C.I.5 Reactor Coolant and Connecting Systems

Chapter 5 of the FSAR should provide information regarding the RCS and systems to which it connects. Special consideration should be given to the RCS and pressure-containing appendages out to and including isolation valving, which is the RCPB, as defined in 10 CFR 50.2(v).

This section should include evaluations, together with the necessary supporting material, to show that the RCS is adequate to accomplish its intended objective and to maintain its integrity under conditions imposed by all foreseeable reactor behaviors, including both normal and accident conditions. The information should permit an independent determination of the adequacy of the evaluations; that is, assurance that the evaluations included are correct and complete, and all necessary evaluations have been performed. Applicants should reference evaluations included in other chapters that have a bearing on the RCS.

C.I.5.1 Summary Description

This section of the FSAR should provide a summary description of the RCS and its various components. This description should indicate the independent and interrelated performance and safety functions of each component and should include a tabulation of important design and performance characteristics.

C.I.5.1.1 *Schematic Flow Diagram*

This section should provide a schematic flow diagram of the RCS denoting all major components, principal pressures, temperatures, flow rates, and coolant volume under normal steady-state full-power operating conditions.

C.I.5.1.2 *Piping and Instrumentation Diagram*

Applicants should provide a piping and instrumentation diagram of the RCS and connected systems delineating the following three items:

(1) extent of the systems located within the containment

(2) points of separation between the RCS (heat transport) and the secondary (heat utilization or removal) system

(3) extent of insolubility of any fluid system as provided by the use of isolation valves between the radioactive and nonradioactive sections of the system, isolation valves between the RCPB and connected systems, and passive barriers between the RCPB and other systems.

C.I.5.1.3 *Elevation Drawing*

Applicants should provide an elevation drawing showing principal dimensions of the RCS in relation to the supporting or surrounding concrete structures from which a measure of the protection afforded by the arrangement and the safety considerations incorporated in the layout can be gained.

C.I.5.2 Integrity of the Reactor Coolant Pressure Boundary

This section of the FSAR should discuss the measures to be employed to ensure and maintain the integrity of the RCPB throughout the plant design lifetime.

C.I.5.2.1 *Compliance with Codes and Code Cases*

C.I.5.2.1.1 ***Compliance with 10 CFR 50.55a***

This section should provide a table showing compliance with the NRC regulations in 10 CFR 50.55a. This table should identify pressure vessel components, piping, pumps, valves, and storage tanks. The applicable component code and code edition and addenda of each Class 1 component within the RCPB, as defined in Section III of the ASME Code, may be identified by reference to the table of SSCs in Section 3.2 of the FSAR or included in this section of the FSAR.

If conformance to the regulations of 10 CFR 50.55a would result in hardships or unusual difficulties without a compensating increase in the level of safety and quality, applicants should provide a complete description of the circumstances resulting in such cases and the basis for proposed alternative requirements. The description should cover how the proposed alternative requirements will provide an equivalent and acceptable level of safety and quality.

C.I.5.2.1.2 ***Compliance with Applicable Code Cases***

Applicants should provide a list of ASME Code cases that will be applied to components within the RCPB. The list should identify each component for which a code case has been applied by code case number, revision, and title. The agency advises applicants to ensure that the applicable revision of the code case is identified for each component application. RG 1.84, "Design, Fabrication, and Materials Code lists those ASME Code cases related to Section III, Division 1, that are acceptable to the NRC staff. Applicants should indicate the extent of conformance with the guidance of RG 1.84, including conditions for approval identified in RG 1.84. If applicants use code cases other than those listed, they should show that their use will result in as acceptable a level of quality and safety for the component as would be achieved by following the code cases that the NRC staff has endorsed in RG 1.84.

C.I.5.2.2 *Overpressure Protection*

This section should provide information, as set forth in the following subsections, to accommodate an evaluation of the systems that protect the RCPB and the secondary side of steam generators from overpressure. These systems include all pressure-relieving devices (safety and relief valves) for the following four systems:

(1) RCS

(2) primary side of auxiliary or emergency systems connected to the RCS

(3) any blowdown or heat dissipation systems connected to the discharge of these pressure-relieving devices

(4) secondary side of steam generators.

C.I.5.2.2.1 ***Design Bases***

This section should provide the design bases on which the functional design of the overpressure protection was established. It should address overpressure protection for the RCPB during reactor power operation and low-temperature operation. Applicants should describe compliance with GDC 15 as defined in Appendix A to 10 CFR Part 50, as it relates to not exceeding the RCPB design conditions during any condition of normal operation or AOO, as well as GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," as it relates to designing the RCPB with sufficient margin to ensure that it behaves in a nonbrittle manner and minimizes the probability of rapidly propagating fracture.

C.I.5.2.2.2 ***Design Evaluation***

This section should provide an evaluation of the functional design of the overpressure protection system. This evaluation should include an analysis of the system's capability to perform its function, describe the analytical model used in the analysis, and discuss the bases for its validity. Applicants should also discuss and justify the assumptions used in the analysis, including the plant initial conditions and system parameters. They should list the systems and equipment assumed to operate and describe their performance characteristics. This section should provide studies that show the sensitivity of the system's performance to variations in these conditions, parameters, and characteristics.

Applicants should describe the design of overpressure protection during low-temperature operations, including the capability to relieve pressure during all overpressure events during startup and shutdown conditions at low temperatures, particularly during water-solid conditions. Applicants should provide the analysis that demonstrates how overpressure protection is achieved, assuming any single active component failure. This section should identify all overpressure events and, as a subset, identify the events that can be prevented by preventive interlocks or locking-out power. Applicants should describe how the overpressure protection system is enabled, the alarms and indications associated with the system, and the power source for the system. They should discuss whether any credit is taken for active components to mitigate an overpressure event and the additional analysis performed that considers inadvertent system initiation or actuation. If this system uses pressure relief from a low-pressure system, this section should discuss how the low-pressure interlocks will not interfere with the operation of this system.

C.I.5.2.2.3 ***Piping and Instrumentation Diagrams***

This section should provide piping and instrumentation diagrams for the overpressure protection system showing the number, type, and location of all components, including valves, piping, tanks, instrumentation, and controls. Applicants should identify the connections and interfaces with other systems.

C.I.5.2.2.4 ***Equipment and Component Description***

This section should describe the equipment and components of the overpressure protection system, including schematic drawings of the safety and relief valves and a discussion of how the valves operate. It should identify the significant design parameters for each component, including the design, throat area, capacity, and set points of the valves and the diameter, length, and routing of piping. Applicants should list the design parameters (e.g., pressure and temperature) for each component and specify the number and type of operating cycles as well as the environmental conditions (e.g., temperature and pressure) for which each component is designed.

