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REGULATORY GUIDE 1.48

DESIGN LIMITS AND LOADING COMBINATIONS FOR SEISMIC CATEGORY I FLUID SYSTEM COMPONENTS

A. INTRODUCTION

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants," requires, in part, that the design bases for structures, systems, and components important to safety reflect appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena such as earthquakes. This guide delineates acceptable design limits and appropriate combinations of loadings associated with normal operation, postulated accidents, and specified seismic events for the design of Seismic Category I fluid system components (i.e., water- and steam-containing components). This guide applies to light-water-cooled reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

The design conditions and functional requirements of fluid system components important to safety in nuclear power plants should be reflected in the application of appropriate design limits (e.g., stress or strain limits) for the most adverse combination of loadings to which these components may be subjected in service.

For components that are constructed in accordance with Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, provision of a design specification which stipulates the design requirements for the component (i.e., the mechanical and operational loadings) and the Code classification of the component (e.g., Code Class 1, 2, or 3) is required. However, neither Section III nor any other published national code or standard provides adequate guidance for selecting code classifications and loading combinations for design or for identifying Seismic Category I fluid system components. The lack of adequate guidance for selecting loading combinations is apparent from a review of recent construction permit applications which reflect design requirements as contained in the code design specifications. For essentially identical components designed for the same plant conditions (i.e., operating conditions of the plant categorized as normal, upset, emergency, and faulted plant conditions) and specified seismic events (i.e., one-half the Safe Shutdown Earthquake (SSE) and the SSE) the loading combinations and associated design limits vary considerably among applications for construction permits. Regulatory Guides 1.26 and 1.29 (Safety Guide 26 and 29) entitled "Quality Group Classifications and Standards" and "Seismic Design Classification," respectively, provide acceptable bases for classifying fluid system components in relation to applicable national codes (e.g., Section III of the ASME Code) and for identifying those structures, systems and components that should be designed to remain functional under the effects of the SSE (i.e., Seismic Category I structures, systems, and components).

To further provide a consistent basis for design of fluid system components important to safety, this guide delineates acceptable design limits and appropriate combinations of loadings associated with applicable plant conditions and specified seismic events. The approach set forth in this guide is directly related to Section III of the ASME Code. Design limits as specified in Section III are extensively utilized to provide assurance of the pressure-retaining integrity of vessels, piping, non-active pumps, and non-active valves of each Code class; however, for the particular case of active pumps and valves (i.e., pumps and valves that must perform a mechanical motion during the course of accomplishing a system safety function), special design limits and supplemental requirements are specified to provide assurance of operability. These special design limits and supplemental requirements are provided for active pumps and valves because the rules for construction of Section III apply to the assurance of pressure-retaining integrity but do not assure that pumps and valves designated to perform a system safety function will operate when required. This conclusion is supported by B-1223.4(b) of Appendix B to Section III, "Owner's Design Specification," which states, "Although Code requirements for the acceptability of a component are not intended to assure the functional adequacy of the component, the higher stress limits permitted for Emergency and Faulted Condition evaluation may result in deformations which preclude operability during or after the event. The Owner may wish to provide more restrictive limits for components which require close dimensional control and which must operate during and after the event. Such requirements are beyond the scope of this Section (i.e., Section III)." Footnote 1 to NB-3510 of Section III also expresses this limitation by stating that, "These requirements for the acceptability of a valve design are not intended to assure the functional adequacy of the valve."

In addition, design limits augmenting Section III of the ASME Code are selected for Code Class 2 and 3 components and certain Code Class 1 components in the absence of design limits for other than the normal plant condition (e.g., the emergency and faulted plant conditions). It is emphasized that the design limits delineated in this guide are intended to apply to all fluid system components (vessels, piping, pumps, and valves) that are relied upon to cope with the effects of specified plant conditions.

Loading combinations are defined as those loadings or combinations thereof that are associated with each plant condition or specified seismic event. These loadings result from the various transients or events that are included within each plant condition and the magnitude of the specified seismic events associated with the nuclear power plant site. Identification of the particular transients or events to be evaluated for each plant condition will be addressed in a future guide; however, only the most adverse loadings resulting from those transients or events associated with each plant condition and specified seismic event as combined herein should be considered for design (e.g., those combinations of loadings that result in the limiting or controlling design condition). The combinations of loadings are based upon information contained in recent applications for construction permits, the anticipated sequence of occurrences which produce loadings, and the most limiting combination of low-probability postulated accidents or events (i.e., the concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition). Although the loadings associated with each plant condition and specified seismic event delineated in this guide are combined in the same manner for all classes of components, the design limits and specific loadings associated with each plant condition are not the same for all classes of components (e.g., the dynamic loadings associated with the faulted plant condition may not be present for all Code Class 2 and 3 components because piping ruptures may be postulated to occur only for certain Code Class 2 and 3 piping). However, a failure in any system or component should be evaluated for its effects on all other systems and components.

