxiliary system since these components must be in operation for the circulator to be operating. The safety-related cooling function of the circulator auxiliaries is addressed as part of the Safe Shutdown Cooling System in TSUP draft Specification 3/4.5.2, which is discussed below in Section 4.4 of this TER.

In TSUP draft Specification 3/4.4.1.1, the specified thermal power limit versus the number of helium circulators in operation in each loop is consistent with the automatic functioning of the plant regulating system. ACTION a to TSUP draft Specification 3/4.4.1.1 is the response to one loop operation caused by loop shutdown as described in FSV UFSAR Section 4.3.1. ACTION b is the response to the trip of a single circulator in which either the operator is assumed to take timely action or the plant regulating system is assumed to respond as designed. Following trip of a single circulator, conceivable failures in the plant regulating

* Comparing UFSAR Tables 4.2-1 and 4.2-3 illustrates that, to achieve desired helium flow rates at about 25 to 30% of rated reactor power, the ratio of helium mass flow per circulator to motive source mass flow per circulator is about 3.6 for reheat steam drive and only about 1.4 for feedwater drive with the circulators delivering essentially the same mass flow at full helium inventory in both cases. Feedwater delivered to the circulator drives is lost to the power production process whereas reheat steam is not. Also, circulator drive steam supply from the auxiliary boilers is pressure-limited (about 150 psig) by header design to below that needed for operation above about 25% power (see UFSAR Table 4.2-1 and UFSAR Sections 10.2 and 10.2.3.1).

system with regard to not adequately controlling primary or secondary flows and reactor thermal power would lead to other PPS actuations such as reactor scram on high reheat steam temperature. Thus, the 30-minute ACTION time to reduce core thermal power to 50% of rated is judged to be adequate because either the plant regulating system will have automatically performed its function to the extent that the operator need only execute minor adjustments or the operator will have to be manually controlling the power and flow runback in an orderly fashion to preclude conditions that could lead to other PPS actuations.

ACTION c to TSUP draft Specification 3/4.4.1.1 would be expected to apply following a loop shutdown PPS actuation since the parameters that determine whether a steam generator is effectively in operation are also inputs to the PPS as described in FSV UFSAR Tables 7.1-3 and 7.1-4: particularly, primary coolant moisture (steam generator tube rupture), low helium circulator speed (loss or reduction of reheat steam flow), and low feedwater flow.

The surveillance requirements in TSUP draft Specification 3/4.4.1 do not address either circulator or steam generator structural integrity because structural integrity is addressed in the TSUP draft Specifications in Section 3/4.5 for components of the Safe Shutdown Cooling System. Thus, TSUP draft Section 3/4.4, Primary Coolant System, does not contain an equivalent to W-STS Specification 3/4.4.5; rather that equivalent is found in TSUP draft Specification 3/4.5.3 and is discussed below in Section 4.4 of this TER.

TSUP draft Specification 3/4.4.1.2 applies to assuring normal process cooling by the operation of at least one coolant loop when the reactor is in STARTUP at thermal power levels up to 5% of rated and otherwise with the CALCULATED BULK CORE TEMPERATURE greater than to 760°F. As written, this Specification does not preclude the generation of fission heat when there is no core flow at a core average temperature below 760°F, but such operation is prohibited by TSUP draft Specification 3/4.2.4 that requires core flow when fission power is being produced independent of the value of the core average temperature. The flexibility afforded by TSUP draft Specification 3/4.4.1.2 in STARTUP relates to allowing the operator to place the reactor mode switch in the RUN position (see TSUP draft Table 1.1) for other purposes while the core is maintained subcritical with no flow and cold with respect to the 760°F limit on CALCULATED BULK CORE TEMPERATURE.

Based on the above discussion, the proposed FSV Technical Specifications that control the normal process cooling function are judged to be acceptable, functionally equivalent to the W-STS when differences between the PWR and HTGR and the unique licensing history of FSV are accounted for, and consistent with the plant's licensing basis. The time-to-depressurization curves in TSUP draft Specification

3/4.4.1 will be addressed below in Section 4.5 with regard to the containment heat removal function.

4.3 Normal Decay Heat Removal Function

4.3.1 Auxiliary Feedwater Subfunction

There is no AFWS designated as such at FSV. To facilitate understanding the specific subfunctions that would be expected to be performed by an equivalent FSV system to the PWR AFWS, it is first necessary to describe the subfunctions that the PWR AFWS is designed to execute. In the current generation PWR as indicated in Table 1, the AFWS performs two subfunctions: normal startup/standby/shutdown feedwater supply and emergency feedwater supply. In the PWR, the latter subfunction is executed to provide for decay heat removal in response to such events as loss of main feedwater, loss of offsite power and small break loss of coolant accident where, in the latter case, the primary liquid coolant can be replenished by charging or safety injection at a sufficient rate to maintain forced or natural circulation from the PWR core to the steam generators. In normal or emergency shutdown cooling, the PWR AFWS operates until the coolant temperature and pressure are reduced to the point that these conditions are within the design limits of the Residual Heat Removal System (RHRS). Thus, in one sense, the AFWS is a high pressure and high temperature equivalent to the RHRS. In the current generation PWR, the AFWS is also a seismically qualified supply system for cooling water to the steam generators, is started up automatically by the Engineered Safety Feature Actuation System, and is powered by the essential busses that are supplied by the emergency diesel generators.

At FSV as indicated in Table 2, there is no seismically qualified system equivalent to the AFWS in a PWR. However, as is readily deduced from reviewing the sections of the FSV UFSAR cited in Table 2, there are sets of FSV SSCs that accomplish both the normal startup/shutdown feedwater supply subfunction and emergency feedwater supply subfunction. Some of these SSCs are part of the seismically and environmentally qualified Safe Shutdown Cooling System which is discussed below in Section 4.4 of this TER.

4.3.2 Auxiliary Feedwater: Normal Startup/Shutdown Feedwater Supply Subfunction

As described in FSV UFSAR Section 10.2, equivalent cooling to the normal startup/shutdown feedwater supply subfunction is accomplished by (1) using the main boiler feed pumps to supply feedwater to the steam generators through the main feedwater lines and (2) using a combination of reactor-generated steam and/or auxiliary boiler steam to drive the helium circulators to provide forced circulation cooling of the core. This configuration utilizes the same grouping of SSCs that is used to accomplish normal process cooling. In this configuration, TSUP draft Specification 3/4.2.4 provides the essential mechanism to assure that adequate flow is maintained in the core to meet either the power-to-flow ratio limit or the core region outlet temperature limit as appropriate. TSUP draft Specification 3/4.4.1.2 specifies the minimum required cooling configuration (one operating loop) of the primary coolant system for cooldown and the initial configuration for hot restart (that is, when the CALCULATED BULK CORE TEMPERATURE exceeds 760°F). TSUP draft Specification 3/4.7.1.1 assures redundancy in the operability of boiler feed pumps although this redundancy is required for fulfilling the equivalent emergency feedwater supply subfunction for reactor depressurization events as opposed to requirements stemming from the equivalent startup/shutdown feedwater supply subfunction.

As noted in FSV UFSAR Section 10.2 and discussed briefly in FSV UFSAR Section 10.3, "normal" shutdown cooling or cooling in preparation for startup can alternately be accomplished without reactor-generated steam or auxiliary boiler steam being available. The single electric motor driven boiler feed pump, which has operability requirements given in TSUP draft Specification 3/4.7.1.1, can be used to provide high pressure feedwater through the emergency feedwater header (TSUP draft Specification 3/4.5.4) to drive the helium circulator water turbines (TSUP draft Specification 3/4.5.1) and to provide water to the circulator auxiliaries (TSUP draft Specification 3/4.5.2). In this "normal" alternative startup/shutdown cooling configuration without steam, either steam generator Economizer-Evaporator-Superheater (EES) section can be supplied either via the main feedwater line or via the emergency feedwater header (TSUP draft Specification 3/4.5.3 and 3/4.5.4). In this "normal" alternative configuration, several of the SSCs as listed above are also part of the Safe Shutdown Cooling System with operability requirements that are addressed in TSUP draft Section 3/4.5.

In the W-STS, the transition between (1) the requirement for SSC configurations that assure normal decay heat removal by the AFWS and (2) the requirement for SSC configurations that assure normal decay heat removal by the RHRS is demarcated by the transition from the HOT STANDBY to the HOT SHUTDOWN operational mode. This demarcation is evidenced by comparing W-STS Table 1.1 to W-STS Specifications 3/4.4.1.2, 3/4.4.1.3 and 3/4.7.1.2. Also in the W-STS the same operational modes demarcate the transition in redundancy requirements for operable trains (subsystems) of the ECCS as evidenced by comparing W-STS Specification 3/4.5.2 and 3/4.5.3. At FSV, as discussed above in Section 4.1 of this TER, the CALCULATED BULK CORE TEMPERATURE is the parameter utilized to demarcate the redundancy requirements for safety-related SSCs, some of which are relied upon as discussed here to accomplish the equivalent to the normal startup/shutdown feedwater supply subfunction.

In addition, the value of the CALCULATED BULK CORE TEMPERATURE is used in TSUP draft Specifications 3/4.2.4 and 3/4.4.1.2 to establish core flow and primary loop cooling configuration requirements for startup/shutdown decay heat removal when the reactor mode switch is in the STARTUP, SHUTDOWN, or REFUELING positions. But the CALCULATED BULK CORE TEMPERATURE does not demarcate the transition from (1) the FSV SSC configuration that can be classified as performing the equivalent normal startup/shutdown subfunction of the PWR AFWS to (2) the FSV SSC configuration that can be classified as performing the equivalent function of the PWR RHRS. Practically, as described in FSV UFSAR Section 10.2, the transition in SSC configurations from that which executes the equivalent startup/shutdown feedwater supply subfunction to that which executes the equivalent RHR subfunction is at a reactor decay heat load of approximately 1% of rated thermal power.* This decay heat load is the point at which the heated flow from the steamline bypass flash tank drains that receive steam generator outlet flow can be effectively cooled by the decay heat removal exchanger. As described in FSV UFSAR Section 10.2, one small ($12\frac{1}{2}$% capacity) condensate pump can provide adequate flow to the steam generator and can take suction off the decay heat removal exchanger thus allowing the condenser and circulating water system to be shutdown if required.** The decay heat removal exchanger rejects heat to the Service Water System (TSUP draft Specification 3/4.7.4), which is a Class I system except for the piping to and from the decay heat removal exchanger. However, since SSCs such as the decay heat removal exchanger are not included in the existing or proposed Technical Specifications, the decay heat load, at which this demarcation of the change-over in equivalent FSV functions is made, is not included in the Technical Specifications.***

* Using the conservative FSV decay heat correlation (p. 4-10, Ref. 35) used to generate FSV UFSAR Figure D.1-9 for accident analyses, the approximate time after shutdown that the decay heat load reaches 1% of rated thermal power is 4.9 hours for previous equilibrium operation at 100% of rated thermal power and 2.3 hours for previous equilibrium operation at 82% of rated thermal power.

** The selection of a decay heat load of 1% of rated thermal power as practically demarcating the transition at FSV from the equivalent auxiliary feedwater subfunction to the equivalent residual heat removal subfunction may be viewed as somewhat arbitrary, but there is a functional analogy that can be made. In Specification 3/4.4.1.3 of the W-STS, the steam generator and reactor coolant pump in each or all loops can be shutdown for other purposes when both RHR loops are OPERABLE and in operation. Similarly, at FSV, the condenser can be shutdown when the decay heat removal exchanger is in operation and the Safe Shutdown Cooling System is OPERABLE.