C.I.5.2.2.5 ***Mounting of Pressure-Relief Devices***

This section should describe the design and installation details of the mounting of the pressure-relief devices within the RCPB and the secondary side of steam generators. Applicants should specify the design bases for the assumed loads (i.e., thrust, bending, and torsion) imposed on the valves, nozzles, and connected piping in the event that all valves discharge. They should describe how these loads can be accommodated and include a listing of these loads and resulting stresses. Applicants may cross-reference material contained in Section 3.9.3.3 of the FSAR.

C.I.5.2.2.6 ***Applicable Codes and Classification***

This section should identify the applicable industry codes and classifications applied to the system.

C.I.5.2.2.7 ***Material Specification***

Applicants should identify the material specifications for each component.

C.I.5.2.2.8 ***Process Instrumentation***

Applicants should identify all process instrumentation.

C.I.5.2.2.9 ***System Reliability***

Applicants should discuss system reliability and the consequences of equipment/component failures.

C.I.5.2.2.10 ***Testing and Inspection***

This section should identify the tests and inspections to be performed (1) before operation and during startup that demonstrate the functional performance and (2) as inservice surveillance to ensure continued reliability. Applicants should describe specific testing of the low-temperature overpressure protection system, particularly operability testing, exclusive of relief valves, before each shutdown.

C.I.5.2.3 ***Reactor Coolant Pressure Boundary Materials***

C.I.5.2.3.1 ***Material Specifications***

This section should provide a list of specifications for the principal ferritic materials, austenitic stainless steels, and nonferrous metals (including bolting and weld materials) to be used in fabricating and assembling each component (e.g., vessels, piping, pumps, and valves) that is part of the RCPB, excluding the RPV. It should identify the grade or type and final metallurgical condition of the material placed in service. "Metallurgical condition" is a technical term used to describe the microstructure of the materials. Based on its phase diagram, the microstructure of a material can vary in accordance with the heat treatments applied to the materials. Different microstructures of a material will possess different mechanical properties. One example is the heat treatment of the austenitic stainless steel in a certain temperature range will create a sensitized microstructure, which is characterized by chromium depletion along the grain boundary. Austenitic stainless steel with sensitized microstructure is susceptible to IGSCC. Materials engineers with metallurgy background should be able to provide the requested information.

If the as-procured, as-built grade, type and final metallurical condition of the materials are unavailable at the time of the COL application, representative or bounding data and information may be submitted for staff review as part of the COL application. The COL applicant should submit the as-procured, as-built grade, type and final metallurical condition of the materials to the staff at a pre-determined time agreed upon by the both parties. The applicant may need to work with the NRC staff during the review to arrive at an appropriate method (e.g., ITAAC, license condition, FSAR update) to ensure that the as-built plant is consistent with the design reviewed during the licensing process.

C.I.5.2.3.2 ***Compatibility with Reactor Coolant***

Applicants should provide the following four pieces of information relative to the compatibility of the materials of construction and the external insulation of the RCPB with the reactor coolant:

(1) Regarding PWR coolant chemistry (PWRs only), applicants should describe the chemistry of the reactor coolant and the additives (such as corrosion inhibitors). They should describe water chemistry, including maximum allowable content of chloride, fluoride, sulfate, and oxygen, as well as the permissible content of hydrogen and soluble poisons. They should discuss methods to control water chemistry, including pH, and others details of the coolant chemistry program to indicate whether coolant chemistry will be maintained at a level comparable to the guidelines in the latest version in the Electric Power Research Institute (EPRI) report serious, "PWR Water Chemistry Guidelines." Applicants should discuss the industry-recommended methodologies that will be used to monitor water chemistry, and provide appropriate references.

(2) Regarding BWR coolant chemistry (BWRs only), applicants should describe the chemistry of the reactor coolant and the methods for maintaining coolant chemistry. They should provide sufficient information about allowable range and maximum allowable chloride, fluoride, and sulfate contents, maximum allowable conductivity, pH range, location of conductivity meters, performance monitoring, and other details of the coolant chemistry program to indicate whether the facility can maintain coolant chemistry at a level comparable to the guidelines in the latest version in the EPRI report series, "BWR Water Chemistry Guidelines." Applicants should discuss the industry-recommended methodologies that will be used to monitor water chemistry and provide appropriate references.

(3) Regarding the compatibility of construction materials with reactor coolant, applicants should provide a list of the materials of construction exposed to reactor coolant and a description of material compatibility with the coolant, contaminants, and radiolytic products to which the materials may be exposed. If nonmetallic materials are exposed to reactor coolant, applicants should include a description of the compatibility of these materials with the coolant.

(4) Regarding the compatibility of construction materials with external insulation and reactor coolant, applicants should provide a list of the materials of construction of the RCPB and a description of their compatibility with external insulation and the environment, especially in the event of coolant leakage. Applicants should provide sufficient information about the selection, procurement, testing, storage, and installation of any nonmetallic thermal insulation for austenitic stainless steel to indicate whether the concentrations of chloride, fluoride, sodium, and silicate in thermal insulation will be within the ranges recommended in RG 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel." They should provide information on the leachable contaminants in insulation on nonaustenitic piping.

C.I.5.2.3.3 ***Fabrication and Processing of Ferritic Materials***

Applicants should provide the following three types of information relative to fabrication and processing of ferritic materials used for components of the RCPB:

(1) Regarding fracture toughness of the ferritic materials, including bolting materials for components (e.g., vessels, piping, pumps, and valves) of the RCPB, applicants should indicate how

compliance with the test and acceptance guidelines of Appendix G to 10 CFR Part 50 and with Article NB-2300 and Appendix G to Section III of the ASME Code is achieved. Applicants should submit the fracture toughness data in tabular form, including information regarding the calibration of instruments and equipment (FSAR).

If the actual, as procured fracture toughness data is unavailable at the time of the COL application, representative or bounding data and information may be submitted for staff review as part of the COL application. The COL applicant should submit the actual, as procured fracture toughness data to the staff at a pre-determined time agreed upon by the both parties. The applicant may need to work with the NRC staff during the review to arrive at an appropriate method (e.g., ITAAC, license condition, FSAR update) to ensure that the as-built plant is consistent with the design reviewed during the licensing process.

(2) Applicants should provide the following information relative to the control of welding of ferritic materials used for components of the RCPB:

(a) They should include sufficient information regarding the avoidance of cold cracking during welding of low-alloy steel components of the RCPB to indicate whether the degree of weld integrity and quality will be comparable to that obtainable by following the recommendations of RG 1.50, “Control of Preheat Temperature for Welding of Low-Alloy Steel,” and RG 1.43, “Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components.” Applicants should provide details on proposed minimum preheat temperature and maximum interpass temperature during procedure qualification and production welding. They should provide information on the moisture control for low-hydrogen, covered-arc-welding electrodes.

