U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.9.3 ASME CODE CLASS 1, 2, AND 3 COMPONENTS, COMPONENT SUPPORTS, AND CORE SUPPORT STRUCTURES

REVIEW RESPONSIBILITIES

Primary - Mechanical Engineering Branch (MEB)

Secondary - None

I. AREAS OF REVIEW

The MEB reviews the information presented in the applicant's safety analysis report (SAR) concerning the structural integrity of pressure-retaining components, their supports, and core support structures which are designed in accordance with the rules of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 1 (hereinafter "the Code") (Reference 3) and General Design Criteria 1, 2, 4, 14, and 15 (Reference 2).

The staff reviews covers the following specific areas:

1. Loading Combinations, System Operating Transients, and Stress Limits

   The design and service loading combinations (e.g., design and service loads, including system operating transients, in combination with loads calculated to result from postulated seismic and other events) specified for Code constructed items designated as Code Class 1, 2, 3 (including Class 1, 2 and 3 component support structures) and CS core support structures are reviewed to determine that appropriate design and service limits have been designated for all loading combinations. This review ascertains that the design and service stress limits and deformation criteria comply with the applicable limits specified in the Code and Appendix A to this SRP section. Service stress limits which allow inelastic deformation of Code Class 1, 2, and 3 components, component supports, and Class CS core support structures are evaluated as are the justifications for the proposed design procedures. Piping which is "field run" should be included. Internal parts of components, such as valve discs and seats and pump shafting, subjected to dynamic loading during operation of the component should be included.

2. <u>Design and Installation of Pressure Relief Devices</u>

The design and installation criteria applicable to the mounting of pressure relief devices (safety valves and relief valves) for the overpressure protection of Code Class 1, 2, and 3 components are reviewed. The review includes evaluation of the applicable loading combinations and stress criteria. The design review extends to consideration of the means provided to accommodate the rapidly applied reaction force when a safety valve or relief valve opens, and the transient fluid-induced loads applied to the piping downstream of a safety or relief valve in a closed discharge piping system. The dynamic structural response due to BWR safety relief valve discharge into the suppression pool is also considered.

The design of safety and relief valve systems is reviewed with respect to the load combinations imposed on the safety or relief valves, upstream piping or header, downstream or vent piping, system supports, and BWR suppression pool discharge devices such as ramsheads and quenchers.

The load combinations should identify the most severe combination of the applicable loads due to internal fluid weight, momentum and pressure, dead weight of valves and piping, thermal load under heatup, steady state and transient valve operation, reaction forces when valves are discharging (thrust, bending, and torsion), seismic forces, and dynamic forces due to BWR safety relief valve discharge into the suppression pool as applicable. The reaction loads due to discharge of loop seal water slugs and subcooled or saturated liquid under transient or accident conditions shall also be included as valve discharge loads.

The structural response of the piping and support system is reviewed with particular attention to the dynamic or time-history analyses employed in evaluating the appropriate support and restraint stiffness effects under dynamic loadings when valves are discharging.

Where the use of hydraulic snubbers is proposed, the snubber performance characteristics are reviewed to assure that their effects have been considered in the analyses under steady state valve operation and repetitive load applications caused by cyclic valve opening and closing during the course of a pressure transient.

3. <u>Component Supports</u>

The review of information submitted by the applicant includes an evaluation of Code Class 1, 2, and 3 components supports. The review includes an assessment of design and structural integrity of the supports. The review addresses three types of supports: plate and shell, linear, and component standard types. All the component supports of these three types are covered in this SRP section. Although classified as component standard supports, snubbers require special consideration due to their unique function. Snubbers provide no load path or force transmission during normal plant operations but function as rigid supports when subjected to dynamic transient loads. Component supports are those metal supports which are designed to transmit loads from the pressure-retaining boundary of the component to the building structure. The methods of analysis for calculating the responses of the reactor coolant pressure boundary supports resulting from the combination of LOCA and SSE events are reviewed in SRP Sections 3.6.2 and 3.9.2.

In addition, the MEB will coordinate other branches evaluations that interface with the overall review of this SRP section as follows: The Equipment Qualification Branch (EQB) evaluates the operability of pumps and valves and judges the design criteria for pressure-relieving devices which may have an active function during and after a faulted plant condition against the requirements of the component operability assurance program as part of its primary review responsibility for SRP Section 3.10. The Auxiliary Systems Branch (ASB) verifies that the number and size of valves specified for the steam and feedwater systems have adequate pressure-relieving capacity as part of its primary review responsibility for SRP Section 10.3. The Reactor Systems Branch (RSB) verifies that the number and size of valves specified for the reactor coolant pressure boundary have adequate pressure-relieving capacity as part of its primary review responsibility for SRP Section 5.2.2. The Containment Systems Branch (CSB) reviews the applicant's analyses of subcompartment differential pressures resulting from postulated pipe breaks as part of its primary review responsibility for SRP Section 6.2.1.2.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

MEB acceptance criteria are based on meeting the relevant requirements of the following regulations:

A. 10 CFR Part 50, §50.55a and General Design Criterion 1 as it relates to structures and components being designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed.