*** Per Attachment F to Amendment No. 15 of the FSV PSAR,[46], the decay heat removal exchanger was included in the initially proposed Specifications that were based on using the emergency condensate system for Class I cooling; however, the proposed specification was deleted in the final proposal that instituted reliance on the firewater system for Class I cooling.

In summary, the FSV equivalent to the PWR auxiliary feedwater normal startup/shutdown subfunction is reflected in the TSUP draft Specifications. TSUP draft Specifications 3.0.5, 3/4.2.4, and 3/4.4.1.2 provide an adequate basis for assuring that this equivalent subfunction is controlled and accomplished at FSV in a manner that is consistent with the FSV licensing basis in the UFSAR. As indicated, other TSUP draft Specifications from Sections 3/4.5 and 3/4.7 also assure that OPERABLE SSC configurations exist to accomplish this subfunction.

4.3.3 Auxiliary Feedwater: Emergency Feedwater Supply Subfunction

At FSV, the equivalent to the emergency feedwater supply subfunction of the PWR seismically qualified AFWS is accomplished by two different non-seismically qualified configurations of SSCs: one to accommodate the accidental depressurization of the reactor with the simultaneous loss of reactor-generated steam (UFSAR Section 14.4.3.2 and 14.11.2.2), the other to accommodate the loss of offsite power with the simultaneous trip of the main turbine-generator (UFSAR Sections 8.2.3.5, 10.3.1, 10.3.2, 14.4.1, and 14.4.2.1 [Case B1]) and both to accommodate a spectrum of events that can lead to loss of either normal feedwater supply or normal condensate supply (UFSAR Sections 10.3.3 through 10.3.8, 14.4.2, 14.4.2.1 and 14.4.4). At FSV, the two basic SSC configurations provide for cooling water supply to the steam generators and also for motive power to the water turbine drives of the helium circulators so that forced circulation and cooling of the primary coolant is effected. In the PWR, the AFWS provides steam generator cooling and a thermal gradient across the primary coolant flowpath through the steam generator that promotes natural circulation. Natural circulation is not possible in FSV because the steam generators are located physically below the down-flow core; however, as described in the UFSAR and provided for in the TSUP draft, there are diverse and redundant SSC configurations to assure forced cooling. In addition, as discussed in Section 4.1 of this TER, the FSV UFSAR demonstrates acceptable dose consequences for a permanent loss of forced cooling as long as the PCRV liner can be cooled by operation of a set of seismically and environmentally qualified SSCs.

At FSV, the response of the two basic SSC configurations that are alluded to above accomplishes the equivalent emergency cooling subfunction as the PWR AFWS: namely, responses to loss of main feedwater, loss of offsite power, and the small break loss of coolant accident as long as there is no gross voiding of the PWR primary system to inhibit flow and forced cooling. As shown in FSV UFSAR Figures 14.4-5 and 14.11-11 through 14.11-13, reactor depressurization does not inhibit effective forced cooling (that is, no fuel damage) as long as the helium circulators can be operated at sufficient speed starting within 60 minutes of the onset of a rapid depressurization (UFSAR Section 14.11.2.2).

The licensing history at FSV has not required the SSCs that perform the equivalent to the emergency feedwater subfunction to be seismically or environmentally qualified. There are two reasons for this. First, the PCRV including the PCRV penetrations and penetration closures has been designed to be seismically qualified (UFSAR Sections 5.2.1.2, 5.3.4 and 5.8.2). Thus, the UFSAR Section 14.11 analysis of core cooling following the rapid depressurization accident (RDA) has historically been separated from the licensing analysis of the plant response to a design basis seismic event because the PCRV penetration closures are designed to survive and function following such an event. In turn, the RDA is an assumed non-mechanistic failure of both closures in a large PCRV penetration. Second, the operation of the redundant trains of the seismically and environmentally qualified Safe Shutdown Cooling System (TSUP draft Section 3/4.5) assumes the unavailability of offsite power following the design basis earthquake or maximum tornado event. The analysis of the acceptable performance of the Safe Shutdown Cooling System, assuming a 90-minute delay in startup (UFSAR Figure 14.4-7), conservatively bounds the performance of the non-Class I SSC configuration that accommodates the non-seismically-induced loss of offsite power event (UFSAR Figures 10.3-2, 10.3-3, and 14.4-2).

The TSUP draft Specifications for the two emergency feedwater equivalent SSC configurations at FSV are discussed as follows.

<u>Depressurized Core Cooling Accident</u>. With reactor-generated steam available, the SSC configuration for the depressurized core cooling accident is the same as normal process cooling. Assuming the simultaneous loss of reactor-generated steam, the UFSAR analysis of the RDA is based on the operability of at least one boiler feed pump. Diversity and redundancy is provided by one electric-motor-driven feed pump and two steam-turbine-driven feed pumps. The motor-driven feed pump requires offsite power, but the turbine-driven feed pumps can be supplied by the auxiliary boiler or backup auxiliary boiler, either or both of which can be fired in less than an hour. The boiler feed pump provides high pressure feedwater to drive two helium circulators in the same loop on their water turbines at a rotational speed of at least 8000 RPM. The boiler feed pump also provides sufficient feedwater flow to flood the EES section of the steam generator in the same loop. If needed, however, the steam generators can be supplied separately by emergency condensate. Per FSV UFSAR Section 14.11.2.2, depressurized core cooling following the RDA can also be accommodated using one circulator in each loop as long as the second steam generator is not made inoperable by the RDA initiator. Independent analysis[30] has been performed to verify that the probability of the RDA or an RDA-equivalent event is sufficiently low to preclude requiring both helium circulators in a loop to

be OPERABLE instead of only one OPERABLE circulator as stipulated in TSUP draft Specification 3/4.5.1.1 for the Safe Shutdown Cooling System. TSUP draft Specification 3/4.7.1.1, Boiler Feed Pumps, requires that two of the three boiler feed pumps be OPERABLE whenever the reactor thermal power levels exceed 5% of rated or otherwise whenever the CALCULATED BULK CORE TEMPERATURE exceeds 760°F. Per TSUP draft Specification SR 4.7.1.1, OPERABLE is defined as the capability of the feed pump to drive two helium circulators simultaneously at an equivalent of 8000 RPM (at atmospheric pressure) on the water turbine, but not necessarily two circulators in the same loop.

The independent analysis[30] has also indicated that, for plant operation limited to 82% of rated thermal power, depressurized core cooling using one train of the seismically and environmentally qualified Safe Shutdown Cooling System (TSUP draft Section 3/4.5) is predicted to limit fuel damage to only about 1%. As indicated in Ref. 30, conservative estimates of the offsite doses resulting from having to rely on the Safe Shutdown Cooling System in response to the RDA or an RDA-equivalent event are well within the dose guidelines of 10 CFR Part 100. Thus, the operability requirements of TSUP draft Specification 3/4.7.1.1 are judged to be acceptable for adequately accommodating a low probability and low consequence event.

As indicated in Table 2, other TSUP draft Specifications from Section 3/4.5 assure that the water turbine drives for the helium circulators, the circulator auxiliaries, the steam generator sections, and the emergency feedwater header are OPERABLE to accommodate the FSV equivalent of the emergency feedwater subfunction due to accidental reactor depressurization. These other SSCs are part of the Safe Shutdown Cooling System that is addressed below in Section 4.4 of this TER.

Loss of Offsite Power. The emergency feedwater subfunction in response to the nonseismically-induced loss of offsite power event at FSV is accomplished by the "essential cooling loads" of the emergency diesel generators. The SSC performance in response to this event is described in FSV UFSAR Sections 8.2.3.5, 8.2.5.2, 10.3.1, 10.3.2, 14.4.1, and 14.4.2.1 (Case B1). The SSCs constituting the "essential loads" for the emergency diesel generators are listed in FSV UFSAR Tables 8.2-4 through 8.2-7 with the essential bus configuration illustrated in UFSAR Figures 8.2-9 and 8.2-10. The "essential loads" include many of the components of the Safe Shutdown Cooling System (UFSAR Table 4.1-2) and most of the Alternate Cooling Method (ACM) System (UFSAR Table 8.2-8); however, the essential cooling configuration relies upon one or both of the small ($12\frac{1}{2}$% capacity) condensate pumps. Preferentially, the small condensate pumps provide condensate flow and net positive suction head for at least one of the turbine-driven boiler feed pumps operating on reactor-generated steam. Without sufficient reactor-generated steam, the small condensate pumps provide both motive power for at least one helium circulator water turbine drive and cooling water to either section of the associated steam generator. The small condensate pumps are neither seismically nor environmentally qualified components. In the latter case, condensate is supplied via the emergency condensate header (TSUP draft Specification 3/4.5.4) which is seismically qualified.

If both emergency diesel generators operate following the inception of the non-seismically-induced loss of offsite power event, decay heat is rejected through the condenser to the circulating water system by operation of one or both of the non-seismically qualified small (7% capacity) circulating water pumps. If only one diesel generator operates, heat can be rejected if necessary for at least the first five hours through an open secondary loop steam relief valve with cold condensate supplied to the EES from the condensate storage tanks[32,33]. After five hours, heated condensate can be recirculated from the helium circulator water turbine drain tank with condensate tank replenishment from the firewater system; alternatively, when the decay heat load falls below 1% of rated thermal power, the decay heat removal exchanger can be used to reject heat in a closed secondary loop configuration to either the Class I or the normally operating non-Class I configuration of the Service Water System (TSUP draft Specification 3/4.7.4).* Both configurations of the Service Water System are essential loads for the emergency diesel generators and can be operated off a single emergency diesel generator (Updated FSAR Tables 8.2-4 through 8.2-7) or the ACM diesel generator (Updated FSAR Table 8.2-8).

As in the case of equivalent emergency feedwater supply for depressurized core cooling, many of the "essential cooling" SSCs are also part of the Safe Shutdown Cooling System (TSUP draft Section 3/4.5) that is discussed below. Because of the diversity in condensate supply from the non-seismically qualified sources, the only components that have been included in the TSUP draft are the small condensate pumps. The rationale for the OPERABILITY requirements and ACTION times for TSUP draft Specification 3/4.7.1.7 has already been addressed above in Section 4.1 of this TER.

Because the primary success path provided by the "essential cooling" configuration is redundantly backed up by the seismically and environmentally qualified Safe Shutdown Cooling System, the provisions of TSUP draft Specification 3/4.7.1.7 are judged to be a conservative and acceptable means for accommodating the equivalent emergency feedwater subfunction at FSV. The "essential cooling" configuration

* Technically supply of service water to the decay heat removal exchanger uses non-Class I piping, but the service water can be supplied from either the Class I circulating water makeup subsystem of the Safe Shutdown Cooling Water Supply System (TSUP draft Specification 3/4.5.5) or the non-Class I service water makeup subsystem (Updated FSAR Figure 9.8-1).

provides the first line of defense and the primary success path for the non-seismically-induced loss of offsite power event.

4.3.4 Residual Heat Removal Subfunction

As described above in Section 4.3.2 of this TER, the functional analogy can be made that, for all practical purposes at FSV, the transition from the equivalent auxiliary feedwater startup/shutdown feedwater supply subfunction to the equivalent residual heat removal subfunction occurs at a decay heat load of about 1% of rated thermal power. At this decay heat load, FSV UFSAR Section 10.2 indicates that the FSV decay heat removal exchanger can be placed in service allowing the condenser, the small circulating water pumps, and/or the condensate storage tanks to be shutdown for other purposes such as maintenance. Although implied by the UFSAR, this is an arbitrary demarcation that is not reflected in either the existing or proposed Technical Specifications at FSV. The residual heat removal subfunction is not substantially addressed in the existing Specifications, especially prior to Amendment No. 57, but, as will be shown, this subfunction is judged to be acceptably addressed in the provisions of the TSUP draft Specifications.