(b) Applicants should provide sufficient information for electroslag welds in the low-alloy steel components of the RCPB to indicate whether the degree of weld integrity and quality will be comparable to that obtainable by following the recommendations of RG 1.34, “Control of Electroslag Weld Properties.” They should provide details on the control of welding variables and the metallurgical tests required during procedure qualification and production welding.

(c) In regard to welding and weld repair during fabrication and assembly of ferritic steel components of the RCPB, applicants should provide sufficient details on welder qualification for weld areas of limited accessibility, requalification, and monitoring of production welding for adherence to welding qualification requirements to indicate whether the degree of weld integrity and quality will be comparable to that obtainable by following the recommendations of RG 1.71, “Welder Qualification for Areas of Limited Accessibility.”

(d) Applicants should describe the controls to limit the occurrence of underclad cracking in low-alloy steel components clad with stainless steel.

(3) Applicants should provide sufficient information about the program for NDE of ferritic steel tubular products (pipe, tubing, flanges, and fittings) for components of the RCPB to indicate whether detection of unacceptable defects (regardless of defect shape, orientation, or location in the product) are consistent with of the ASME Code.

If data, test results, or other information are unavailable at the time of the COL application, representative or bounding data and information may be submitted for staff review as part of the COL application. The COL applicant should submit the data, test results, or other information that was not available at the time of COL application to the staff at a pre-determined time agreed upon by the both parties. The applicant may need to work with the NRC staff during the review to arrive at an appropriate method (e.g., ITAAC, license condition, FSAR update) to ensure that the as-built plant is consistent with the design reviewed during the licensing process.

C.I.5.2.3.4 ***Fabrication and Processing of Austenitic Stainless Steels***

Applicants should provide the following three types of information relative to fabrication and processing of austenitic stainless steels for components of the RCPB:

(1) Applicants should provide the following information relative to avoidance of stress-corrosion cracking of austenitic stainless steels for components of the RCPB during all stages of component manufacture and reactor construction:

(a) Applicants should include sufficient details about the avoidance of sensitization during fabrication and assembly of austenitic stainless steel components of the RCPB to indicate whether the degree of freedom from sensitization will be comparable to that obtainable by following the recommendations of RG 1.44, "Control of the Use of Sensitized Stainless Steel." They should describe provisions in material selection and processing to minimize susceptibility to IGSCC consistent with the recommendations in Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," dated January 25, 1988, and NUREG-0313, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping."

(b) Applicants should provide sufficient details about the process controls to minimize exposure to contaminants capable of causing stress-corrosion cracking of austenitic stainless steel components of the RCPB to show whether process controls will provide, during all stages of component manufacture and reactor construction, a degree of surface cleanliness comparable to that obtainable by following the recommendations of RG 1.44 and RG 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants." Applicants should describe the controls for abrasive work on austenitic stainless steel surfaces. They should identify any pickling used in processing austenitic stainless steel components and describe the restrictions placed on pickling of sensitized materials. Applicants should also identify the upper yield strength limit of the austenitic stainless steel materials used.

If the actual, as-procured yield strength of the austenitic stainless steel materials is unavailable at the time of the COL application, representative or bounding data and information may be submitted for staff review as part of the COL application. The COL applicant should submit the actual, as-procured yield strength of the austenitic stainless steel materials to the staff at a pre-determined time agreed upon by the both parties. The applicant may need to work with the NRC staff during the review to agree on an appropriate method (e.g., ITAAC, license condition, FSAR update) to ensure that the as-built plant is consistent with the design reviewed during the licensing process.

(c) Applicants should provide assurance that cold-worked austenitic stainless steels will have a maximum 0.2-percent offset yield strength of 620 megapascal (90,000 psi) to reduce the probability of stress-corrosion cracking in RCPB applications. Applicants should identify augmented ISI to ensure the structural integrity of the components during service. In general, cold-worked austenitic stainless steels should not be used for RCPB applications, but they may be used when no proven alternative is available. If such materials are used, applicants should describe the service experience and laboratory testing in the simulated environment to which the components will be exposed. They should describe the controlled, measured, and documented fabrication process for cold-worked components.

(2) Applicants should provide the following information relative to the control of welding of austenitic stainless steels for components of the RCPB:

(a) Applicants should provide sufficient information on electroslag welds in austenitic stainless steel components of the RCPB to indicate whether the degree of weld integrity and quality will be comparable to that obtainable by following the recommendations of RG 1.34. The information should include the control of welding variables and the metallurgical tests required during procedure qualification and production welding.

(b) In regard to welding and weld repair during fabrication and assembly of austenitic stainless steel components of the RCPB, applicants should provide sufficient details about welder qualification for areas of limited accessibility, requalification, and monitoring of production welding for adherence to welding qualification requirements to indicate whether the degree of weld integrity and quality will be comparable to that obtainable by following the recommendations of RG 1.71.

(3) Applicants should provide sufficient information about the program for NDE of austenitic stainless steel tubular products (pipe, tubing, flanges, and fittings) for components of the RCPB to indicate whether detection of unacceptable defects (regardless of defect shape, orientation, or location in the product) are consistent with the ASME Code.

C.I.5.2.3.5 *Prevention of Primary Water Stress-Corrosion Cracking for Nickel-Base Alloys (PWRs only)*

This section should provide the following two pieces of information relative to fabrication and processing of nickel-based alloys for components of the RCPB:

(1) Applicants should identify the nickel-based alloy components of the RCPB and discuss the prevention of PWSCC. Applicants should describe test results that demonstrate the nickel-based alloy materials are not susceptible to PWSCC, and identify the ISI that will be performed to confirm that PWSCC is not occurring in the materials.

(2) For nickel-chromium-iron alloys used as RCPB materials, applicants should provide the technical basis for use either by identification (based upon demonstrated satisfactory use in similar applications) or presentation of information to support use of the material under the expected environmental conditions (e.g., exposure to reactor coolant). Operating experience has indicated that certain nickel-chromium-iron alloys (e.g., Alloy 600 and Alloy 182/82) are susceptible to PWSCC. Alloy 690 has improved resistance to stress-corrosion cracking in comparison to Alloy 600 and Alloy 182/82 previously used in reactor plants.

C.I.5.2.3.6 *Threaded Fasteners*

This section should provide a summary description of the program for ensuring the integrity of bolting and threaded fasteners and their adequacy. Applicants should reference FSAR Section 3.13, as appropriate.

C.I.5.2.4 *Inservice Inspection and Testing of the Reactor Coolant Pressure Boundary*

C.I.5.2.4.1 ***Inservice Inspection and Testing Program***

This section should discuss the ISI and testing program for the NRC Quality Group A components of the RCPB (ASME Code, Section III, Code Class 1 components) that complies with the guidelines of 10 CFR 50.55a. It should provide sufficient detail to show that the ISI program meets the requirements of Section XI of the ASME Code. Because the ISI program is an operational program, applicants should describe the program and its implementation with sufficient scope and level of detail to enable the staff to make a reasonable assurance finding regarding its acceptability. Therefore, applicants should provide descriptive information on the system boundary, subject to inspection. In particular, they should discuss components (other than steam generator tubes) and associated supports to include all pressure vessels, piping, pumps, valves, and bolting covering the following eight areas:

(1) Regarding accessibility, applicants should describe provisions for access to components and identify any remote access equipment needed to perform inspections.