B. General Design Criterion 2 as it relates to structures and components important to safety being designed to withstand the effects of earthquakes combined with the effects of normal or accident conditions.

C. General Design Criterion 4 as it relates to structures and components important to safety being designed to accommodate the effects of and to be compatible with the environmental conditions of normal and accident conditions.

D. General Design Criterion 14 as it relates to the reactor coolant pressure boundary being designed, fabricated, erected, and tested to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

E. General Design Criterion 15 as it relates to the reactor coolant system being designed with sufficient margin to assure that the design conditions are not exceeded.

Specific criteria necessary to meet the relevant requirements of §50.55a and General Design Criteria 1, 2, 4, 14, and 15 by which the areas of review defined in subsection I of this SRP section judged to be acceptable are as follows:

1. <u>Loading Combinations, System Operating Transients, and Stress Limits</u>

The design and service loading combinations, including system operating transients, and the associated design and service stress limits considered for each component and its supports should be sufficiently defined to provide the basis for design of Code Class 1, 2, and 3 components, component supports and Class CS core support structures for all conditions.

The acceptability of the combination of design and service loadings (including system operating transients), applicable to the design of Class 1, 2, and 3 components, component supports, and Class CS core support structures, and of the designation of the appropriate design or service stress limit for each loading combination, is judged by comparison with positions stated in Appendix A, and with appropriate standards acceptable to the staff developed by professional societies and standards organizations.

The design criteria for internal parts of components such as valve discs, seats, and pump shafting should comply with applicable ASME Code or Code Case criteria. In those instances where no ASME criteria exist, the design criteria are acceptable if they assure the structural integrity of the part such that no safety-related functions are impaired.

2. <u>Design and Installation of Pressure Relief Devices</u>

The applicant should use design criteria for pressure relief stations specified in Appendix O, ASME Code, Section III, Division 1, "Rules for the Design of Safety Valve installations" (Reference 6). Additionally, the following criteria are applicable:

(1) Where more than one valve is installed on the same run pipe, the sequence of valve openings to be assumed in analyzing for the stress at any piping location should be that sequence which is estimated to induce the maximum instantaneous value of stress at that location.

(2) Stresses should be evaluated, and applicable stress limits should be satisfied for all components of the run pipe and connecting systems and the pressure relief valve station including supports and all connecting welds between these components.

(3) In meeting the stress limit requirements, the contribution from the reaction force and the moments resulting from that force should include the effects of the Dynamic Load Factor or should use the maximum instantaneous values of forces and moments for that location as determined by the dynamic hydraulic/structural system analysis. This requirement should be satisfied in demonstrating satisfaction of all design limits at all locations of the run pipe and the pressure relief valve for Class 1, 2, and 3 piping. A Dynamic Load Factor (DLF) of 2.0 may be used in lieu of a dynamic analysis to determine the DLF.

The SAR must also include a description of the calculational procedures, computer programs, and other methods to be used in the analysis. The analysis must include the time history or equivalent effects of changes of momentum due to fluid flow changes of direction. The fluid states considered must include postulated water slugs where water seals are used and subcooled or saturated liquid if such fluid can be discharged under postulated transient or accident conditions. Plants utilizing suppression pools shall also consider the applicable pool dynamic loads on the safety relief valve system. Stress computations and stress limits must be in accord with applicable rules of the Code.

3. Component Supports

a. The component support designs should provide adequate margins of safety under all combinations of loadings. The combination of loadings (including system operating transients) considered for each component support within a system, including the designation of the appropriate service stress limit for each loading combination should meet the criteria in Appendix A and Regulatory Guides 1.124 and 1.130 (References 7 and 8).

Component supports of active pumps and valves should be considered in context with the other features of the operability assurance program as presented in SRP Section 3.10. If the component support affects the operability requirements of the supported component, then deformation limits should also be specified. Such deformation limits should be compatible with the operability requirements of the components supported and incorporated into the operability assurance program. In establishing allowable deformations, the possible movements of the support base structures must be taken into account.

b. Where snubbers are utilized as supports for safety-related systems and components, acceptable criteria for snubber operability assurance should contain the following elements:

(1) Structural Analysis and Systems Evaluation.