As indicated in Table 2, there is no unique set of SSCs defined by the TSUP draft Specifications as an equivalent to the PWR RHRS; however, as illustrated in UFSAR Sections 10.2 and 10.3, a diversity in SSC configurations exists that can accommodate the residual heat removal subfunction. Because of this diversity, the licensing history at FSV has not previously required unique Specifications for assuring the residual heat removal subfunction nor the definition of a set of SSCs that equate to an equivalent RHRS. However, as also indicated in Table 2, there are three conditions at FSV wherein the set of proposed upgraded Specifications will assure that the residual heat removal subfunction is being accomplished in a manner that can be described as consistent with the FSV licensing basis and equivalent or analogous to provisions of the W-STS.

First, when the CALCULATED BULK CORE TEMPERATURE exceeds 760°F as calculated per TSUP draft Specification 3.0.5, TSUP draft Specification 3/4.4.1.2 requires that one loop of forced circulation cooling be in operation at all times. TSUP draft Specification 3/4.2.4 will also apply with regard to precluding conditions that could result in core channel flow instabilities. The SSC configuration is not specified in the TSUP draft although a review of the operating history as recorded in FSV Reportable Occurrences reveals that for all practical purposes, such an SSC configuration is normally built around the operation of the condensate pumps, either the two large (60% capacity) pumps, which require offsite power, but principally the two small ($12\frac{1}{2}$% capacity) pumps which are "essential loads" for the emergency diesel generators. FSV UFSAR Section 10.3.6 indicates that the auxiliary boiler and backup auxiliary boiler feed pumps can also be used with suction off the condensate storage tanks in lieu of operating the condensate pumps, but this capacity is not quantified by analysis documented in the USFAR, although the use of these components was considered in the first proposal for the original FSV Technical Specifications (Attachment F to Ref. 48). Design documentation indicates that each auxiliary boiler feed pump can provide at least 5% of rated condensate flow at sufficient pressure, thus implying the capability to remove decay heat at loads up to 1% of rated thermal power. A review of Reportable Occurrences also indicates that, in similar circumstances, one of the auxiliary boilers may be used to provide steam to the helium circulator drives as an alternate drive source while condensate is supplied to the steam generator. Because of the diversity available in SSC configurations, the TSUP draft Specifications requiring (1) forced circulation cooling by operation of one primary loop and (2) the provision of adequate core flow to preclude core channel flow instabilities are judged to be an adequate basis for assuring accomplishment of the residual heat removal subfunction when the decay heat generation falls below 1% of rated thermal power and the CALCULATED BULK CORE TEMPERATURE exceeds 760°F.

Second, when the CALCULATED BULK CORE TEMPERATURE is less than or equal to 760°F, TSUP draft Specifications 3/4.2.4 and 3/4.4.1.2 do not stipulate a requirement for forced circulation cooling in the SHUTDOWN and REFUELING modes;* however, TSUP draft Specification 3/4.6.2.2 requires that, in this condition, residual heat removal must be effected either by maintaining forced circulation cooling or by operating one train of the PCRV liner cooling system. At a core average temperature below 760°F as stipulated in the draft Technical Specification and at an implied decay heat load below 1% of rated reactor thermal power (that is, beyond about 5 hours of normal shutdown cooling), the analysis in FSV UFSAR Appendix D.4 and other independent analysis[31] of extreme challenges to the liner cooling system's capability in preventing fuel damage imply that effective residual heat removal can be expected by operation of one train of the PCRV liner cooling system in the absence of forced circulation cooling. In concert with the NRC requirements stipulated in Ref. 23, the licensee is also committed to assuring the operability of firewater as a backup supply to the liner cooling system when "planned" interruptions of forced cooling are effected for maintenance. This is an administrative commitment that is not included in the draft Technical Specifications. Thus, the implication of not including this specific commitment in the proposed Technical Specifications is the licensee's implied commitment to maintain forced circulation cooling at all times for residual heat removal unless an interruption has been planned and meets the non-Technical

* Recall that TSUP draft Specification 3/4.2.4 applies when the reactor mode switch is in RUN for STARTUP regardless of the value of the CALCULATED BULK CORE TEMPERATURE.

Specification administrative requirements of Ref. 23. The further implication is that an inadvertent loss of forced circulation cooling will be responded to in an expeditious manner with regard to restoring forced circulation cooling even if the CALCULATED BULK CORE TEMPERATURE remains below 760°F.

It is judged that the flexibility afforded in ACTION a of TSUP draft Specification 3/4.6.2.2 with regard to the 12-hour ACTION time when in STARTUP is acceptable because forced circulation cooling is being maintained and TSUP draft Specification 3/4.2.4 applies with regard to assuring adequate core cooling. Thus, the combined requirements of TSUP draft Specifications 3.0.5, 3/4.2.4, and 3/4.6.2.2 provide assurance that the residual heat removal subfunction is accomplished in an effective manner when the CALCULATED BULK CORE TEMPERATURE is less than 760°F.

Finally, as also indicated in Table 2, during fuel handling operations incore with the reactor at atmospheric pressure, the respective requirements of TSUP draft DEFINITION 1.12, Core Average Inlet Temperature, and of TSUP draft Specifications LCO 3.9.1.b and LCO 3.9.3.a assure that forced circulation cooling of the core is maintained independent of the value of the CALCULATED BULK CORE TEMPERATURE. In this condition, the pressure in the fuel handling machine and reactor is maintained at atmospheric conditions with a Core Average Inlet Temperature less than 165°F. Per TSUP draft DEFINITION 1.12, the Core Average Inlet Temperature is measured using input parameters that are indicative of primary and secondary coolant flow and cooling by the PCRV liner cooling system. Thus, during fuel handling incore, forced circulation cooling or regenerative heating is maintained and monitored so that the residual heat removal subfunction is accomplished or otherwise accommodated.

The TSUP draft Specifications for core cooling during fuel handling and manipulation are judged to be functionally equivalent to the provisions of W-STS Specifications 3/4.9.8 and 3/4.9.10, which require having respectively one PWR RHRS loop OPERABLE and in operation and sufficient water in the reactor vessel to scrub 99% of iodine that could be released from a damaged fuel element. At FSV, unlike the PWR, the primary coolant pressure boundary including that of the refuelling machinery remains intact during fuel handling with reactor pressure controlled by forced circulation cooling or regenerative heating, if necessary. The fuel handling machine is also purged with clean helium through-flow to the gas waste system per the provisions of TSUP draft Specification LCO 3.9.3.b, and the FSV graphite fuel blocks are not subject to an equivalent potential for fuel clad structural damage and gas gap leakage as the PWR fuel element might be during fuel handling.

4.4 Emergency Core Cooling Function

As indicated in Table 2, the equivalent to the PWR emergency core cooling function is accomplished at FSV by the seismically and environmentally qualified Safe Shutdown Cooling System. As discussed above in Section 4.1 of this TER, actuation of the Safe Shutdown Cooling System is accomplished manually, not automatically, with an available 90-minute time allowance for completing manual startup per the accident analysis given in FSV UFSAR Sections 10.3.9 and 14.4.2.2 (Case B3). As also indicated above in Section 4.1, the Safe Shutdown Cooling System accomplishes the equivalent to the PWR emergency core cooling function by providing for the assured restoration of forced circulation cooling using at least one of two redundant trains of Class 1E equipment. The PWR relies on coolant injection that must be accomplished rapidly to accommodate the large break loss of coolant accident or the total loss of normal heat sink. A permanent loss of normal forced cooling capability at FSV is an emergency that is functionally analogous to the large break loss of coolant accident or the loss of the normal heat sink accident at a PWR, and the Safe Shutdown Cooling System at FSV provides for restoration of forced circulation cooling in response to such an emergency and in a timely manner consistent with the larger thermal margins and longer response times inherent in the FSV core.

The TSUP draft Specifications for the Safe Shutdown Cooling System address the five major equipment divisions of the system: (1) the helium circulator operated on water turbine drives, (2) the helium circulator auxiliaries of which most of the components operate continuously to support normal process and normal shutdown cooling, (3) the steam generator sections, (4) the alternate flowpaths to the helium circulator water turbines and steam generator sections, and (5) the Class I water supply source. The testing of the Safe Shutdown Cooling Valves per existing Specification SR 5.3.4 will be included in the implementing procedures associated with specifications on each of the equipment divisions, and the licensee will identify the valve correlation for the respective Specifications in the final TSUP submittal. Automatically activated valves that are part of the Steam Line Rupture Detection and Isolation System (SLRDIS) will be surveilled per TSUP draft specifications 3/4.7.8 and not in the specifications for the Safe Shutdown Cooling System. Each of the Safe Shutdown Cooling System equipment divisions is discussed as follows.

<u>Helium Circulators</u>. Only one OPERABLE circulator is required in each loop to support the existence of two independent and redundant Safe Shutdown Cooling trains. In this regard, OPERABLE refers only to the capability of the helium circulator to provide forced circulation of primary coolant at up to 3.8% of rated helium flow using the water turbine drive. For operation at power levels exceeding 5% of rated thermal power or otherwise when the CALCULATED BULK CORE TEMPERATURE exceeds 760°F, TSUP draft Specification 3/4.5.1.1 permits 72-hour restoration time for the inoperability of either primary coolant loop due to

an inoperable helium circulator. Only 1-hour restoration time is permitted for the inoperability of both loops (that is, all four helium circulators). As discussed previously, the subsequent ACTION time to be in SHUTDOWN is 24 hours in both cases. This is consistent with the existing FSV Specifications.

The SR includes periodic testing of the helium shutoff (flapper) valves to assure that hot helium is not drawn through unwetted steam generator tubing when the loop is shutdown and a pressure differential is created by the operation of a circulator in the other operating loop. The SR also provides for verification of circulator structural integrity consistent with the existing Specifications and NRC requirements for FSV.

When the CALCULATED BULK CORE TEMPERATURE is less than or equal to 760°F, TSUP draft Specification 3/4.5.1.2 requires only one OPERABLE helium circulator to support the existence of one Safe Shutdown Cooling train. When in STARTUP, this Specification in conjunction with the draft Specifications for the other components covered in TSUP draft Section 3/4.5, requires the reactor to be in SHUTDOWN within 12 hours upon the loss of the one OPERABLE Safe Shutdown Cooling train due to the loss of any single component, such as the helium circulator. As noted previously, this ACTION time is more restrictive than that of the existing FSV Specifications.

Inservice inspection and testing requirements for the helium circulators are being developed outside the TSUP.

Helium Circulator Auxiliaries. TSUP draft Specification 3/4.5.2 stipulates the OPERABLE auxiliary equipment required for each OPERABLE circulator. The redundancy requirements respectively for two trains and one train OPERABLE are the same as those for the helium circulator as stipulated in TSUP draft Specifications 3/4.5.1.1 and 3/4.5.1.2, respectively. TSUP draft Specification 3/4.5.2 covers the following subsystems and components: (1) the Safe Shutdown Cooling (firewater) supplies and flowpaths downstream of the emergency feedwater and emergency condensate headers and including the redundant emergency water booster pumps, (2) the turbine water removal subsystem, (3) the normal bearing water subsystem, and (4) the bearing water accumulators for assuring circulator shaft bearing lubrication during circulator trip and coast down to shutdown.

In addition, TSUP draft Specification 3/4.5.2.1 addresses the operability of components ensuring the automatic water turbine start capability which is only required at POWER when the emergency feedwater header is both OPERABLE and in operation. The auto-start feature is not relied upon for Safe Shutdown Cooling but is a PPS-actuated mitigation feature (UFSAR Sections 4.2.2.3.5, 4.3.2 and 7.1.2.4) for conservatively accommodating helium circulator trips due to accidents involving loss of reactor-generated steam (UFSAR Sections 14.4.2 and 14.11.2.2).