(2) Regarding examination categories and methods, applicants should discuss the methods, techniques, and procedures used to meet ASME Code requirements. For performing ultrasonic testing not covered by Appendix VIII to Section XI of the ASME Code, the applicant should address the issues/concerns identified in RG 1.150, "Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations," to ensure that the ultrasonic testing methods, techniques, and procedures used for ASME Code examinations are consistent with those recommended in the regulatory guide.

(3) Regarding inspection intervals, applicants should discuss program scheduling in comparison with the ASME Code.

(4) Applicants should discuss provisions for evaluating examination results, including evaluation methods for detected flaws and repair procedures for components that reveal defects.

(5) Applicants should provide descriptive information on system pressure tests and correlated TS requirements.

(6) Applicants should identify any components that are exempted from the ASME Code Section XI examination requirements.

(7) Applicants should discuss any requests for relief from ASME Code requirements that are impractical as a result of limitations of component design, geometry, or materials of construction.

(8) Applicants should identify ASME Code cases that are invoked.

Because the ISI and IST programs are operational programs, the programs and their implementation milestones should be fully described and reference any applicable standards. Fully described should be understood to mean that the program is clearly and sufficiently described in terms of the scope and level of detail to allow for a reasonable assurance finding of acceptability.

C.I.5.2.4.2 ***Preservice Inspection and Testing Program***

This section should describe the preservice examination program that meets the guidelines of Article NB-5280 of Section III, Division I, of the ASME Code. Because the preservice inspection and preservice testing programs are operational programs, the programs and their implementation milestones should be fully described and reference any applicable standards. Fully described should be understood to mean that the program is clearly and sufficiently described in terms of the scope and level of detail to allow for a reasonable assurance finding of acceptability.

C.I.5.2.5 *Reactor Coolant Pressure Boundary Leakage Detection*

Applicants should describe in this section the RCPB leakage detection systems in sufficient detail to demonstrate the extent to which the recommendations of RG 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems," and RG 1.29, "Seismic Design Classification," have been followed. Specifically, the applicant should provide information that will permit comparison with the regulatory positions of these guides, giving a detailed description of the systems employed, their sensitivity and response time, and the reliance placed on their proper functioning. This section should also identify the limiting leakage conditions that will be included in the TS.

In addition, this section should identify the leakage detection systems that are designed to meet the sensitivity and response guidelines of RG 1.45 and that will be included in the TS. Applicants should describe these systems and those that are used for alarm as an indirect indication of leakage and provide the design criteria. They should describe how signals from the various leakage detection systems are correlated to provide information to plant operators regarding leakage location and quantitative leakage flow rate.

Applicants should demonstrate that the system is capable of separately monitoring and collecting leakage from both identifiable and unidentifiable sources. They should describe the floor drain system to demonstrate that leakage will flow to the sump or tank where it is collected and identify all potential intersystem leakage paths and the instrumentation used in each path. Applicants should demonstrate adequate monitoring capability to ensure that the limits of intersystem leakage assumed in the accident analyses are not exceeded. For radioactivity monitoring leakage detection, they should describe the primary coolant radioactivity concentration assumption being used to analyze the sensitivity of the leak detection systems.

This section should describe the provisions to test and calibrate all leakage detection systems and provide and justify the frequency of testing and calibration. The applicant should describe the periodic testing of the floor drainage system that will check for blockage and ensure operability.

C.I.5.3 <u>Reactor Vessels</u>

C.I.5.3.1 *Reactor Vessel Materials*

This section of the FSAR should contain pertinent data in sufficient detail to provide assurance that the materials (including weld materials), fabrication methods, and inspection techniques used for the reactor vessel and applicable attachments and appurtenances conform to all applicable regulations. The FSAR should also describe the specifications and criteria to be applied and should demonstrate that the requirements have been met.

C.I.5.3.1.1 <u>*Material Specifications*</u>

This section should list all materials in the reactor vessel, applicable attachments, and appurtenances and provide the material specifications, making appropriate references to the applicable sections in Chapter 3 of the FSAR. If any materials other than those listed in Appendix I to Section III of the ASME Code are used, applicants should provide the data identified in Appendix IV to Section III of the ASME Code for approval of the new material. This section should reference information regarding material specifications provided in other documents or sections of the FSAR. It should address mechanical and physical properties of these materials and describe the effects of radiation on these materials, where applicable.

C.I.5.3.1.2 ***Special Processes Used for Manufacturing and Fabrication***

This section should describe the manufacture of the product forms and methods used to fabricate the vessel or any of its applicable attachments and appurtenances. Applicants should discuss any special or unusual processes used and show that they will not compromise the integrity of the reactor vessel.

C.I.5.3.1.3 ***Special Methods for Nondestructive Examination***

This section should describe in detail all special procedures for detecting surface and internal discontinuities, with emphasis on procedures that differ from those in Section III of the ASME Code. Applicants should pay particular attention to calibration methods, instrumentation, method of application, sensitivity, reliability, reproducibility, and acceptance standards.

C.I.5.3.1.4 ***Special Controls for Ferritic and Austenitic Stainless Steels***

Making appropriate references to the applicable sections in Chapter 3 of the FSAR, applicants should describe controls on welding, composition, heat treatments, and similar processes covered by regulatory guides to verify that these recommendations or equivalent controls are employed. The description should include controls for abrasive work (e.g., grinding) on austenitic stainless steel. Applicants should address the following guidance:

- RG 1.34, "Control of Electroslag Weld Properties"
- RG 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants"
- RG 1.43, "Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components"
- RG 1.44, "Control of the Use of Sensitized Stainless Steel"
- RG 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel"
- RG 1.71, "Welder Qualification for Areas of Limited Accessibility"
- RG 1.99, "Radiation Embrittlement of Reactor Vessel Materials"
- RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence"
- NUREG-0313, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping"

C.I.5.3.1.5 ***Fracture Toughness***

This section should describe the fracture testing and acceptance criteria specified for materials of the reactor vessel and appurtenances thereto. In particular, it should describe how the toughness requirements of Appendix G to 10 CFR Part 50 will be met. Applicants should specify the maximum nil-ductility reference temperature (RT_{NDT}) to which the ferritic materials of the reactor vessel will be fabricated. They should identify ITAAC that will be completed to verify that these ferritic reactor vessel materials meet these specifications.