Systems and components which utilize snubbers as shock and vibration arrestors must be analyzed to ascertain the interaction of such devices with the systems and components to which they are attached. Snubbers may be used as shock and vibration arrestors and in some instances as dual purpose snubbers. When used as a vibration arrestor or dual purpose snubbers, fatigue strength must be considered. Important factors in the fatigue evaluation include: (i) unsupported system component movement or amplitude, (ii) force imparted to snubber and corresponding reaction on system or component due to restricting motion (damped amplitude), (iii) vibration frequency or number of load cycles, and (iv) verification of system or component and snubber fatigue strength.

Snubbers used as shock arrestors do not require fatigue evaluation if it can be demonstrated that (i) the number of load cycles which the snubber will experience during normal plant operating conditions is small (<2500) or (ii) motion during normal plant operating conditions does not exceed snubber dead band.

Snubbers utilized in systems or components which may experience high thermal growth rates either during normal operating conditions or as a result of anticipated transients should be checked to assure that such thermal growth rates do not exceed the snubber lock-up velocity.

(2) Characterization of Mechanical Properties.

A most important aspect of the structural analysis is realistic characterization of snubber mechanical properties (i.e. spring rates) in the analytical model. Since the "effective" stiffness of a snubber is generally greater than that for the snubber support assembly (i.e., the snubber plus clamp, transition tube extension, back-up support structure, etc.) the snubber response characteristics may be "washed out" by the added flexibility in the support structure. The combined effective stiffness of the snubber and support assembly must therefore be considered in evaluating the structural response of the system or component.

Snubber spring rate should be determined independent of clearance/lost motion, activation level, or release rate. The stiffness should be based on structural and hydraulic compliance only, and should consider the effects of temperature.

The snubber end fitting clearance and lost motion must be minimized and should be considered when calculating snubber reaction loads and stress which are based on a linear analysis of the system or component. This is especially important in multiple snubber applications where mismatch of end fitting clearance has a greater effect on the load sharing of these snubbers than does the mismatch of activation level or release rate. Equal load sharing of multiple snubber supports should not be assumed if mismatch in end fitting clearance exists.

(3) Design Specifications

The required structural and mechanical performance of snubbers is determined from the user's system analysis described in (1) and (2). The snubber Design Specification is the instrument provided by the purchaser to the supplier to assure that the requirements are met. The Design Specification should contain (i) the general functional requirements, (ii) operating environment, (iii) applicable codes and standards, (iv) materials of construction and standards for hydraulic fluids and lubricants, (v) environmental, structural, and performance design verification tests, (vi) production unit functional verification tests and certification, (vii) packaging, shipping, handling, and storage requirements, and (viii) description of provisions for attachments and installation.

In addition, the snubber manufacturer should be requested to submit his quality assurance and assembly quality control procedures for review and acceptance by the purchaser.

(4) Installation and Operability Verification

Assurance that all snubbers and properly installed prior to preoperational piping vibration and plant start-up tests should be provided. Visual observation of piping systems and measurement of thermal movements during plant start-up tests could verify that snubbers are operable (not locked up). Provisions for such examinations and measurements should be discussed in the piping preoperational vibration and plant start-up test programs as described in SRP Section 3.9.2.

(5) Use of Additional Snubbers

Snubbers could in some instances be installed during or after plant construction which may not have been included in the design analysis. This could occur as a result of unanticipated piping vibration as discussed in SRP Section 3.9.2 or interference problems during construction. The effects of such installation should be fully evaluated and documented to demonstrate that normal plant operations and safety are not diminished.

(6) Inspection and Testing

Inservice inspection and testing are critical elements of operability assurance programs for mechanical components. The applicant should provide a discussion of accessibility provisions for maintenance, inservice inspection and testing, and possible repair or replacement of snubbers consistent with the requirements of the NRC Standard Technical Specifications.

(7) Classification and Identification

All safety-related components which utilize snubbers in their support systems should be identified and tabulated in the FSAR. The tabulation should include the following information: (i) identification of the systems and components in those systems which utilize snubbers, (ii) the number of snubbers utilized in each system and on components in that system, (iii) the type(s) of snubber (hydraulic or mechanical) and the corresponding supplier identified, (iv) specify whether the snubber was constructed to the rules of ASME Code Section III, Subsection NF, (v) state whether the snubber is used as a shock, vibration, or dual purpose snubber, and (vi) for snubbers identified as either dual purpose or vibration arrestor type, indicate if both snubber and component were evaluated for fatigue strength.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

For each area of review, the following review procedures apply:

1. Loading Combinations, System Operating Transient, and Stress Limits

The objectives in reviewing the loading combinations and stress limits employed by the applicant in the design of Code Class 1, 2, and 3 components, component supports, and Class CS core support structures are to confirm that the appropriate postulated events have been included, that the loading combinations (including system operating transients) and the designation of design and service stress limits are appropriate. The review conducted during the CP stage determines that the objectives have been addressed and are being implemented in the design by obtaining a commitment from the applicant that specific design criteria will be utilized.