Such events are addressed above in Section 4.3.2 of this TER with regard to accomplishing the auxiliary feedwater subfunction. These events are conservatively bounded by the acceptable results of the accident analysis documented in FSV UFSAR Sections 10.3.9, 14.4.2.2 and 14.11.2.2 wherein the assumption is made that the auto-start feature either does not function or is ineffective due to other failures in non-Class I components.

Steam Generators. TSUP draft Specification 3/4.5.3 stipulates the requirements for OPERABLE steam generator sections in each loop with an OPERABLE helium circulator. When in POWER, LOW POWER or otherwise with the CALCULATED BULK CORE TEMPERATURE greater than 760°F, both the EES and reheater sections in both loops must be OPERABLE with, as provided in TSUP draft Specification 3/4.5.1, one helium circulator also OPERABLE in each loop. When the CALCULATED BULK CORE TEMPERATURE is less than or equal to 760°F, one steam generator section in the loop with the OPERABLE helium circulator must be OPERABLE.

When in POWER, LOW POWER, or otherwise with the CALCULATED BULK CORE TEMPERATURE greater than 760°F, the inoperability of a single steam generator section requires the same restoration and ACTION times as the inoperability of both helium circulators in a loop. Under the same operating conditions, the inoperability of two or more steam generator sections requires the same restoration and ACTION times as the inoperability of all four helium circulators. TSUP draft Specification 3/4.5.3.1 does not make a distinction between the EES sections and the reheater sections for Safe Shutdown Cooling. This is conservative for equilibrium operation at lower power levels since credit is not taken for the redundancy afforded by either the reheater section or the EES section being effective in accomplishing Safe Shutdown Cooling following equilibrium powered operation at or below 39% of rated reactor power.[34] For equilibrium operation above 39% of rated reactor power, the redundant EES sections are relied upon to effect Safe Shutdown Cooling.

TSUP draft Specification SR 4.5.3.1.2 provides for periodic verification of the operability of the steam generator Safe Shutdown Cooling inlet and outlet flow paths. TSUP draft Specifications SR 4.5.3 1.b and c provide respectively for surveillances of steam generator structural integrity and tube leak examinations. The extent and frequency of surveillances are consistent with the FSV licensing basis, the existing FSV Specifications, and current NRC requirements for FSV.

Emergency Water Supply Headers. Per TSUP draft Specification 3/4.5.4.1, both the emergency feedwater and emergency condensate headers are required to be OPERABLE to provide diverse, independent and redundant flow paths for Safe Shutdown Cooling when the reactor is in POWER, LOW POWER or otherwise with the CALCULATED BULK CORE TEMPERATURE greater than 760°F. At or below a CALCULATED BULK CORE TEMPERATURE of 760°F, TSUP draft Specification 3/4.5.4.2 requires that only one header be OPERABLE to constitute a single train. Restoration and ACTION times are the same for single and dual train inoperabilities as described above for the other Safe Shutdown Cooling subsystems and components and also in Section 4.1 of this TER.

Safe Shutdown Cooling Water Supply. TSUP draft Specification 3/4.5.5 requires the operability of redundant pumps and flow paths to constitute two OPERABLE supply trains when the CALCULATED BULK CORE TEMPERATURE is greater than 760°F and to constitute one OPERABLE supply train otherwise. Redundant flow paths originate at the two seismically qualified storage ponds which can provide up to nine days of water supply for Safe Shutdown Cooling (FSV UFSAR Section 10.3.9). The restoration and ACTION times for dual and single train inoperabilities are generally consistent with those of the other Safe Shutdown Cooling equipment. However, above a CALCULATED BULK CORE TEMPERATURE of 760°F, a maximum time of 48 hours is mandated for the restoration of two equivalent trains if the operability of only a single equivalent train is caused by more than one component being inoperable. This allowance is made because an equivalent OPERABLE train can be constituted from redundant subsystems and components by cross-tie flowpaths which are designed to withstand single active and passive failures as discussed in FSV UFSAR Section 10.3.10. TSUP draft Specification 3/4.5.5 is judged to be functionally equivalent to W-STS Specification 3/4.5.5, Refueling Water Storage Tank, as well as to W-STS Specifications 3/4.7.1.3, Condensate Storage Tank, 3/4.7.5, Ultimate Heat Sink. The latter functional equivalencies are discussed below in Section 4.6 of this TER.

4.5 Containment Heat Removal Function

As indicated previously in Section 4.1 of this TER, the FSV PCRV executes both the primary coolant pressure boundary function per GDC 14 and the containment function per GDC 16 and 50. During power operation, the dual (redundant) trains of the FSV Reactor Plant Cooling Water (RPCW)/PCRV Liner Cooling System (LCS)* are in continuous operation to cool the PCRV metallic liner and structural concrete and thereby to maintain PCRV integrity with respect to accomplishing both functions. This dual role is unique and is not reflected in W-STS Section 3/4.6 with regard to Specifications for the PWR containment cooling and depressurization systems. Since the FSV vessel and containment functions (that is, PCRV integrity)

* Redundancy in the PCRV LCS is carried down to the cooling tubes on the PCRV liner. Adjacent cooling tubes are supplied with cooling water by different trains of the PCRV LCS.

are assumed to effectively exist in all transient and accident analyses of the FSV UFSAR, including the time following the RDA or RDA-equivalent event,* the continued operation of the seismically and environmentally qualified SSCs that effect containment heat removal at FSV must be assured so that at least one of two trains of the PCRV LCS operates to remove decay heat loads on the PCRV thermal barriers and liner.

The FSV equivalent containment heat removal function is provided by either of two redundant trains of the Class I RPCW/PCRV LCS rejecting heat preferentially to the normal closed loop (non-Class I) operation of the Service Water System or, in emergencies, either to open loop (Class I) operation of the Service Water System (TSUP draft Specification 3/4.7.4) or otherwise to firewater flow from open loop operation of the Class I Safe Shutdown Cooling Water Supply System (TSUP draft Specification 3/4.5.5). Any one of the three configurations can be accommodated within the Alternate Cooling Method (ACM) as described in FSV UFSAR Section 8.2.8 and TSUP draft Specification 3/4.8.4 (previously TSUP draft Specification 3/4.7.8). The ACM system provides an alternate non-Class 1E electrical power source for assuring containment heat removal and containment integrity if a disruptive fault, such as a fire, occurs in the congested cable areas.

For accommodating a permanent loss of both normal and emergency (safe shutdown) forced circulation cooling from equilibrium operating conditions above 35% of rated reactor power, the efficacy of the FSV equivalent containment heat removal system that is provided by either of the redundant trains of the RPCW/PCRV LCS (UFSAR Sections 5.9 and 9.7) depends upon limiting the rate of core heat dissipation to the PCRV liner, particularly the PCRV upper head barrier cover plates. In this case (FSV UFSAR Section 14.10.3.1 and Appendices D.1.2.1.2 and D.1.2.1.7) to prevent damage to the PCRV upper head liner by hot plumes of gas rising from the core, the PCRV is depressurized so that the dominant core heat removal mechanism is by conduction through core graphite to the core surfaces and then by conduction and thermal radiation to the cover plates of PCRV liner thermal insulation. In addition, to assure minimum dose consequence from the permanent loss of forced cooling (that is, to assure net containment integrity), the FSV UFSAR accident analysis assumes that the depressurization is carried out using the Helium Purification System both to filter circulating radioactivity from the exhausted reactor coolant and to reduce the driving force behind PCRV leakage of fission products released from fuel damaged during the subsequent core heatup. The timing for initiating PCRV depressurization is limited by the performance

* Once the PCRV depressurizes to essentially atmospheric conditions in the RDA, further degradation of the PCRV is assumed not to occur such that a second failure would allow air flow through the PCRV.

of components in the Helium Purification System (UFSAR Section 9.4.3.3.2) when exposed to hot helium rather than by the cooling capabilities of the PCRV LCS. For equilibrium operation below 35% of rated reactor power, recent analysis indicates that the PCRV does not require depressurization to accommodate a permanent loss of forced cooling (FSV UFSAR Appendix D.4 and Ref. 31); however, the requirement for depressurization following accidental loss of forced circulation at power levels below 35% of rated has been carried over into the TSUP from existing Specification LCO 4.2.18 and is judged to be reasonable and conservative.

For assuring the efficacy of the containment and containment heat removal functions (GDC 16, 38, and 50) during accidental interruptions of forced circulation cooling, TSUP draft Specification 3/4.4.1 stipulates the time limits for initiating PCRV depressurization after loss of forced cooling. These time limits are a direct carry over from existing FSV Specification LCO 4.2.18. For assuring the efficacy of the containment and containment atmosphere cleanup functions (GDC 16, 41, and 50) during PCRV depressurization, TSUP draft Specification 3/4.7.5 provides for depressurization/filtration flowpaths through the helium purification system to reactor building ventilation and exhaust systems. TSUP draft Specifications 3/4.4.1 and 3/4.7.5 provide partial equivalency to the functions assured by W-STS Specifications 3/4.6.2 and 3/4.6.3 in terms of mitigating challenges to containment integrity and removal of gas-bourne radioactive materials. However, the nature of the respective challenges to containment integrity differ essentially between the potential for temperature/heat-load-induced failures in FSV and the potential for pressure-induced failures in the PWR. Further, the FSV depressurization through the helium purification system removes virtually all gaseous fission product contamination due to releases during normal plant operation whereas the PWR spray and/or iodine removal systems accommodate the trapping of iodine released by fuel failures prior to and resulting from an accident. At FSV, PCRV integrity prevents or mitigates the release of fission products to the reactor building during long-term core heatup following loss of forced cooling. Any leakage of radioactive material from the PCRV is further attenuated by the confinement afforded by the reactor building (TSUP Specification 3/4.6.5.1) and by filtration by the reactor building exhaust system (TSUP draft Specification 3/4.6.5.2).

For assuring the efficacy of the containment and containment heat removal functions (GDC 16, 38, and 50) during all normal operating, transient and accident conditions, TSUP draft Specification 3/4.6.2 stipulates the operability requirements of the RPCW/PCRV LCS, the required redundancy in adjacent cooling tubes on the PCRV liner, and the temperature rise limits on individual cooling tubes in various locations. Similarly, TSUP draft Specification 3/4.6.3 stipulates the overall temperature limits for the RPCW/PCRV LCS cooling water and for PCRV concrete. TSUP draft Specification 3/4.6.2 requires the operability of both trains for the RPCW/PCRV LCS during powered operation of the reactor and when the

CALCULATED BULK CORE TEMPERATURE exceeds 760°F. Only one train is required to be OPERABLE otherwise. These requirements impose redundancy during the most limiting conditions of plant operation and assure the availability of one train as assumed in the UFSAR accident analyses. Restoration times are 48 hours for the inoperability of one of two trains required OPERABLE with an additional 24-hour ACTION time to be in SHUTDOWN. Loss of both trains requires reactor shutdown within 15 minutes. Restoration of the loss of redundancy in adjacent cooling tubes must be performed within 24 hours with a subsequent 24-hour ACTION time to be in SHUTDOWN if restoration is not accomplished. The identification of new or unexpected hot spots due to observed increases in LCS tube cooling water temperature rise must be corrected within seven days or reported to NRC with plans for corrective action within 14 days. With a CALCULATED BULK CORE TEMPERATURE below 760°F, TSUP draft Specification 3/4.6.2.2 also imposes requirements for assuring backup residual heat removal as discussed above in Section 4.3.4 of this TER.