C.I.5.3.1.6 ***Material Surveillance***

This section should describe the material surveillance program in sufficient detail to provide assurance that the program meets the requirements of Appendix H, "Reactor Vessel Material Surveillance Program Requirements," to 10 CFR Part 50. It should describe the method for calculating neutron fluence for the reactor vessel beltline and the surveillance capsules. Because the material surveillance program is an operational program, as discussed in SECY-05-0197, the program and its implementation milestones should be fully described and reference any applicable standards. Fully described should be understood to mean that the program is clearly and sufficiently described in terms of the scope and level of detail to allow for a reasonable assurance finding of acceptability. In particular, applicants should address the following six topics:

(1) basis for selection of material in the program

(2) number and type of specimens in each capsule

(3) number of capsules and proposed withdrawal schedule comparable with American Society for Testing and Materials (ASTM) Standard E-185, "Surveillance Tests on Structural Materials in Nuclear Reactors," as referenced in 10 CFR Part 50, Appendix H

(4) neutron flux and fluence calculations for vessel wall and surveillance specimens and conformance with the guidance of RG 1.190

(5) expected effects of radiation on vessel wall materials and basis for estimation

(6) location of capsules, method of attachment, and provisions to ensure that capsules will be retained in position throughout the vessel lifetime.

C.I.5.3.1.7 ***Reactor Vessel Fasteners***

This section should describe the materials and design for the stud bolts, washers, nuts, and other fasteners for the reactor vessel closure. It should include sufficient detail regarding materials property requirements, nondestructive evaluation techniques, lubricants or surface treatments, and protection provisions to show the specifications of Appendix I to Section III of the ASME Code, providing the data called for under Appendix IV to Section III of the ASME Code and the recommendations of RG 1.65, "Materials and Inspections for Reactor Vessel Closure Studs," or equivalent measures, are followed. The FSAR should describe the mechanical property and fracture toughness tests that will be performed to demonstrate that the materials from which these fasteners are fabricated conform to these recommendations or their equivalent. Applicants should identify any ITAAC that will be completed to verify that the materials from which these fasteners are constructed met these specifications.

C.I.5.3.2 ***Pressure-Temperature Limits, Pressurized Thermal Shock, and Charpy Upper-Shelf Energy Data and Analyses***

This section of the FSAR should describe the bases for setting operational limits on pressure and temperature for the RCPB during any condition of normal operation, including AOO, and hydrostatic tests. In addition, this discussion should provide detailed assurance that Appendices G and H to 10 CFR Part 50 and 10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events," (PWRs only) will be complied with throughout the life of the plant.

C.I.5.3.2.1 *Limit Curves*

This section should describe how the applicant will develop pressure-temperature limit curves for (1) preservice system hydrostatic tests, (2) inservice leak and hydrostatic tests, (3) normal operation, including heatup and cooldown, and (4) reactor core operation.

If procedures or criteria other than those recommended in the ASME Code are used, applicants should show that equivalent safety margins are provided. This section should describe the bases used to determine these limits and provide typical curves with temperatures relative to the RT_{NDT} of the limiting material (as defined in Article NB-2331 of Section III of the ASME Code).

Based on material properties, such as initial RT_{NDT} and material chemical composition, to which reactor vessel ferritic materials will be procured, applicants should demonstrate how pressure-temperature limits that meet the requirements of Appendix G to 10 CFR Part 50 can be met for the licensed life of the facility. Applicants should describe the bases used for the prediction and indicate the extent to which the recommendations of RG 1.99 are followed.

This section should describe procedures that will be used to update these limits while in service and address radiation effects and the extent to which the recommendations of RG 1.190 are followed.

C.I.5.3.2.2 *Operating Procedures*

This section should describe how the applicant will develop operating procedures, that will ensure that the pressure-temperature limits in Section 5.3.2.1 of the FSAR will not be exceeded during any condition of normal operation, including AOO, and system hydrostatic tests. The FSAR should include a commitment that plant operating procedures will ensure that the pressure-temperature limits identified in Section 5.3.2.1 of the FSAR will not be exceeded during any foreseeable upset condition.

C.I.5.3.2.3 *Pressurized Thermal Shock (PWRs only)*

This section should discuss pressurized thermal shock (PTS). Using limiting material properties to which the ferritic reactor vessel materials will be procured, applicants should provide the calculational methods and assumptions and compare the projected values of the PTS reference temperature (RT_{PTS}) for reactor vessel beltline materials with the screening criteria in 10 CFR 50.61. If RT_{PTS} values are projected to exceed the PTS screening criterion before the expiration date of the operating license, applicants should provide safety analyses to support reactor operation.

C.I.5.3.2.4 *Upper-Shelf Energy*

Applicants should specify minimum Charpy upper-shelf energy values to which ferritic materials of the reactor vessel will be procured. They should identify the ITAAC that will be completed to verify that these ferritic reactor vessel materials meet or exceed these specifications. Applicants should provide projected Charpy upper-shelf energy values at the expiration date of the operating license based on the methodology in RG 1.99 and demonstrate that beltline materials will satisfy the requirement of Appendix G (paragraph IV.A.1.a) to 10 CFR Part 50.

C.I.5.3.3 *Reactor Vessel Integrity*

This section of the FSAR should provide a summary of all information related to the integrity of the reactor vessel, including the major considerations in achieving reactor vessel safety and a description of the factors contributing to the vessel's integrity. The COL applicant may identify a specific manufacturer, if one has been chosen, and provide a description of its experience.

C.I.5.3.3.1 ***Design***

This section should briefly describe the reactor vessel design, preferably with a schematic, including materials, construction features, fabrication methods, and inspections. Applicants should summarize applicable design codes and bases and reference other sections of the FSAR as appropriate.

C.I.5.3.3.2 ***Materials of Construction***

Applicants should identify the reactor vessel materials, including weld materials, and describe any special requirements. They should emphasize the reasons for selection and provide assurance of suitability.

C.I.5.3.3.3 ***Fabrication Methods***

This section should identify the reactor vessel fabrication methods, including forming, welding, cladding, and machining. Applicants should describe the service history of vessels constructed using these methods and the vessel supplier's experience with the procedures.

C.I.5.3.3.4 ***Inspection Requirements***

This section should summarize the inspection test methods and requirements, paying particular attention to the level of initial integrity. Applicants should describe any methods that are in addition to the guidelines established in Section III of the ASME Code.

C.I.5.3.3.5 ***Shipment and Installation***

This section should summarize the means used to protect the vessel so that its as-manufactured integrity will be maintained during shipment and site installation. Applicants should reference other FSAR sections as appropriate.

C.I.5.3.3.6 ***Operating Conditions***

This section should summarize the operational limits that will be specified to ensure vessel safety. Applicants should provide a basis for concluding that vessel integrity will be maintained during the most severe postulated transients and PTS events at PWRs, referencing other FSAR sections as appropriate.