By checking selected Code required Design Documents such as Design Reports, Load Capacity Data Sheets, and related material, the OL stage review verifies that the design criteria have been utilized and that components have been designed to meet the objectives. To assure that these objectives are met, the review is performed as follows:

a. The applicant's proposed design and service loadings, and combinations thereof, are reviewed for completeness and for appropriate designation of corresponding design and service stress limits.

b. The combination of design and service loadings, including procedures for combination, proposed by the applicant for each Code-constructed item are reviewed to determine if they are adequate. This aspect of the review is made by comparison with the loading combinations and procedures for combination set forth in Appendix A. Deviations from the position are evaluated on a case-by-case basis by questions addressed to the applicant to determine the rationale and justification for exceptions. Final determination is based on engineering judgment and past experience with prior applications.

c. The design and service stress limits selected by the applicant for each set of design and service loading combinations as established in (a) are reviewed to determine if they meet those specified in Appendix A. The provisions for piping component functional capability are reviewed to determine their adequacy in meeting the objectives set forth in Appendix A. Deviations from the position may be permitted provided justification is presented by the applicant. The acceptability determination is based on considerations of adequate margins of safety.

2. Design and Installation of Pressure Relief Devices

The objective of the review of the design and installation of pressure relief devices is to assure the adequacy of the design and installation so that there is assurance of the integrity of the pressure relieving devices and associated piping during the functioning of one or more of the relief devices. In the CP review, it is determined whether there is reasonable assurance that the final design will meet these objectives. At the OL stage, the final design is reviewed to determine that the objectives have been met.

The review is performed as follows:

a. The design of the pressure retaining boundary of the device is reviewed by comparison with the Code. Since explicit rules are not yet available within the Code for the design of safety and pressure relief valves, the design is reviewed on the basis of reference to sections of the Code on vessels, piping, and line valves, and ASME Code Case N-100 (Reference 6).

Allowable stress limits are compared with those in the Code for the appropriate class of construction. Deviations are identified and the applicant is requested to provide justification. Stress limits and loading combinations are covered under the areas entitled "Loading Combinations, System Operating Transients, and Stress Limits" in this SRP section.

b. The design of the installation is reviewed for structural adequacy to withstand the dynamic effects of relief valve operation. The applicant should include and discuss: reaction force, valve opening sequence, valve opening time, method of analysis, and magnitude of a dynamic load factor (if used). In reaching an acceptance determination, the reviewer compares the submission with the requirements in subsection II.2 of this SRP section.

Where deviations occur, they are identified and the justification is evaluated. Valve opening sequence effects must consider the worst combination possible and forcing functions must be justified with valve opening time data. The review is based in part on comparisons with prior acceptable designs tested in operating plants.

3. Component Supports

The objective in the review of component supports is to determine that adequate attention has been given the various aspects of design and analysis, so that there is assurance as to structural integrity of supports and as to operability of active components that interact with component supports.

The reviewer should be assured that the applicant's PSAR contains discussions and commitments to develop and utilize a snubber operability assurance program containing the elements specified in paragraphs (1) through (6) of subsection II.3.b of this SRP section. A commitment to provide in the FSAR the information specified in paragraph (7) of subsection II.3.b of this SRP section is sufficient for the CP review stage. During the OL review the FSAR should contain summaries in sufficient detail to verify the PSAR commitments.

The structural integrity of the three types of component supports described in subsection I.3 of this SRP section are reviewed against the criteria and guidelines of subsection II.3 of this SRP section.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided in accordance with the requirements of this SRP section, and that his evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report:

The staff concludes that the specified design and service combinations of loadings as applied to ASME Code Class 1, 2, and 3 pressure retaining components are acceptable and meet the requirements of 10 CFR Part 50, §50.55a and General Design Criteria 1, 2, 4, 14, and 15. This conclusion is based on the following:

1. The applicant met the requirements of 10 CFR Part 50, §50.55a and General Design Criteria 1, 2, and 4 with respect to the design and service load combinations and associated stress and deformation limits specified for ASME Code Class 1, 2, and 3 components by insuring that systems and components important to safety are designed to quality standards commensurate with their importance to safety and that these systems can accommodate the effects of normal operation as well as postulated events such as loss-of-coolant accidents and the dynamic effects resulting from earthquakes. The specified design and service combinations of loadings as applied to ASME Code Class 1, 2, and 3 pressure retaining components in

systems designed to meet seismic Category I standards are such as to provide assurance that in the event of an earthquake affecting the site or other service loadings due to postulated events or system operating transients, the resulting combined stresses imposed on system components will not exceed allowable stress and strain limits for the materials of construction. Limiting the stresses under such loading combinations provides a conservative basis for the design of system components to withstand the most adverse combination of loading events without loss of structural integrity.