TSUP draft Specification 3/4.6.3, which is applicable at all times, allows only 24 hours to restore diverse temperature limits to within acceptable values followed by a 24-hour ACTION time to be in SHUTDOWN if limits can not be so restored. The temperature limits assure minimum and maximum operating values for PCRV concrete as an initial condition for any accident or challenge (UFSAR Section 5.4.5.3). Known hot spots on the PCRV liner (UFSAR Section 5.9.2.8) are controlled per TSUP draft Specification SR 4.6.2.1.b by surveilling the average temperature rise in OPERABLE LCS cooling tubes in the affected regions.

The combination of TSUP draft Specifications 3/4.4.1, 3/4.6.2, 3/4.6.3, and 3/4.7.5 provide for the assurance of the containment function against the challenge of thermally-induced failures due to potential accident conditions that are unique to PCRV-enclosed HTGRs such as FSV. The containment function is assured by effecting the containment heat removal function which is facilitated at FSV by assuring the timely depressurization of the PCRV in response to a permanent loss of forced circulation cooling. Under both normal operating conditions and other accident conditions in which forced circulation cooling is continued or restored, including accidental depressurization, the continuation of the containment and reactor coolant pressure boundary functions is assured by the operation of the RPCW/PCRV LCS. Both trains of the RPCW/PCRV LCS are required for normal operation; only one train is required to accommodate accident conditions.

Also, in subsequent discussions with the licensee during NRC-initiated teleconferences and, contrary to the licensee's positions given in Attachment 2 to Ref. 5, agreement was reached that TSUP draft Specification 3/4.6.4.3, PCRV Integrity, would incorporate carry-over requirements of existing Specification SR 5.2.24.h with regard to testing valves used for assuring confinement integrity by automatic isolation of the RPCW (addressed in TSUP draft SR 4.6.2.1) and the purification cooling water system (addressed in TSUP draft SR 4.7.5). In addition, functional testing of the purification water pumps per existing Specification SR 5.2.24.g will be carried-over into SR 4.7.5 to assure confinement integrity against leaks in the purification cooler during emergency depressurizations.

However, the licensee's positions with regard to deleting explicit surveillances on the PCRV LCS temperature and flow scanner instrumentation per existing Specifications SR 5.4.4 and SR 5.4.5 were accepted since the intent of this Specification is judged to be met by TSUP SR 4.6.2.1. Surveillance of instrumentation that does not function to provide automatic actuation of safety-related equipment is generally not required in the W-STS; however, discussions with the licensee centered on the applicability of functional analogies drawn between the PCRV LCS temperature scanner in assuring PCRV thermal barrier integrity per UFSAR Section 9.7.3.1 and the Basis for W-STS Section 6B Specification 3/4.6.7.2 for the ice bed temperature monitoring system in ice condenser containments. The judgment was made that the larger thermal margins and longer thermal response times of the PCRV thermal barrier compared to the PWR ice bed containment were sufficient to accept the surveillance intervals in TSUP draft SR 4.6.2.1 without requiring separate specific surveillances on the scanner instrumentation.

4.6 Cooling Water Functions

4.6.1 Condensate Storage Function

As indicated in Table 2, condensate is not relied upon at FSV as a Seismic Category I source of cooling water. The equivalent function at FSV is accommodated by the supply of firewater using the Safe Shutdown Cooling Water Supply System that is addressed in TSUP draft Specification 3/4.5.5. This Specification is discussed above in Section 4.4 of this TER.

As discussed in Section 4.3.2 of this TER, condensate supply for the equivalent emergency feedwater subfunction is from the condenser hot well or the condensate storage tank; however, as also discussed, this equivalent subfunction is accomplished by these SSCs only for nonseismically-induced transients. Firewater is the seismically and environmentally qualified source for Safe Shutdown Cooling, and, consistent with the FSV licensing basis, only this source is the subject of Technical Specification requirements.

4.6.2 Component Cooling Water Functions

At a PWR, this function is effected by the Reactor Auxiliary Cooling Water System as discussed in Section 9.2.2 of the *Standard Review Plan*. At FSV, as described in UFSAR Sections 5.9 and 9.7, the equivalent functions are performed by the RPCW/PCRV LCS that is covered by TSUP draft Specifications 3/4.6.2 and 3/4.6.3. These draft Specifications are discussed above in Section 4.5 of this TER. Heat from the RPCW/PCRV LCS is rejected to the non-Class I configuration of the Service Water System during normal operation and can be rejected to Class I Service Water (TSUP draft Specification 3/4.7.4) or Class I firewater flow (TSUP draft Specification 3/4.5.5) in open loop operation during abnormal or accident conditions.

Also, during normal plant operation, other component cooling functions are provided in the Helium Purification System (TSUP draft Specification 3/4.7.5) by the Purification Cooling Water Subsystem (UFSAR Section 9.7.3.4) of the RPCW System and by the Nitrogen System (UFSAR Section 9.6). During depressurization required to accommodate the permanent loss of forced cooling as discussed in Section 4.5 of this TER, the Helium Purification System (HPS) performs the safety-related function of providing fission product removal in the depressurization flow path. Per UFSAR Section 9.4.3.3.2, the RPCW with firewater backup is used to cool the high temperature filter/adsorber; purification cooling water is used to assure structural integrity of the flow path through the purification coolers and confinement of fission gas leakage from the HPS; and liquid nitrogen is used to cool the low temperature adsorber. Operability of these component cooling subsystems is assured by the operability requirements for effecting primary coolant depressurization per TSUP draft Specification 3/4.7.5.

4.6.3 Service Water Functions

As described in FSV UFSAR Section 9.8, the FSV Service Water System is functionally equivalent to that of the PWR as described in Section 9.2.1 of the *Standard Review Plan*. However, the FSV non-Class I configuration of the Service Water System supports the PCRV functions of assuring the primary coolant pressure boundary (GDC 14) both during normal operation and during the equivalent of cold shutdown conditions at FSV and provides the primary heat rejection capability for backup residual heat removal through the RPCW/PCRV LCS during the equivalent of cold shutdown conditions, that is, when the CALCULATED BULK CORE TEMPERATURE is less than or equal to 760°F. The non-Class I configuration of the Service Water System includes the three seismically qualified service water pumps with associated Class I piping and valves as well as the non-Class I service water makeup subsystem consisting of the three service water return pumps and pump pit and the service water cooling tower and fans. Equipment comprising both the Class I and non-Class I configurations of the Service Water System constitutes a set of essential loads (Updated FSAR Tables 8.2-4 through 8.2-7) for the emergency diesel generators in response to nonseismically-induced transients such as loss of offsite power. Both configurations can also be powered by the Alternate Cooling Method (ACM) diesel generator (Updated FSAR Table 8.2-8). However, with the exception of certain nonseismically qualified safety-related equipment (service water cooling tower fans and return pumps) that is part of the ACM and surveilled per TSUP draft Specification SR 4.8.4.e.2 and Table 4.8.4.2, the non-Class I equipment of the Service Water System has not been subjected to Technical Specifications requirements as part of the FSV license and licensing basis, because, as indicated above, this equipment is normally operating and is redundantly and diversely backed up by a Class I water supply from circulating water makeup and with alternate flowpaths available through the Class I firewater system.

W-STS Specification 3/4.7.4 requires two independent trains of service water to be OPERABLE in POWER, STARTUP, HOT STANDBY, and HOT SHUTDOWN, and has no requirement for OPERABLE trains otherwise.

For the Class I portions of the Service Water System, TSUP draft Specification 3/4.7.4.1 requires the equivalent of two independent trains to be OPERABLE in POWER, LOW POWER or otherwise when the CALCULATED BULK CORE exceeds 760°F, but, on the other hand, TSUP draft Specification 3/4.7.4.2 also requires the equivalent of one train to be OPERABLE when the CALCULATED BULK CORE TEMPERATURE is less than or equal to 760°F. The independent Class I trains are supplied by circulating water makeup (TSUP draft Specification 3/4.5.5). The operability requirements of TSUP draft Specification 3/4.7.4.2 complement and support meeting the operability requirements of the RPCW/PCRV LCS as given in TSUP draft Specification 3/4.6.2.2. TSUP draft Specification 3/4.7.4.1 in general adopts the 72-hour restoration time used in W-STS Specification 3/4.7.4; however, the ACTION statements in the TSUP draft are relatively more complicated to account for the backup alternate flowpath that is both afforded by and relied upon in the firewater system (TSUP draft Specification 3/4.5.5) that is also supplied via circulating water makeup. TSUP draft Specification 3/4.7.4.1 also calls out specific ACTIONs necessary to assure cooling water supply to the emergency diesel generator coolers.

Thus, TSUP draft Specification 3/4.7.4 is judged to be functionally equivalent to W-STS Specification 3/4.7.4

4.6.4 Ultimate Heat Sink (Optional) Function

As described in FSV UFSAR Section 10.3.9, the two circulating water makeup storage ponds of the Safe Shutdown Cooling Water Supply System (TSUP draft Specification 3/4.5.5) provide the functional equivalent to the seismically qualified ultimate heat sink that is described in Section 9.2.5 of the *Standard Review Plan* and addressed in W-STS Specification 3/4.7.5. As described in FSV UFSAR

Sections 2.5.1 and 10.3.9, the minimum nine day seismically qualified water supply at FSV can be replenished indefinitely from other diverse sources after the storage ponds' initial inventory is exhausted. Consistent with the FSV licensing basis, the diverse replenishment sources have not been subject to Technical Specifications in the past.

4.7 Spent Fuel Cooling Function

As indicated in Table 2, spent fuel cooling is assured both during and after refueling. This cooling function is cited here merely for completeness in comparison to the W-STS. The TSUP draft Specifications 3/4.9.3 and 3/4.9.4 are to be discussed in a separate TER. However, from the standpoint of accomplishing the required cooling function, the TSUP draft Specifications are judged to be functionally equivalent to and more comprehensive than W-STS Specifications 3/4.9.10 and 3/4.9.11. From the standpoint of iodine scrubbing, the robust design of the FSV fuel elements and the gas-tight and water-tight design both of the fuel handling containment system, which is purged with clean helium, and the fuel storage containment system (UFSAR Sections 9.1.1 and 9.1.2, respectively) obviates the iodine scrubbing function discussed in the Bases for the W-STS Specifications.

4.8 Steam Safety Valves (Steam Safety-Relief Functions)

Although not part of the functional analogies drawn between the W-STS and the TSUP draft in Tables 1 and 2, the FSV Technical Specifications for the superheat steam and reheat steam safety valves were included as associated components in the package of draft cooling function Specifications.[3,18,20] As described in FSV UFSAR Section 10.2.5.3, both the superheater and reheater safety valves protect the respective sections of the steam generator against overpressure in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class A.