C.I.5.3.3.7 ***Inservice Surveillance***

This section should summarize the ISI and material surveillance programs and explain their adequacy relative to the guidelines of Appendix H to 10 CFR Part 50 and Section XI of the ASME Code. Applicants should reference Section 5.3.1.6 as appropriate.

C.I.5.3.3.8 *Threaded Fasteners*

This section should summarize the programs for ensuring the integrity of bolting and threaded fasteners and their adequacy. Applicants should reference FSAR Section 3.13 as appropriate.

C.I.5.4 Reactor Coolant System Component and Subsystem Design

This section of the FSAR should provide information regarding performance requirements and design features to ensure overall safety of the various components and subsystems within or allied with the RCS. Because these components and subsystems differ for various types and designs of reactors, the components and subsystems are not assigned specific subsection numbers. The FSAR should contain a separate subsection (numbered 5.4.1 through 5.4.x) for each principal component or subsystem. Each subsection should present the design bases, description, evaluation, and necessary tests and inspections for the component or subsystem, including radiological considerations from the viewpoints of how radiation affects operation and how radiation levels affect the operators and capabilities of operation and maintenance. Applicants should describe the appropriate details regarding the mechanical design in FSAR Sections 3.7, 3.9, and 5.2.

The following subsections identify components and subsystems that should be discussed and the corresponding information that should be provided. As appropriate to the specific reactor type and design, certain subsections are not applicable, and additional subsections are necessary to address other components and subsystems (e.g., core makeup tanks, automatic depressurization system valves, passive residual heat removal (RHR) heat exchanger, isolation condenser system, gravity-driven cooling system, passive containment cooling system).

C.I.5.4.1 *Reactor Coolant Pumps*

Applicants should provide the RCP design bases, description, evaluations, and tests and inspections. They should discuss the provisions taken to preclude rotor overspeeding of the RCP in the event of a design-basis LOCA.

C.I.5.4.1.1 *Pump Flywheel Integrity (PWRs only)*

Applicants should provide explicit information to demonstrate how the RCP flywheel design complies with GDC 1 and GDC 4 as specified in Appendix A to 10 CFR Part 50. Applicants should discuss the extent to which the recommendations of RG 1.14, "RCP Flywheel Integrity," are followed with respect to the design, testing, analysis, preservice inspection, and ISI of the RCP flywheels. They should identify any particular exceptions or alternatives to the regulatory positions and criteria in RG 1.14 and, if applicable, discuss and justify how a particular exception or alternative will provide an acceptable level of quality and safety and will ensure continued compliance with GDC 4.

C.I.5.4.2 *Steam Generators (PWRs only)*

Applicants should provide estimates of design limits for radioactivity levels in the secondary side of the steam generators during normal operation. They should discuss the bases for those estimates and the potential effects of tube ruptures.

Applicants should provide the steam generator design criteria to prevent unacceptable tube damage from FIV and cavitation, referencing the information provided in FSAR Section 3.9.3 and including the following two specific pieces of information:

(1) design conditions and transients that will be specified in the design of the steam generator tubes and the operating condition category selected (i.e., upset, emergency, or faulted) that defines the allowable stress intensity limits to be used and the justification for this selection

(2) extent of tube-wall thinning that could be tolerated without exceeding the allowable stress intensity limits defined above under the postulated condition of a design-basis pipe break in the RCPB or a break in the secondary piping during reactor operation.

C.I.5.4.2.1 ***Steam Generator Materials***

Applicants should discuss the design of the steam generator, including (1) the selection, processing, testing, and inspection (during fabrication/processing) of the materials used to fabricate the steam generator, (2) design provisions for limiting the susceptibility of the steam generator to degradation and/or corrosion, (3) fracture toughness of the ferritic materials used in the steam generator, (4) fabrication and processing of austenitic stainless materials (if used in pressure boundary applications), (5) compatibility of materials with the primary (reactor) and secondary coolant, and (6) provisions for accessing the secondary side of the steam generator for maintenance and cleaning.

Applicants should address the following six considerations:

(1) Making appropriate references to FSAR Section 5.2.3, applicants should provide information on the selection and fabrication of materials for components of the steam generators, including tubing, tubesheet, channel head casting or plate, tubesheet and channel head cladding, forged nozzles, shell pressure plates, access plates (manway and handhole), tube supports, feedring, bolting, and threaded fasteners. They should list the code cases used in material selection and provide technical justification for any code cases not listed in RG 1.84.

(2) Applicants should provide information on the fracture toughness properties of ferritic materials, making appropriate references to FSAR Section 5.2.3. The information on materials for Class 1 components should be sufficient to show how the guidelines of Article NB-2300 and Appendix G to Section III of the ASME Code can be verified. For Class 2 materials, applicants should provide sufficient information to show how the guidelines of Article NC-2300 of Section III of the ASME Code will be verified. They should address welding qualification, fabrication, and inspection during manufacture and assembly as discussed in of Sections III and IX of the ASME Code.

(3) Applicants should provide information on those aspects of design that may affect the performance of steam generator materials. The information should describe methods used to avoid extensive crevice areas where the tubes pass through the tubesheet and tubing supports. It should describe the corrosion allowance for steam generator materials. Applicants should identify the method used to fasten tubes to the tubesheet and compare it guidelines of Sections III and IX of the ASME Code, including the extent of tube expansion and the methods of expansion used. Applicants should describe the heat treatment of the steam generator tube material and the design of the support structures.

(4) Applicants should provide information on the fabrication and processing of austenitic stainless steel materials (if used in pressure boundary applications), as discussed in Section C.I.5.2.3.4 of this guide.

(5) Applicants should provide information on the compatibility of steam generator tubing with both the primary and secondary coolant. They should describe the methods used in monitoring and maintaining the chemistry of the primary and secondary coolant within the specified ranges.

(6) Applicants should describe the design provisions for removing surface deposits, sludge, loose parts (foreign objects), and excessive corrosion products from the secondary side of the steam generator.

C.I.5.4.2.2 ***Steam Generator Program***

Applicants should describe provisions in the design of the primary and secondary side of the steam generator that permit implementation of a steam generator tube integrity program. They should describe the elements of the steam generator tube integrity program, addressing the following three considerations:

(1) Regarding steam generator design, applicants should describe the design provisions for permitting access to both the primary and secondary side of the steam generator. They should discuss the extent to which each tube is accessible for periodic inspection, testing, and repair (including plugging and stabilizing) using currently available methods and techniques (which are capable of finding the forms of degradation that may affect the tube throughout its service life). Applicants should discuss the extent to which secondary-side internals that can affect tube integrity may be accessed. The application should describe design provisions for inspecting and removing loose parts (foreign objects) from the steam generator as well as for limiting the introduction of loose parts into the steam generator.

(2) Applicants should describe the elements of the steam generator program and the extent to which they are consistent with the steam generator program requirements provided in the latest revision of the Standard Technical Specifications (STS_. They should discuss the method for determining tube repair criteria and describe the scope and extent of the preservice inspection of the steam generator tubes.