2. The applicant has met the requirements of 10 CFR Part 50, §50.55a and General Design Criteria 1, 2, and 4 with respect to the criteria used for design and installation of ASME Code Class 1, 2, and 3 overpressure relief devices by insuring that safety and relief valves and their installations are designed to standards which are commensurate with their safety functions, and that they can accommodate the effects of discharge due to normal operation as well as postulated events such as loss-of-coolant accidents and the dynamic effects resulting from the safe shutdown earthquake. The relevant requirements of General Design Criteria 14 and 15 are also met with respect to assuring that the reactor coolant pressure boundary design limits for normal operation including anticipated operational occurrences are not exceeded. The criteria used by the applicant in the design and installation of ASME Class 1, 2, and 3 safety and relief valves provide adequate assurance that, under discharging conditions, the resulting stresses will not exceed allowable stress and strain limits for the materials of construction. Limiting the stresses under the loading combinations associated with the actuation of these pressure relief devices provides a conservative basis for the design and installation of the devices to withstand these loads without loss of structural integrity or impairment of the overpressure protection function.

3. The applicant has met the requirements of 10 CFR Part 50, §50.55a and General Design Criteria 1, 2, and 4 with respect to the design and service load combinations and associated stress and deformation limits specified for ASME Code Class 1, 2, and 3 component supports by insuring that component supports important to safety are designed to quality standards commensurate with their importance to safety, and that these supports can accommodate the effects of normal operation as well as postulated events such as loss-of-coolant accidents and the dynamic effects resulting from the safe shutdown earthquake. The combination of loadings (including system operating transients) considered for each component support within a system, including the designation of the appropriate service stress limit for each loading combination, has met the positions and criteria of Regulatory Guides 1.124 and 1.130 and are in accordance with NUREG-0484 and NUREG-0609. The specified design and service loading combinations used for the design of ASME Code Class 1, 2, and 3 component supports in systems classified as seismic Category I provide assurance that in the event of an earthquake or other service loadings due to postulated events or system operating transients, the resulting combined stresses imposed on system components will not exceed allowable stress and strain limits for the materials of construction. Limiting the stresses under such loading combinations provides a conservative basis for the design of support components to withstand the most adverse combination of loading events without loss of structural integrity.

Class CS component evaluation findings are covered in SRP Section 3.9.5 in connection with reactor internals.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs.

VI. REFERENCES

1. 10 CFR Part 50, §50.55a, "Codes and Standards."

2. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," (a) General Design Criterion 1, "Quality Standards and Records," (b) General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," (c) General Design Criterion 4, "Environmental and Missile Design Bases," (d) General Design Criterion 14, "Reactor Coolant Pressure Boundary," and (e) General Design Criterion 15, "Reactor Coolant System Design."

3. ASME Boiler and Pressure Vessel Code, Section III, Division 1, "Nuclear Power Plant Components," American Society of Mechanical Engineers.

4. Standard Review Plan Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment Important to Safety."

5. Appendix A to SRP Section 3.9.3, "Stress Limits for ASME Class 1, 2, and 3 Components and Component Supports of Safety-Related Systems and Class CS Core Support Structures Under Specified Service Loading Combinations."

6. ASME Code Case N-100, "Pressure Relief Valve Design Rules, Section III, Division 1, Class 1, 2 and 3."

7. Regulatory Guide 1.124, "Design Limits and Loading Combinations for Class 1 Linear-Type Component Supports."

8. Regulatory Guide 1.130, "Design Limits and Loading Combinations for Class 1 Plate- and Shell-Type Component Supports."

9. NUREG-0484, "Methodology for Combining Dynamic Loads."

10. NUREG-0609, "Asymmetric Blowdown Loads on PWR Primary Systems."

APPENDIX A

STANDARD REVIEW PLAN SECTION 3.9.3
STRESS LIMITS FOR ASME CLASS 1, 2, AND 3 COMPONENTS AND COMPONENT SUPPORTS OF SAFETY-RELATED SYSTEMS AND CLASS CS CORE SUPPORT STRUCTURES UNDER SPECIFIED SERVICE LOADING COMBINATIONS

A. INTRODUCTION

Nuclear power plant components and supports are subjected to combinations of loadings derived from plant and system operating conditions, natural phenomena, postulated plant events, and site-related hazards. Section III, Division 1 of the ASME Code (hereafter referred to as the Code) provides specific sets of design and service stress limits that apply to the pressure retaining or structural integrity of components and supports when subjected to these loadings. The design and service stress limits specified by the Code do not assure, in themselves, the operability of components, including their supports, to perform the mechanical motion required to fulfill the component's safety function. Certain of the service stress limits specified by the Code (i.e., level C and D) may not assure the functional capability of components, including their supports, to deliver rated flow and retain dimensional stability. Since the combination of loadings, the selection of the applicable design and service stress limits appropriate to each load combination and the proper consideration of operability is beyond the scope of the Code; and the treatment of functional capability, including collapse and deflection limits, is not adequately treated by the Code for all situations, such factors must be evaluated by designers and appropriate information developed for inclusion in the Design Specification or other referenced documents.