TSUP draft Specification 3/4.7.1.5 (Ref. 55) is applicable whenever fission heat is being generated in the reactor core and is judged to be functionally equivalent to W-STS Specification 3/4.7.1.1. The FSV Specification requires the single low-pressure reheater safety valve to be operable at all times but restricts the reactor power level for each inoperable superheater safety valve (three per loop) in a loop by requiring one operable superheater safety in each operating loop for each operating boiler feed pump (three total). Each boiler feed pump is capable of delivering approximately one third of the total feedwater flow capacity (UFSAR Section 10.2.3.1). The FSV Specification is less restrictive than the W-STS in allowing a 72-hour restoration time for an inoperable valve; however, the nature of the plant challenge posed by a steam line rupture differs between the HTGR and the PWR. At FSV, the operability of the safety valves protects against ruptures of the steam generator once-through-flow tubing or the rupture of high energy fluid lines to and from the steam generator. Steam generator tube ruptures, which would be contained inside the PCRV, are bounded by accident analysis given in UFSAR Sections 6.4, 14.2.1.4, and 14.5.2 through 14.5.4. FSV is not sensitive to overcooling transients to the same extent that the PWR is due to steam line rupture (see Section 15.1.5 of the *Standard Review Plan*), but a significant steam line rupture at FSV will actuate the Steam Line Rupture Detection and Isolation System, or SLRDIS (to be included in TSUP draft Section 3/4.3.1), which will in turn initiate a loss of forced circulation cooling from which the plant has to recover. However, SLRDIS actuation facilitates plant recovery of forced circulation cooling as discussed in FSV UFSAR Sections 1.4.6, 7.3.10, 10.3.9, 10.3.11, 10.3.12, and 14.5.1. The 72-hour restoration time for inoperability of a single safety valve as implemented in TSUP draft Specification 3/4.7.1.5 differs from the W-STS but is judged to be acceptable for FSV since the nature of steam line rupture challenge differs between the HTGR and the PWR.

TSUP draft Specification 3/4.7.1.6 (Ref. 55) requires only one safety valve on each operating steam generator section to be OPERABLE for SHUTDOWN and REFUELING. These provisions are functionally equivalent to those imposed by the last entry, respectively, in W-STS Tables 3.7-1 and 3.7-2 that require only one OPERABLE safety valve on each operating steam generator of the Standard PWR when rated thermal power is less than 42% for all loops in operation and less than 25% for all but one loop in operation. However, the W-STS requirements extend only to HOT STANDBY since the steam generators are not necessarily required for PWR decay heat removal in HOT SHUTDOWN per W-STS Specification 3/4.4.1.3 and because the associated steam loads for the PWR would be small for the prevailing thermal-hydraulic conditions below HOT STANDBY. TSUP draft Specification 3/4.7.1.6 conservatively requires an OPERABLE safety valve on each operating steam generator section for SHUTDOWN and REFUELING because the FSV steam generator sections are required for both normal and abnormal decay heat removal under these conditions per TSUP draft Specifications 3/4.4.1 and 3/4.5.3.

4.9 Review for Identifying Other Cooling Functions in the FSV Licensing Basis

For completeness, the FSV UFSAR and *Reference Design Book* (that is, system design descriptions and design criteria) have been reviewed to identify other cooling functions and associated SSCs that are unique to FSV but not covered by Technical Specifications. None has been identified as being safety-related or important-to-safety except as noted in Section 4.3.4 of this TER with regard to effecting residual heat removal. In these instances, the diversity in SSC design and the large thermal margins inherent in the shutdown FSV reactor have been sufficient reasons for not requiring Technical Specifications to be implemented for SSCs such as the decay heat removal exchanger, the condensate storage tanks, the auxiliary boiler feed pumps, and the two small (7% capacity) circulating water pumps.

There are other important-to-safety cooling functions that are addressed directly or indirectly in the draft upgraded Technical Specification. These include cooling of the control rod drive mechanism (TSUP draft Specification 3/4.1.1), the PPS and analytical moisture monitors (TSUP draft Specifications 3/4.3.1 and 3/4.3.2.1), the three-room complex including the control room (TSUP draft Specifications 3/4.3.3 and 3/4.7.9) and the reactor building environment (TSUP draft Specification 3/4.6.5.2). The affected Specifications are addressed in a separate TER.

5.0 Conclusions

A comprehensive function-based evaluation has been performed for the TSUP draft Specifications for FSV SSCs that perform safety-related and important-to-safety cooling functions. This evaluation has compared the generic cooling functions implemented in the W-STS to the equivalent functions implemented by the TSUP draft. In each case, functionally equivalent Specifications were identified for the FSV TSUP draft in comparison to the W-STS. In some cases, FSV SSCs that constitute the preferred or primary success path for accomplishing a cooling function did not require equivalent Specifications because the cooling function, each of which is addressed in at least one TSUP draft Specification, could be accomplished by a diversity of non-Class I SSCs and is backed up redundantly by the seismically and environmentally qualified Safe Shutdown Cooling System. Without exception, however, the TSUP draft Specifications were found to be functionally analogous with and equivalent to the W-STS. This finding provides confidence that the FSV TSUP draft Specifications are complete in the coverage of safety-related cooling functions and ensure defense-in-depth through the diversity and redundancy provided by the assured operability of the important-to-safety SSC configurations.

6.0 References

1. PSC letter, O. R. Lee to H. N. Berkow (NRC), *Upgrade Technical Specifications*, P-85448, Public Service Company of Colorado, Denver, Colorado, November 27, 1985. (Public Document Room [PDR] Accession No. [ACN] 8512020401)

2. PSC letter, H. L. Brey to H. N. Berkow (NRC), *Technical Specification Upgrade Program*, P-87063 Public Service Company of Colorado, Denver, Colorado, February 20, 1987. (PDR ACN 8702260180)

3. PSC letter, H. L. Brey to J. A. Calvo (NRC), *Technical Specification Upgrade Program (TSUP), Safety Related Cooling Function Resubmittal*, P-87441, Public Service Company of Colorado, Denver, Colorado, December 23, 1987. (PDR ACN 8712300208)

4. PSC letter, H. L. Brey to J. A. Calvo (NRC), *Technical Specification Upgrade Program (TSUP) Additional Information*, P-88045, Public Service Company of Colorado, Denver, Colorado, February 2, 1988. (PDR ACN 8802110019)

5. PSC letter, H. L. Brey to J. A. Calvo (NRC), *Technical Specification Upgrade Program (TSUP) Additional Information*, P-88082, Public Service Company of Colorado, Denver, Colorado, March 8, 1988. (PDR ACN 8803160023)

6. **Safety-Related Structures, Systems, and Components (SSCs).** General definition: For SSCs requiring seismic qualification, see Section III (c), Appendix A, Part 100, Title 10, *Code of Federal Regulations (CFR)*; and, for electrical equipment requiring environmental qualification, see Section 50.49(b)(1), Part 50, Title 10, *CFR*. For FSV, safety-related specifically refers to the SSC configurations that form the primary or backup success paths for mitigating the consequences of accidents, transients, malfunctions, and other challenges to fission product barriers and that, except for a few components used in the Alternate Cooling Method (ACM), are required to be seismically and environmentally qualified. For FSV, safety-related SSCs are defined in Ref. 8: Appendix B.5.2.7, and Tables 1.4-1 (Class I), 1.4-2 (Safe Shutdown Cooling), and 8.2-8 (ACM).

7. Important-to-Safety SSCs. General definition: With regard to providing "reasonable assurance" for plant operation without undue risk to public health and safety, the first paragraph in the Introduction to Appendix A, Part 50, Title 10, *CFR*; and, for certain electrical equipment, the nonexclusive definition in Section 50.49(b), Part 50, Title 10, *CFR*. For FSV, important-to-safety specifically refers to the SSC configurations that are the preferred primary success paths in providing "reasonable assurance" of avoiding undue risk to public health and safety by mitigating the consequences or effects of accidents, transients, malfunctions, and other challenges but that are not required to be fully seismically or environmentally qualified. At FSV, each important-to-safety SSC configuration is redundantly backed up by a safety-related SSC configuration, and the failure of nonsafety-related equipment in the important-to-safety SSC configurations will not cause loss of function of safety-related equipment. Thus, the provisions of 10CFR Part 50.49(b)(2) would not apply to equipment in the important-to-safety SSC configurations as defined here.

8. *Fort St. Vrain Nuclear Generating Station Updated Final Safety Analysis Report*, Docket No. 50-267, Public Service Company of Colorado, Denver, Colorado, updated through Revision 5, July 22, 1987. (Available in PDR)

9. U.S. NRC, *Standard Technical Specifications for Westinghouse Pressurized Water Reactors*, NUREG-0452, Revision 5 (Proof and Review Copy), U.S. Nuclear Regulatory Commission, Washington, D.C., July 8, 1983. (PDR ACN 8307190388)

10. U.S. NRC, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition*, July 1981, NUREG-0800, U.S. Nuclear Regulatory Commission, Washington, D.C., July 1981, Revised through June 1986. (Available in PDR)

11. U.S. NRC letter, H. R. Denton to R. F. Walker (PSC), *Preliminary Report Related to the Restart and Continuing Operation of Fort St. Vrain Nuclear Generating Station*, U.S. Nuclear Regulatory Commission, Washington, D.C., October 16, 1984. (PDR ACN 8410240125)

12. *Appendix A to Operating License No. DPR-34: Technical Specifications for the Fort St. Vrain Nuclear Generating Station, Public Service Company of Colorado, DOCKET No. 50-267*, Issued December 21, 1983, Revised through Amendment 58, January 22, 1988. (Available in PDR)

13. PSC letter, O. R. Lee to E. Johnson (NRC), *Technical Specification Upgrade Program*, P-84498, Public Service Company of Colorado, Denver, Colorado, November 16, 1984. (PDR ACN 8411280225)

14. U.S. NRC-Region IV letter, E. H. Johnson to O. R. Lee (PSC), *Changes and Clarifications Regarding the Scope of the FSV Technical Specification Upgrade Program*, Docket No. 50-267, U.S. Nuclear Regulatory Commission, Arlington, Texas, December 20, 1984. (PDC ACN 8501140462)

15. U.S. NRC, *Standard Technical Specifications for Babcock and Wilcox Pressurized Water Reactors*, NUREG-0103, Revision 4, U.S. Nuclear Regulatory Commission, Washington, D.C., Fall 1980. (PDR ACN 8010240042)

16. U.S. NRC, *Standard Technical Specifications for General Electric Boiling Water Reactors (BWR/5)*, NUREG-0123, Revision 3, U.S. Nuclear Regulatory Commission, Washington, D.C., Fall 1980. (PDR ACN 8012240312)

17. U.S. NRC, *Standard Technical Specifications for Combustion Engineering Pressurized Water Reactors*, NUREG-0212, Revision 2, U.S. Nuclear Regulatory Commission, Washington, D.C., Fall 1980. (PDR ACN 8012180510)

18. PSC letter, H. L. Brey to E. J. Butcher (NRC), *Technical Specification Upgrade Program*, P-85363, Public Service Company of Colorado, Denver, Colorado, October 11, 1985. (PDR ACN 8510160173)

19. U.S. NRC letter, H. N. Berkow to R. F. Walker (PSC), *Proposed Changes to Helium Circulator, Steam Generator and Liner Cooling System Limiting Condition for Operation*, Docket No. 50-267, U.S. Nuclear Regulatory Commission, Washington, D.C., December 27, 1985. (PDR ACN 8601070733)

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21. U.S. NRC letter, K. L. Heitner to R. O. Williams (PSC), *NRC Comments on the Technical Specification Upgrade Program (TSUP), LCOs for Safety-Related Cooling Functions*, Docket No. 50-267, Nuclear Regulatory Commission, Washington, D.C., April 17, 1987. (PDR ACN 8704280502)

22. PSC letter, D. M. Warembourg to J. T. Collins (NRC), *Reportable Occurrence Report No. 50-267/83-043, Preliminary*, P-83346, Public Service Company of Colorado, Platteville, Colorado, October 25, 1983. (PDR ACN 8311070285)

23. U.S. NRC letter, K. L. Heitner to R. O. Williams (PSC), *Fort St. Vrain Technical Specification LCO 4.1.9*, Docket No. 50-267, U.S. Nuclear Regulatory Commission, Washington, D.C., December 5, 1986. (PDR ACN 8612100225)

24. U.S. NRC letter, K. L. Heitner to R. O. Williams (PSC), *Fort St. Vrain Nuclear Generating Station, Amendment No. 57 to Facility Operating License No. DPR-34 (TAC No. 52634)*, Docket No. 50-267, U.S. Nuclear Regulatory Commission, Washington, D.C., November 23, 1987. (PDR ACN 8712030104)