(3) Applicants should describe the steam generator tube inspection and reporting requirements to be adopted into the TS (including the limiting conditions for operation (LCO), surveillance requirements, and primary-to-secondary leakage limits). They should discuss the extent to which any potential conflicts (i.e., differences) exist between the TS and Article IWB-2000 of Section XI of the ASME Code (refer to 10 CFR 50.55a(b)(2)(iii)).

C.I.5.4.3 *Reactor Coolant Piping*

Applicants should provide an overall description of the reactor coolant piping system with detailed information on the criteria, methods, and materials and include appropriate references to FSAR Chapter 3 and Section 5.2.3. The description should include the design, fabrication, and operation provisions to control those factors that contribute to stress-corrosion cracking.

C.I.5.4.4 ***[Reserved]***

C.I.5.4.5 ***[Reserved]***

C.I.5.4.6 *Reactor Core Isolation Cooling System (BWRs only)*

C.I.5.4.6.1 ***Design Bases***

Applicants should provide a summary of the reactor core isolation cooling (RCIC) system. The summary should discuss the RCIC system design bases and criteria for both the steam side and pump side and include the following four considerations:

(1) compliance with respect to GDC 4; GDC 5, "Sharing of Structures, Systems, and Components," GDC 29, "Protection Against Anticipated Operational Occurrences," GDC 33, "Reactor Coolant Makeup," GDC 34, "Residual Heat Removal," and GDC 54, "Systems Penetrating Containment"

(2) reliability and operability requirements, including the bases for manual operations needed to operate the system

(3) design for operation following a LOOP event and compliance with 10 CFR 50.63, "Loss of All Alternating Current Power," regarding station blackout (SBO) events by conformance with RG 1.155, "Station Blackout"

(4) design bases for protecting the RCIC system from physical damage, including the bases for the RCIC system support structure and protection against incidents that could jointly fail the RCIC and high-pressure core spray systems.

C.I.5.4.6.2 ***System Design***

Applicants should provide the following five pieces of information about RCIC system design:

(1) Applicants should provide a description of the RCIC system, including piping and instrumentation diagrams showing all components, piping, points where connecting systems and subsystems tie together, and instrumentation and controls (I&C) associated with subsystem and component actuation. They should provide a complete description of component interlocks as well as a diagram showing temperatures, pressures, and flow rates for RCIC operation.

(2) Applicants should provide equipment and component descriptions that cover each component of the system. The descriptions should identify the significant design parameters for each component, state the design pressure and temperature of components for various portions of the system, and explain the bases for their selection.

(3) Applicants should identify the applicable industry codes and classifications for the system design.

(4) Applicants should discuss system reliability considerations, including provisions incorporated in the design to ensure that the system will operate when needed and will deliver the required flow rates.

(5) Applicants should discuss all manual actions that an operator must take for the RCIC system to operate properly, assuming all components are operable. The discussion should identify any actions that must be taken from outside the control room. Applicants should repeat this discussion for the most limiting single failure in the combined RCIC and high-pressure core spray system.

C.I.5.4.6.3 ***Performance Evaluation***

Applicants should provide an evaluation of the ability of the RCIC system to perform its function. They should describe the analytical methods used and clearly state all assumptions.

C.I.5.4.7 ***Residual Heat Removal System***

C.I.5.4.7.1 ***Design Bases***

Applicants should provide a summary description of the RHR system. The description should discuss the design bases, including the following 10 considerations:

(1) Applicants should discuss design bases with respect to GDC 2, GDC 4, GDC 5, GDC 19, "Control Room," and GDC 34.

(2) Applicants should discuss functional design bases, including the time required to reduce the RCS temperature to approximately 100 °C (212 °F) and to a temperature that would permit refueling. They should present the design-basis times for the case where the entire RHR system is operable as well as the case with the most limiting single failure in the RHR system.

(3) Applicants should discuss the design bases for the isolation of the RHR system from the RCS. The discussion should cover the isolation design bases, including any interlocks that are provided, and the design bases regarding prevention of RHR pump damage in the event of closure of the isolation valves.

(4) Applicants should discuss the design bases of the RHR system for the prevention of an interfacing system LOCA.

(5) Applicants should discuss the design bases for the pressure relief capacity of the RHR system. The discussion should include the design bases and considerations for limiting transients, equipment malfunctions, and possible operator errors during plant startup and cooldown when the RHR system is not isolated from the RCS.

(6) Applicants should discuss the design bases for reliability and operability requirements. They should describe the design bases regarding the manual actions required to operate the system, emphasizing any operations that cannot be performed from the control room in the event of a single failure. The description should cover protection against single failure in terms of piping arrangement and layout, selection of valve types and locations, redundancy of various system components, redundancy of power supplies, and redundancy of instrumentation. It should also include protection against valve motor flooding and spurious single failures.

(7) Applicants should discuss the design bases established to protect the RHR system from physical damage. The discussion should cover the design bases for the RHR system support structure and for protection against incidents and accidents that could render redundant components inoperative (e.g., fires, pipe whip, internally generated missiles, LOCA loads, seismic events).

(8) Applicants should discuss the design bases of the RHR system for shutdown and midloop operations.

(9) Applicants should discuss the design bases of the RHR system relief valves for low-temperature overpressure protection, if applicable.

(10) Since PWR designs might include active RHR systems designated as nonsafety-related systems for defense-in-depth functions, applicants should provide an evaluation in accordance with the process of RTNSS to determine necessary regulatory oversight for the active RHR system.

C.I.5.4.7.2 ***System Design***

Applicants should provide the following six pieces of information about RHR system design:

(1) Applicants should provide a description of the RHR system, including schematic piping and instrumentation diagrams showing all components, piping, points where connecting systems and subsystems tie together, and I&C associated with subsystem and component actuation. The description should cover component interlocks. Applicants should provide a mode diagram showing temperatures, pressures, and flow rates for each mode of RHR operation (e.g., the RCIC condensing mode in a BWR).

(2) Applicants should provide equipment and component descriptions that cover each component of the system. The descriptions should identify the significant design parameters for each component, state the design pressure and temperature of components for various portions of the system, and explain the bases for their selection. Applicants should provide pump characteristic curves and pump power requirements. This information should specify the available and required net positive suction head for the RHR pumps. Applicants should describe heat exchanger characteristics, including design flow rates, inlet and outlet temperatures for the cooling fluid and for the fluid being cooled, the overall heat transfer coefficient, and the heat transfer area. They should identify each component of the RHR system that is also a portion of some other system (e.g., the ECCS).