Applicants require guidance with regard to the selection of acceptable design and service stress limits associated with various loadings and combinations thereof, resulting from plant and system operating conditions and design basis events, natural phenomena, and site-related hazards. The relationship and application of the terms "design conditions," "plant operating conditions," "system operating conditions," and the formerly used term "component operating conditions," now characterized by four levels of service stress limits, have not been clearly understood by applicants and their subcontractors.

For example, under the "faulted plant or system condition" (e.g., due to LOCA within the reactor coolant pressure boundary), the emergency core cooling system (ECCS) should be designed to operate and deliver rated flow for an extended period of time to assure the safe shutdown of the plant. Although the "plant condition" is termed "faulted," components in the functional ECCS must perform the safety function under a specified set of service loadings which includes those resulting from the specified plant postulated events. The selection of level "D" (related to the "faulted" condition) service stress limits for this system, based solely on the supposition that all components may use this limit for a postulated event resulting in the faulted plant condition cannot be justified, unless system operability is also demonstrated.

This appendix is necessary to improve consistency and understanding of the basic approach in the selection of load combinations applicable to safety-related systems and to establish acceptable relationships between plant postulated events, plant and system operating conditions, component and component support design, and service stress limits, functional capability, and operability.

B. DISCUSSION

Current reviews of both standardized plants and custom plants have indicated the need for additional guidance to reach acceptable design conclusions in the following areas:

(1) Relationship between certain plant postulated events, plant and system operating conditions, resulting loads and combinations thereof, and appropriate design and service stress limits for ASME Class 1, 2 and 3 components and component supports and Class CS core support structures.

(2) Relationship of component operability assurance, functional capability, and allowable design and service stress limits for ASME Class 1, 2, and 3 components and component supports.

The Code provides five categories of limits applicable to design and service loadings (design, level A, level B, level C, and level D). The Code rules provide for structural integrity of the pressure retaining boundary of a component and its supports, but specifically exclude the subject of component operability and do not directly address functional capability. The types of loadings to be taken into account in designing a component are specified in the Code, but rules specifying how the loadings, which result from postulated events and plant and system operating conditions, are to be combined and what stress level is appropriate for use with loading combinations are not specified in the Code. It is the responsibility of the designer to include all this information in the Code required Design Specification of each component and support.

C. POSITION

Effective with the 1977 Edition, the Code provides design stress limits and four sets of service stress limits for all classes of components, component supports, and core support structures. The availability of such design and service stress limits within the Code requires that the MEB review and determine maximum acceptable design and service stress limits which may be used with specified loads, or combinations thereof, for components and component supports of safety-related systems (refer to definition in Table III) and core support structures.

This appendix provides guidance for dealing with the components and component supports of safety-related systems and core support structures in the following areas:

(1) Consideration of design loadings and limits.

(2) Consideration of service loading combinations resulting from postulated events and the designation of acceptable service limits.

(3) Consideration of piping functional capability and operability of active pumps and valves under service loading combinations resulting from postulated events.

(4) Applicability of the appendix to components, component support structures, and core support structures and procedures for compliance.

1.0 ASME CLASS 1, 2, AND 3 COMPONENTS AND COMPONENT SUPPORTS OF SAFETY-RELATED SYSTEMS AND CLASS CS CORE SUPPORT STRUCTURES

1.1 Design Considerations and Design Loadings

ASME Code Class 1, 2, and 3 components, component supports, and class CS core support structures shall be designed to satisfy the appropriate subsections of the Code in all respects, including limitations on pressure, and the requirements of this appendix. Component supports that are intended to restrain either force and displacement or anchor movement shall be designed to maintain deformations within appropriate limits as specified in the component support Design Specifications.

Design loadings shall be established in the Design Specification. The design limits of the appropriate subsection of the Code shall not be exceeded for the design loadings specified.

1.2 Service Loading Combinations

The identification of individual loads and the appropriate combination of these loads (i.e., sustained loads, loads due to system operating transients SOT, OBE, SSE, LOCA, DBPB, MS/FWPB and their dynamic effects) shall be in accordance with Section 1.3. The appropriate method of combination of these loads shall be in accordance with NUREG-0484, "Methodology for Combining Dynamic Loads" (Reference 9).