25. PSC letter, R. O. Williams to H. N. Berkow (NRC), *Propsed Technical Specification Change Eliminating Reliance on Reheater Section of the Steam Generator for Safe Shutdown Cooling*, P-87002, Public Service Company of Colorado, Denver, Colorado, January 15, 1987. (PDR ACN 8701210005)

26. U.S. NRC letter, K. L. Heitner to R. O. Williams (PSC), *Request for Additional Information for Technical Specification Upgrade Program for Fort St. Vrain Nuclear Generating Station (TAC No. 56565)*, Docket No. 50-267, U.S. Nuclear Regulatory Commission, Washington, D.C., July 2, 1987. (PDR ACN 8707130420)

27. U.S. NRC Memorandum, K. L. Heitner for J. A. Calvo, *Summary of Meeting With Public Service Company of Colorado to Discuss Fort St. Vrain Technical Specification Upgrade Program—August 25 and 26, 1987*, U.S. Nuclear Regulatory Commission, Washington, D.C., October 1, 1987. (PDR ACN 8710080024)

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Table 1. Correlation of Generic Cooling Functions B the Westinghouse Standard Technical

Function/Subfunctions	Applicable GDC[a] Primary	Applicable GDC[a] Related	Implement
1. Normal Process Cooling (or Reactor Cooling—Critical Core)	10	15, 33	3/4.1, Reactivity
			3/4.2, Power Di:
			3/4.3.1, Reactor
			3/4.4.1.1, Reacto Coolant Circulat
			3/4.4.5, Steam C
			Also, during phy 3/4.10.4, Reacto
2. Normal Decay Heat Removal (or Reactor Cooling—Subcritical Core)			
a. Auxiliary Feedwater[c] (both the normal startup/standby/shutdown feedwater subfunction and the emergency feedwater subfunction)	10,[d] 34, 44	45, 46	3/4.4.1.2 and 3/ and Hot Shutdov
			3/4.4.5, Steam C
			3/4.7.1.2, Auxili
			3/4.7.1.3, Conde
b. Residual Heat Removal (RHR)	10,[d] 34		3/4.4.1.3 and 3/ and Cold Shutdo
			3/4.9.8 and 3/4. and Coolant Circ Reactor Vessel
3. Emergency Core Cooling	35	36, 37	3/4.3.2, Enginee Actuation Systen
			3/4.5, Emergenc
4. Containment Heat Removal	16, 50, 38	39, 40	3/4.6.2, Contain and Cooling Syst
5. Cooling Water	10,[d] 34, 44	45, 46	3/4.7, Plant Syst
a. Condensate Storage	44	45, 46	3/4.7.1.3, Conde
b. Component Cooling Water	44	45, 46	3/4.7.3, Compon
c. Service Water	44	45, 46	3/4.7.4, Service
d. Ultimate Heat Sink	45	44, 46	3/4.7.5, Ultimat
6. Spent Fuel Cooling	61, 44	45, 46	3/4.9.11, Water

[a]That is, the GDC that directly or indirectly invoke a cooling function. The GDC that

[b]That is, sections that relate to the structures, systems, or components (SSCs) tha functions are not cited here.

[c]In current LWR designs, the auxiliary feedwater function is generally recognized as ((see NUREG-0770). Per the Basis for Specification 3/4.7.1.2 in the W-STS, the emerg cooling subfunction must accommodate the effects of Seismic Category I events and the s

[d]Criterion 10 is cited here even though it is not cited in the applicable SRP section sin

[e]To accommodate accident conditions, the emergency feedwater supply source must be

ween the General Design Criteria (GDC) of Appendix A to 10 CFR Part 50, Specifications (W-STS), and the Standard Review Plan (SRP)

ng W-STS Section(s)[b]	Controlled Parameter(s)	Primary SRP Sections
Control System	Reactivity control systems operability and capability	4.3, Nuclear Design
ribution Limits	Axial and radial power peaking	
Trip System Instrumentation	Reactor scram setpoints	7.2, Reactor Trip System
Coolant Loops and on	Operating status of primary loops, steam generators, and reactor coolant pumps	4.4, Thermal and Hydraulic Design
enerators	Operability of steam generators (including structural integrity)	
cs tests: Coolant Loops	Criticality without primary loop flow	
4.1.3, Hot Standby n	Operating status of primary loops steam generator and reactor coolant pumps	
enerators	Operability of steam generators (including structural integrity)	
y Feedwater System	System operability/availability	10.4.9, Auxiliary Feedwater System (PWR)
sate Storage Tank[c]	Availability and capacity of Seismic Category I water source	
4.1.4, Hot Shutdown	Operability of RHR loops	5.4.7, Residual Heat Removal (RHR) System
10, Residual Heat Removal lation and Water Level—	Operability of RHR loop and reactor vessel water inventory	
d Safety Feature Instrumentation	Automatic actuation setpoints for coolant injection	7.3, Engineered Safety Features Systems
Core Cooling Systems	Operability of high- and low-pressure coolant injection	6.3, Emergency Core Cooling System
ent Depressurization ns	Operating status and availability	6.2.1 and 6.2.3, Containment Functional Design and Containment Heat Removal Systems
ns		
ate Storage Tank[c]	Availability and capacity of startup/shutdown water source	9.2.6, Condensate Storage Facilities
t Cooling Water System	System operability	9.2.2, Reactor Auxiliary Cooling Water Systems
ater System	System operability	9.2.1, Station Service Water System
Heat Sink (Optional)	Capacity/temperature	9.2.5, Ultimate Heat Sink
vel—Storage Pool	Water inventory	9.1.3, Spent Fuel Pool Cooling and Cleanup System

e listed in the SRP and relate to such matters as seismic and environmental qualification are not cited here. omprise and control the cooling configuration or heat transfer path. Sections relating to overpressure relief

ompassing both a normal startup/standby/shutdown cooling subfunction and an emergency cooling subfunction y cooling subfunction is to accommodate a total loss of offsite power. Per SRP Section 10.4.9, the emergency ll-break loss of coolant accident.
the function accomplished provides for heat rejection from the reactor core.
ismic Category I per SRP Section 10.4.9.

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Table 2. Correlation of Generic Cooling Functions/Subfunctions with the [
Program (TSUP) Draft, the Updated Final Safety Analysis Report (U

Functions/Subfunctions	Implementing Sections of FSV TSUP Draft	Cont
1. Normal Process Cooling (or Reactor Cooling Critical Core)	3.0.5, Limiting Conditions for Operation	CALCULATED BULK (
	3/4.1.4.1, Control Rod Worth and Position Requirements—Operating	Core reactivity and powe[
	3/4.1.7, Reactivity Status	Directly: Reactivity devia[peaking anomalies due
	3/4.2.2, Core Inlet Orifice Valves/Region Outlet Temperature Limits	Directly: Regionwise outl[Indirectly: Regionwise
	3/4.2.3, Core Inlet Orifice Valves/Comparison Regions	Power distribution inferre[temperature and orifice
	3/4.2.4, Core Inlet Orifice Valves/Minimum Helium Flow and Core Region Temperature Rise	Core region coolant flow
	3/4.2.6, Power-to-Flow Ratio	Core power-to-flow ratio
	3/4.3.1, Plant Protective System	Reactor scram and loop s
	3/4.3.2.7, Power-to-Flow Ratio Instrumentation System	Instrument operability
	3/4.3.2.8, Core Region Outlet Thermocouples	Instrument operability
	3/4.4.1, Primary Coolant Loops and Coolant Circulation	Operating status of heliur
2. Normal Decay Heat Removal (or Reactor Cooling Subcritical Core)		
a. Auxiliary Feedwater	No exact Seismic Category I equivalent to LWRs due to unique design and licensing history at FSV	
Normal Startup/Shutdown Feedwater (or equivalent) Supply	3.0.5, Limiting Conditions for Operation	CALCULATED BULK (
	3/4.2.4, Core Inlet Orifice Valves/Minimum Helium Flow and Core Region Temperature Rise	Core region coolant flow
	3/4.4.1.2, Primary Coolant Loops and Coolant Circulation	Operating status of heliur
	3/4.5.1, Helium Circulators	Operability of water turb
	3/4.5.2, Helium Circulator Auxiliaries	Operability of water turb
	3/4.5.3, Steam Generators	Capability for alternate v
	3/4.5.4.1, Emergency Condensate and Emergency Feedwater Headers Operation	Availability of high press and circulator drive
	3/4.7.1.1, Boiler Feed Pumps	Availability of high press (if needed) for water t[
Emergency Feedwater (or equivalent) Supply	For depressurized core cooling given simultaneous loss of reactor generated steam	
	3/4.5.1 through 3/4.7.1.1, as cited above	Availability of high press supply and water turbi
	For total loss of offsite power (non-seismic):	
	3/4.5.1 through 3/4.5.4.1, as cited above, and 3/4.7.1.7, Condensate Pumps	Availability of low pressu supply and water turbi to a combination of Cl
b. Residual Heat Removal (RHR)	When CBCT > 760°F	
	3/4.2.4 and 3/4.4.1.2, as cited above, but, in general, all SSCs addressed under the auxiliary feedwater subfunction also apply to assuring RHR capability	Forced circulation coolin[that can redundantly a[Many are covered by T[but the diversity of cap[margins inherent in th[in equipment configur[forced circulation cool[
	When CBCT ≤ 760°F	
	3/4.6.2.2, Reactor Plant Cooling Water/PCRV Liner Cooling System: Shutdown	Forced circulation coolin
	During refueling when fuel handling is being performed	
	DEFINITION 1.12, Core Average Inlet Temperature	Primary and secondary f[inlet temperature
	3/4.9.1, Fuel Handling and Maintenance in the Reactor	Core average inlet tempe[pressure changes
	3/4.9.3, Fuel Handling Machine	Pressure limit in fuel han[

ort St. Vrain (FSV) Technical Specification Upgrade
SAR), and the Existing Technical Specifications

lled Parameters(s)	UFSAR Sections That Form Licensing Basis	Equivalent Existing FSV Specifications (LCO/SR)
ORE TEMPERATURE (CBCT)	Pending	4.0.4/None
peaking[a],	3.5.4[b]	4.1.3, 4.1.4/5.1.5
on. Indirectly: Axial power long-term burn-up effects[c]	None	4.1.8/5.1.4
coolant temperature. wer-to-flow ratio	3.6.7	4.1.7/5.1.7
from region outlet osition	3.6.7	4.1.7/5.1.7
d/or temperature rise	3.6.7	4.1.9/5.1.8
	3.6.7, 3.6.8	SAFETY LIMIT (SL) 3.1/5.1.6
tdown setpoints	7.1	4.4.1/5.4.1
	3.6.7, 3.6.8	None/5.4.8
	3.6.7, 7.3.3.1	None/5.4.3
circulators and steam generators	4.3	None
ORE TEMPERATURE	Pending	4.0.4/None
d/or temperature rise	3.6.7	4.1.9/5.1.8
circulators and steam generators[a]	4.3, 10.2.1, 10.3	None
drive	4.2.2	4.2.1/5.2.7
drive	4.2.2	4.2.2, 4.2.3/5.2.8, 5.2.9, 5.2.23, 5.2.27
er supply and structural integrity	4.2.4	4.3.1/5.3.10, 5.3.11, 5.3.12
feedwater for steam generator supply	10.2.1, 10.2.3.3, 10.3	4.3.4/5.2.7
feedwater and auxiliary boilers ine drive	10.2.1, 10.2.3.1, 10.2.6	4.3.2/5.2.7
feedwater for steam generator drive	14.4.3.2, 14.11.2.2	Cited elsewhere
condensate for steam generator drive using Class 1E electrical supply I and non-Class I components	10.2.1, 10.3.2, 14.3.6, 14.4.2.1, 14.4.4.2	Cited elsewhere None for condensate pump
There is a diversity of SSCs mplish forced circulation cooling. hnical Specifications as indicated. le SSCs and the large thermal ramic core allow for flexibility ns for accomplishing RHR by	10.2.1, 10.3, 14.3.5, 14.4	4.1.9/5.1.8
r PCRV liner cooling	Pending	4.2.13, 4.2.14/5.4.4, 5.4.11
required to measure core average	None	DEFINITION 2.24
ure controlled to limit reactor	9.1.1.4	4.7.1/None
ne machine	9.1.1.4	4.7.2/5.7.1