(3) Regarding control, applicants should state the RHR system relief valve capacity and settings and the method of collecting fluids discharged through the relief valve. Applicants should describe provisions with respect to the control circuits for motor-operated isolation valves in the RHR system, including consideration of inadvertent actuation. The description should include discussions of the controls and interlocks for these values (e.g., intent of Institute of Electrical and Electronics Engineers (IEEE) Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"), considerations for automatic valve closure (e.g., RCS pressure exceeds design pressure of RHR system), valve position indications, and valve interlocks and alarms.

(4) Applicants should identify the applicable industry codes and classifications for the system design.

(5) Applicants should discuss system reliability considerations, including provisions incorporated in the design to ensure that the system will operate when needed and will deliver the required flow rates (e.g., redundancy and separation of components and power sources).

(6) Applicants should discuss all manual actions that an operator must take for the RHR system to operate properly with all components assumed to be operable. The discussion should identify any actions that must be taken from outside the control room. Applicants should repeat this discussion for the most limiting single failure in the RHR system.

C.I.5.4.7.3 ***Performance Evaluation***

Applicants should provide an evaluation of the ability of the RHR system to reduce the temperature of reactor coolant at a rate consistent with the design basis (see Section C.I.5.4.7.1 of this guide).

Applicants should describe the analytical methods used and clearly state all assumptions. They should provide curves showing the reactor coolant temperature as a function of time for the two following cases:

(1) all RHR system components are operable

(2) the most limiting single failure has occurred in the RHR system.

C.I.5.4.8 *Reactor Water Cleanup System (BWRs only)*

C.I.5.4.8.1 ***Design Bases***

Applicants should provide the design objectives and design criteria for the reactor water cleanup system in terms of (1) within the guidelines of the latest version in the EPRI report series, "BWR Water

Chemistry Guidelines," (2) providing system isolation capabilities to maintain the integrity of the RCPB, and (3) precluding liquid poison removal when the poison is required for reactor shutdown. Applicants should describe how they will implement the applicable requirements of 10 CFR Part 50 by indicating the extent to which the recommendations of RG 1.26 will be followed.

C.I.5.4.8.2 ***System Description***

Applicants should describe each component and its capacity, indicating the processing routes and the expected and design flow rates. The description should cover the I&C to (1) isolate the system to maintain the RCPB, (2) isolate the system in the event the liquid poison system is needed for reactor shutdown, and (3) monitor, control, and annunciate abnormal conditions concerning the system temperature and differential pressure across filter/demineralizer units and resin strainers. Applicants should indicate the means to be used for holding filter/demineralizer beds intact if system flow is reduced or lost. They should describe control features to prevent inadvertent opening of the filter/demineralizer backwash valves during normal operation. They should describe the resin transfer system and indicate the provisions to ensure that transfers are complete and that crud traps in transfer lines are eliminated. For systems using other than filter/demineralizer units, applicants should provide appropriate information. They should indicate the routing and termination points of system vents. Applicants should provide piping and instrumentation diagrams indicating system interconnections and seismic and quality group interfaces.

C.I.5.4.8.3 ***Performance Evaluation***

Applicants should provide the design bases for the system capacity and discuss the system's capability to maintain acceptable reactor water purity for normal operation, including AOO (e.g., reactor startup, shutdown refusing, condensate demineralizer breakthrough, and equipment downtime). They should indicate any reliance on other plant systems to meet the design objectives (e.g., liquid radwaste system). Applicants should present the design criteria for components and piping in terms of temperature, pressure, flow, or volume capacity. They should provide the seismic design and quality group classifications for components and piping. Applicants should discuss the capability of the nonregenerative heat exchanger to reduce the process temperature to a level low enough to be compatible with the cleanup demineralizer resins in the event that there is no flow return to the reactor system.

C.I.5.4.9 *[Reserved]*

C.I.5.4.10 *[Reserved]*

C.I.5.4.11 *Pressurizer Relief Tank (PWRs only)*

C.I.5.4.11.1 ***Design Bases***

Applicants should describe the design bases for the pressurizer relief tank system, including provisions for compliance with GDC 2 (comparing with the guidelines of RG 1.29) and GDC 4. The description should cover the maximum step load and the consequent steam volume that the pressurizer relief tank must absorb as well as the maximum heat input that the volume of water in the tank must absorb under any normal conditions or AOO. It should include information for (1) relief valve discharge to the tank and (2) combined relief and safety valves discharge to the tank.

C.I.5.4.11.2 ***System Description***

Applicants should provide a description of the system, including the tank, the piping connections from the tank to the loop seals of the pressurizer relief and safety valves, the relief tank spray system and associated piping, the nitrogen supply piping, and the piping from the tank to the cover gas analyzer and the reactor coolant drain tank. They should provide a piping and instrumentation diagram and a drawing of the pressurizer relief tank.

C.I.5.4.11.3 ***Performance Evaluation***

Applicants should demonstrate that the system, including the tank, is designed to handle the maximum heat load and that the tank design pressure and temperature are adequate. They should present the results of a failure modes and effects analysis to demonstrate that the auxiliary systems serving the tank can meet the single-failure criterion without compromising safe plant shutdown. Applicants should identify the tank rupture disk and relief valve capacities and show that their relief capacity is at least equal to the combined capacity of the pressurizer relief and safety valves.

C.I.5.4.11.4 ***Instrumentation***

Applicants should discuss the instrumentation and controls for the pressurizer relief tank and associated piping.

C.I.5.4.12 ***Reactor Coolant System High Point Vents***

C.I.5.4.12.1 ***Design Bases***

Applicants should provide a summary of the RCS high point vents system and discuss the design bases and criteria. The summary should describe compliance with the provisions of 10 CFR 50.34(f)(2)(vi); 10 CFR 50.44, "Combustible Gas Control for Nuclear Power Reactors," 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," 10 CFR 50.49, 10 CFR 50.55a, GDC 1, GDC 14, "Reactor Coolant Pressure Boundary," GDC 17, "Electric Power Systems," GDC 19, GDC 30, "Quality of Reactor Coolant Pressure Boundary," GDC 34, and GDC 36, "Inspection of Emergency Core Cooling System."

C.I.5.4.12.2 ***System Design***

Applicants should provide a description of the vent system, including its location, size, discharge capacity, functions, and discharge areas. They should provide piping and instrumentation diagrams showing all components, piping, and I&C. They should describe electrical power supplied from emergency buses and operability from the control room and system instrumentation. Applicants should identify information available to the operator for initiating and terminating system operation.

C.I.5.4.12.3 ***Performance Evaluation***

Applicants should provide an evaluation of the vent system's capability to remove noncondensible gases from the primary coolant system with a minimal probability of inadvertent or spurious actuation. The evaluation should cover vent system operation, including procedures that address (1) when venting is/is not needed, (2) the method to determine the size of a noncondensible bubble, (3) initial conditions for venting, (4) requisite instrumentation, and (5) operator actions.

C.I.5.4.13 ***[Reserved]***

C.I.5.4.14 ***[Reserved]***