1.3 Service Conditions

1.3.1 Service Limit A

Class 1, 2, and 3 components, component supports, and Class CS core support structures shall meet a service limit not greater than Level A when subjected to sustained loads resulting from normal plant/system operation.

1.3.2 Service Limit B

Class 1, 2, and 3 components, component supports, and Class CS core support structures shall meet a service limit not greater than Level B when subjected to the appropriate combination of loadings resulting from (1) sustained loads, (2) specified plant/system operating transients (SOT), and (3) the OBE.

1.3.3 Service Limit C

(a) Class 1, 2, and 3 components, component supports, and Class CS core support structures shall meet a service limit not greater than Level

C when subjected to the appropriate combination of loadings resulting from (1) sustained loads, and (2) the DBPB.

(b) The DBPB includes loads from the postulated pipe break, itself, and also any associated system transients or dynamic effects resulting from the postulated pipe break.

1.3.4 Service Limit D

(a) Class 1, 2, and 3 components, component supports, and Class CS core support structures shall meet a service stress limit not greater than Level D when subjected to the appropriate combination of loadings resulting from (1) sustained loads, (2) either the DBPB, MS/FWPB, or LOCA, and (3) and SSE.

(b) The DBPB, MS/FWPB, and LOCA include loads from the postulated pipe breaks, themselves, and also any associated system transients or dynamic effects resulting from the postulated pipe breaks. Asymmetric blowdown loads on PWR primary systems shall be incorporated per NUREG-0609 (Reference 10).

2.0 OPERABILITY AND FUNCTIONAL CAPABILITY

2.1 Active Pumps and Valves

SRP Section 3.10 (Reference 4) shall demonstrate that the pump or valve, as supported, can adequately sustain the designated combined service loadings at a stress level at least equal to the specified service limit, and can perform its safety function without impairment. Loads produced by the restraint of free end displacement and anchor point motions shall be included.

2.2 Snubbers

The operability requirements specified for mechanical and hydraulic snubbers installed on safety-related systems is subject to review by the staff. When snubbers are used, their need shall be clearly established and their design criteria presented.

2.3 Functional Capability

The design of Class 1, 2, and 3 piping components shall include a functional capability assurance program. This program shall demonstrate that the piping components, as supported, can retain sufficient dimensional stability at service conditions so as not to impair the system's functional capability. The program may be based on tests, analysis, or a combination of tests and analysis.

3.0 TABLES

3.1 Table I summarizes the requirements of this appendix for use with ASME Class 1, 2, and 3 components, component supports, and Class CS core support structures. The table illustrates plant events, system operating conditions, service loading combinations, and service stress limits and should always be used in conjunction with the text of this appendix.

3.2 Table II defines all the terms used in this appendix.

4.0 PROCEDURES FOR COMPLIANCE

4.1 Design Specification and Safety Analysis Report

(a) The design options provided by the Code and related design criteria specified in the Code required Design Specification for ASME Class 1, 2, and 3 components, component supports, and Class CS core support structures should be summarized in sufficient detail in the Safety Analysis Report of the application to permit comparison with this Appendix.

(b) The presentation in the PSAR should specify and account for all design and service loadings, method of combination, the designation of the appropriate design and service stress limits (including primary and secondary stresses, fatigue consideration, and special limits on pressure when appropriate) for each loading combination presented, and the provisions for functional capability.

(c) The presentation in the FSAR should indicate how the criteria in Sections 1 and 2 of this appendix have been implemented.

(d) The staff may request the submission of the Code required Design Documents such as Design Specifications, Design Reports, Load Capacity Data Sheets, or other related material or portions thereof to establish that the design criteria, the analytical methods, and functional capability satisfy the guidance provided by this appendix. This may include information provided to, and received from, component and support manufacturers. As an alternative to the applicant submitting these documents, the staff may require them to be made available for review at the applicant's or vendor's office.

4.2 Use with Regulatory Guides

The information and requirements contained in this appendix supersede those in the October 1973 version of Regulatory Guide 1.67 and the May 1973 version of Regulatory Guide 1.48. Regulatory Guides 1.124 and 1.130 on Class 1 linear and Class 1 plate and shell component support structures are to be supplemented by this appendix.

TABLE I

Allowable Service Stress Limits for Specified Service Loading Combinations for ASME Class 1 Components and Class CS Support Structures

	Plant Event[2]	System Operating Conditions	Service Loading Combination[1,4]	Service Stress Limit
1.	Normal Operation	Normal	Sustained Loads	A
2.	Plant/System Operating Transients (SOT) + OBE	Upset	Sustained Loads + SOT + OBE	B[3]
3.	DBPB	Emergency	Sustained Loads + DBPB	C[3]
4.	MS/FWPB	Faulted	Sustained Loads + MS/FWPB	D[3]
5.	DBPB or MS/FWPB + SSE	Faulted	Sustained Loads + DBPB or MS/FWPB + SSE	D[3]
6.	LOCA	Faulted	Sustained Loads + LOCA	D[3]
7.	LOCA + SSE	Faulted	Sustained Loads + LOCA + SSE	D[3]

NOTE: [1]The appropriate method of combination is subject to review and evaluation. Refer to Section 1.2.