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Function/Subfunctions	Implementing Sections of FSV TSUP Draft	
3. Emergency Core Cooling	3/4.5, Safe Shutdown Cooling Systems	O
4. Containment Heat Removal	3/4.4.1, Primary Coolant Loops and Coolant Circulation	Ti
	3/4.6.2, Reactor Plant Cooling Water/PCRV Liner Cooling System	St
	3/4.6.3, Reactor Plant Cooling Water/PCRV Liner Cooling System Temperatures	L
	3/4.7.5, Primary Coolant Depressurization	Fi
5. Cooling Water		
a. Condensate Storage	Condensate is not relied upon as a Seismic Category I source of cooling water. The equivalent function is accommodated by firewater supply: 3/4.5.5, Safe Shutdown Cooling Water Supply System	T
b. Component Cooling	3/4.6.2 and 3/4.6.3, as cited above, under Containment Heat Removal. See also Service Water, 3/4.7.4. Firewater is Class I backup, 3/4.5.5	S
c. Service Water	3/4.7.4, Service Water System	S
d. Ultimate Heat Sink (Optional)	3/4.5.5, as cited above under condensate storage	N
6. Spent Fuel Cooling	During Refueling:	
	3/4.9.3, Fuel Handling Machine	C
	Post Refueling:	
	3/4.9.4, Fuel Storage Wells	C

[a]Local power peaking is controlled by reviewed calculations per TSUP Draft Specification Design Featu under administrative controls per TSUP Draft Specification 6.5.2.9.a.

[b]However, the licensing basis is judged to be incomplete in comparison with regulatory guidelines and verification against experimental data is not presented for these methods and models.

[c]Reactivity status is tracked using the base reactivity curve that is approved per 10 CFR Part 50.59 under

Table 2 (continued)

Controlled Parameters(s)	UFSAR Sections That Form Licensing Basis	Equivalent Existing FSV Specifications (LCO/SR)
rability of seismically and environmentally qualified SSCs for forced circulation cooling of reactor and for ater supply to steam generators	10.3.9, 10.3.10, 14.4.2.1, 14.4.2.2	Cited elsewhere
e to depressurize PCRV following loss of forced cooling	14.10.2	4.2.18/None
ply of cooling water during reactor operation and shutdown	5.9, 9.7, 14.10, App. D	4.2.13, 4.2.14/5.4.4, 5.4.11
S cooling water and PCRV concrete temperatures	5.9, 9.7, 14.10, App. D	4.2.15/5.4.5
ered flow path for PCRV depressurization	9.4.3.3.2, 14.10.2	4.2.18/None
circulating water makeup storage ponds with operable owpaths to firewater pump pits	10.3.9	4.2.6/5.2.10, 5.2.24
tem operability	9.7, 9.8	4.2.13, 4.2.14, 4.2.15/5.4.4, 5.4.5, 5.4.11
tem operability	9.8	4.2.4/None
e day seismically qualified water supply with non-seismic ong-term makeup available	2.5.1, 10.3.9	4.2.6/5.2.10, 5.2.24
ling coil outlet water temperature	9.1.1.4	4.7.2/5.7.1
rable cooling coils, cooling water outlet temperature, air flow	9.1.2	4.7.3/5.7.2

5.3.4. The calculaed control rod withdrawal sequence is approved per 10 CFR Part 50.59 cceptance criteria. Analytical methods and models are not described in the UFSAR, and ministrative controls per TSUP Draft Specification 6.5.2.9.b.

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Scope and Guidelines for the Fort St. Vrain (FSV) Technical Specification Upgrade Program (TSUP)

I. Commitments[13] by Public Service Company of Colorado (PSC) plus clarifying comments in brackets.

P-1 Limiting Conditions for Operation (LCOs) will be revised to identify the applicable operating modes, limiting condition and action statement defining remedial actions to be taken if the limiting condition is exceeded.

P-2 All applicable operating modes will be clearly identified for each LCO.

P-3 Limiting conditions and action statements will agree with Final Safety Analysis Report (FSAR) accident and safety analyses. [However, for purposes of the TSUP, the interpretation has been made that licensing bases will not be required to be added to the UFSAR at this time for those Technical Specifications that lack such documentation. See 10CFR Parts 50.34(a)(5) and (b), 50.36(b), and 50.71(e).]

P-4 LCOs will cross reference the applicable Surveillance Requirement (SR) and SRs will cross reference the applicable LCO. All LCOs will have associated with them one or more SRs and all SRs will have associated with them one or more LCOs.

P-5 Surveillances will be specified as necessary and sufficient to verify compliance with the associated LCO(s).

P-6 SRs will describe the associated acceptance criteria.

P-7 Technical Specification statements will be unambiguous with a singular interpretation.

P-8 Terminology used in the Technical Specifications will be clearly defined.

P-9 Technical Specifications will be simplified if possible.

P-10 LCO format will be revised to include the LCO number and title, applicability statement, LCO statement, action statement(s), and cross reference to the associated SR(s). [Format has actually adhered more closely to that of the Standard Technical Specifications than implied by this scope item.]

P-11 Technical Specifications will be reviewed and expanded as necessary to assure accuracy, completeness, and consistency with existing design and safety analysis documentation. [However, for purposes of the TSUP, the interpretation has been made that licensing bases will not be required to be added to the UFSAR at this time for those Technical Specifications that lack such documentation. See 10CFR Parts 50.34(a)(5) and (b), 50.36(b), and 50.71(e).]

P-12 The Technical Specifications will account for and utilize existing plant equipment and safety systems. [This includes equipment changes made during the TSUP reviews such as the 6-inch vent lines installed on the main steam lines to meet Environmental Qualification requirements.]

P-13 The initial draft of the upgraded Technical Specifications will be submitted to the Nuclear Regulatory Commission (NRC) by April 1, 1985. [Completed.]

P-14 A schedule for the Technical Specification Upgrade Program will be submitted to the NRC for information by December 14, 1984. [Completed.]

II. NRC Changes and Clarifications[14] Regarding the FSV TSUP Scope.

N-1 ANSI/ANS Standard 58.4 (1979 Edition), *Criteria for Technical Specifications for Nuclear Power Stations*, will be used for guidance regarding the content of the Technical Specifications [Ref. 51].

N-2 The bases for the Technical Specifications will be included in the upgrade effort. [However, for purposes of the TSUP, this has been interpreted by NRC to refer restrictively to the "summary statement of the bases or reasons for such specifications" per 10CFR Part 50.36(a) but not to the FSAR "analyses and evaluations" from which the Technical Specifications are to be derived per 10CFR Parts 50.34(a)(5) and (b), 50.36(b), and 50.71(e)].

N-3 The Standard Technical Specifications for Westinghouse pressurized water reactors (PWRs) will be used as guidance, where applicable, in performing the upgrade.

N-4 A thorough review of the FSV-FSAR and other relevant design documentation will be done to ensure the Technical Specifications are complete and correct. ["Correctness" of the Technical Specifications was interpreted by NRC not to mean that the FSV UFSAR had to be updated at this time to support the carry-over provisions of existing Specification that lack a formally documented licensing basis. See 10CFR Parts 50.34(a)(5) and (b), 50.36(b), and 50.71(e).]

N-5 Operating experience to date will be considered and factored into the upgrade effort.

N-6 The need for additional instrumentation or other hardware to ensure compliance with the upgraded Technical Specifications will be considered on a case-by-case basis.

N-7 Any hardware change, analytical effort, or developmental work, which may be proposed by PSC as a result of the upgrade effort, will be scheduled for completion at a later date if it cannot be done by July 1, 1985.

III. PSC Guidelines[13] for Use of the Standard Technical Specifications (STS).

G-1 Plant modifications and backfits would not be undertaken to permit the adoption of any Standard Technical Specification requirement.

G-2 It is outside the scope of the Fort St. Vrain Technical Specification Upgrade Program to utilize or consider any Standard Technical Specification requirement which opens the licensing basis of the Fort St. Vrain plant for further justification or analysis.

G-3 Significant research and development efforts or analytical investigations would not be undertaken to determine how to utilize, or whether or not a Standard Technical Specification requirement can be utilized at Fort St. Vrain. Questionable Standard Technical Specifications requiring such efforts and investigations would not be utilized or given further consideration.

G-4 The numbering system of the Standard Technical Specifications and the Standard Technical Specification format, whereby each LCO is juxtaposed to its associated SR, would not be utilized for the Fort St. Vrain Technical Specification Upgrade Program. [Withdrawn, or at least not adhered to.]

G-5 The Fort St. Vrain Technical Specification Upgrade Program will adopt relevant Standard Technical Specification definitions where the definitions are consistent with existing plant features and the licensing basis of the Fort St. Vrain plant, i.e., FSAR terminology and analyses.

G-6 The Fort St. Vrain Technical Specification Upgrade Program will adopt relevant Standard Technical Specification requirements, including limiting conditions for operation, surveillance requirements, and surveillance frequencies, which are consistent with existing plant features and the licensing basis of the Fort St. Vrain plant as embodied in the FSAR.

G-7 Each Fort St. Vrain Upgraded Technical Specification requirement need only be supported and justified relative to the licensing basis of the Fort St. Vrain plant as embodied in the FSAR, and justification would not be required regarding the Standard Technical Specification treatment of the same or similar requirements for light water reactor plants.

GLOSSARY OF ABBREVIATIONS

AC	Administrative controls
ACM	Alternate cooling method
ACN	Accession number
AEC	Atomic Energy Commission
AFWS	Auxiliary feedwater system
ASME	American Society of Mechanical Engineers
CBCT	Calculated Bulk Core Temperature
CFR	Code of Federal Regulations
DF	Design feature
ECCS	Emergency core cooling system
EES	Economizer-evaporator-superheater
FSAR	Final Safety Analysis Report
FSV	Fort St. Vrain
GDC	General Design Criteria
HPS	Helium purification system
HTGR	High-temperature gas-cooled reactor
LCO	Limiting condition for operation
LCS	Liner cooling system
LWR	Light water reactor
NFSC	Nuclear Facility Safety Committee
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PCRV	Prestressed concrete reactor vessel
PDR	Public Document Room
PPS	Plant protection system
PRI	Potomac Research Institute

Glossary of Abbreviations (Continued)

PSAR	Preliminary Safety Analysis Report
PSC	Public Service Company of Colorado
PWR	Pressurized water reactor
RDA	Rapid depressurization accident
RHR	Residual Heat Removal
RHRS	Residual heat removal system
SLRDIS	Steam line rupture detection and isolation system
SR	Surveillance requirement
SRP	Standard Review Plan
SSC	Structures, systems, and components
STS	Standard Technical Specifications
TER	Technical Evaluation Report
TSUP	Technical Specification Upgrade Program
UFSAR	Updated Final Safety Analysis Report
W-STS	Westinghouse Standard Technical Specifications