[2]Refer to Table II for definition of terms.

[3]In addition to meeting the specified service stress limits for given load combinations, operability and functional capability must also be demonstrated as discussed in Subsection 2.0 of this appendix and in SRP Section 3.10.

[4]These events must be considered in the pipe stress analysis and pipe support design process when specified in the ASME Code-required Design Specification. The Design Specification shall define the load and specify the applicable Code Service Stress Limit. For clarification, it should be noted that the potential for water hammer and water (steam) hammer occurrence should also be given proper consideration in the development of Design Specifications.

TABLE II

DEFINITION OF TERMS

Active Pumps and Valves - A pump or valve which must perform a mechanical motion in order to shut down the plant or mitigate the consequences of a postulated event. Safety and relief valves are specifically included.

Component and Support Functional Capability - Ability of a component, including its supports, to deliver rated flow and retain dimensional stability when the design and service loads, and their resulting stresses and strains, are at prescribed levels.

Component and Support Operability - Ability of an active component, including its support, to perform the mechanical motion required to fulfill its designated safety function when the design and service loads, and their resulting stresses and strains, are at prescribed levels.

DBPB - Design Basis Pipe Breaks - Those postulated pipe breaks other than a LOCA or MS/FWPB. This includes postulated pipe breaks in Class 1 branch lines that result in the loss of reactor coolant at a rate less than or equal to the capability of the reactor coolant makeup system.

This condition includes loads from the postulated pipe breaks, itself, and also any associated system transients or dynamic effects resulting from the postulated pipe break.

Design Limits - The limits for the design loadings provided in the appropriate subsection of Section III, Division 1, of the ASME Code.

Design Loads - Those pressures, temperatures, and mechanical loads selected as the basis for the design of a component.

Functional System - That configuration of components which, irrespective of ASME Code Class designation or combination of ASME Code Class designations, performs a particular function (i.e., each emergency core cooling system performs a single particular function and yet each may be comprised of some components which are ASME Class 1 and other components which are ASME Code Class 2).

LOCA - Loss-of-Coolant Accidents - Defined in Appendix A of 10 CFR Part 50 as "those postulated accidents that result from the loss of reactor coolant, at a rate in excess of the capability of the reactor coolant makeup system, from breaks in the reactor coolant pressure boundary, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system."

This condition includes the loads from the postulated pipe break, itself, and also any associated system transients or dynamic effects resulting from the postulated pipe break.

MS/FWPB - Main Steam and Feedwater Pipe Breaks - Postulated breaks in the main steam and feedwater lines. For a BWR plant this may be considered as a LOCA event depending on the break location.

This condition includes the loads from the postulated pipe break, itself, and also any associated system transients or dynamic effects resulting from the postulated pipe break.

OBE - Operating Basis Earthquake - Defined in Section III (d) of Appendix A of 10 CFR Part 100 as "that earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant. It is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant, necessary for continued operation without undue risk to the health and safety of the public, are designed to remain functional."

This condition includes the loads from the postulated seismic event, itself, and also any associated system transients or dynamic effects resulting from the postulated seismic event.

Piping Components - These items of a piping system such as tees, elbows, bends, pipe and tubing, and branch connections constructed in accordance with the rules of Section III of the ASME Code.

Postulated Events - Those postulated natural phenomena (i.e., OBE, SSE), postulated site hazards (i.e., nearby explosion), or postulated plant events (i.e., DBPB, LOCA, MS/FWPB) for which the plant is designed to survive without undue risk to the health and safety of the public. Such postulated events may also be referred to as design basis events.

SSE - Safe Shutdown Earthquake - Defined in Section III(c) of Appendix A of 10 CFR Part 100 as "that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is the earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional. These structures, systems, and components are those necessary to assure:

(1) The integrity of the reactor coolant pressure boundary.

(2) The capability to shut down the reactor and maintain it in a safe shutdown condition, or

(3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline."

This condition includes the loads from the postulated seismic event, itself, and also any associated system transients or dynamic effects resulting from the postulated seismic event.

Service Limits - The four limits for the service loading as provided in the appropriate subsection of Section III, Division 1, of the ASME Code.

Service Loads - Those pressure, temperature, and mechanical loads provided in the Design Specification.

SOT - System Operating Transients - The transients and their resulting mechanical responses due to dynamic occurrences caused by plant or system operation.