ASME Code Class 1 Components

Code Class 1 components, except for pumps and valves, benefit from the most complete design coverage that Section III of the ASME Code provides. Design rules and design limits are available for other than the normal plant condition (e.g., for the severe loadings associated with the emergency and faulted plant conditions and specified seismic events). These severe loadings are accomodated by application of the design limits for the emergency and faulted operating condition categories (as defined in NB-3113 of Section III) which permit design limits in excess of those allowed for the normal operating condition category. Loadings associated with the normal plant condition and loadings associated with the upset plant condition (i.e., anticipated operational occurrences as defined in Appendix A to 10 CFR Part 50) are sustained by application of the design limits specified for the normal operating condition category and the upset operating condition category of Section III, respectively.

ASME Code Class 1 Vessels and Piping

To provide assurance of pressure-retaining integrity, the upset, emergency, and faulted operating condition category design limits given in NB-3200, "Design by Analysis," and NB-3600, "Piping Design," of Section III of the ASME Code should be applied to design vessels and piping for the combination of loadings delineated in regulatory positions 1.a., 1.b., and 1.c., respectively.

Non-Active ASME Code Class 1 Pumps and Valves (Designed by Analysis)

As permitted by Section III of the ASME Code within the limitations of NB-3400 and NB-3211, Code Class 1 pumps may be designed by analysis (i.e., the design procedures specified in NB-3200 of Section III). Case 1552 (Interpretations of ASME Boiler and Pressure Vessel Code) allows design by analysis of Code Class 1 valves if additional requirements are met. Non-active pumps and valves are those pumps and valves that are not required to perform a mechanical motion during the course of accomplishing a system safety function. Since non-active pumps and valves need only be assured of pressure-retaining integrity, the upset, emergency, and faulted operating condition category design limits of NB-3200 should be designated for the combination of loadings delineated in regulatory positions 2.a., 2.b., and 2.c., respectively.

Non-Active ASME Code Class 1 Valves (Designed by Standard or Alternative Design Rules).

Standard or alternative design rules for Code Class 1 valves are specified by NB-3512 and NB-3513 of Section III of the ASME Code. These design rules encompass the use of pressure-temperature ratings of valves. The design limits specified in this guide are in terms of P_r which differs from the definition given by Section III in that P_r is related to maximum transient temperature in lieu of the design temperature. P_r is defined in this guide as the primary-pressure rating corresponding to the maximum transient temperature for each plant condition as specified in Tables NB-3531-1 to NB-3531-7 of Section III. Therefore, the maximum transient temperature for each plant condition should be determined before the pressure rating of the valve is selected (e.g., Class 600, 900, or 1500). In order to provide assurance of pressure-retaining integrity, P_r should not be exceeded by more than 10, 20, and 50 percent when the valve is subjected to the combination of loadings delineated in regulatory positions 3.a., 3.b., and 3.c., respectively. One hundred ten percent and 120 percent of P_r, respectively, are analogous to the upset and emergency operating condition category limits of NB-3200 of Section III. One hundred fifty percent of P_r is analogous to the hydrostatic test pressure specified for Code Class 1 valves in Section III.

Active ASME Code Class 1 Pumps and Valves (Designed by Analysis)

The normal operating condition category design limits given by NB-3222 of Section III should be applied to design active pumps and valves for the combination of loadings delineated in regulatory positions 4.a.(1), 4.a.(2), and 4.a.(3). The design limits of NB-3222 are selected because the primary stress intensities associated with those limits are in the elastic range and thus provide greater assurance of operability for pumps and valves (i.e., less probability of unacceptable deformations that would impede or prevent operation) than the design limits for the upset, emergency, and faulted operating condition categories of Section III. Secondary effects (stresses and deformations) in components whose only function is pressure retention are not usually evaluated for the loading combinations delineated in regulatory positions 4.a.(2) and 4.a.(3). However, these effects should be considered for active Class 1 pumps and valves so that unacceptable deformations do not result. Local effects (peak stresses) need not be evaluated for these loading combinations. In addition to compliance with the design limits specified, demonstration of operability as outlined by Note 6 to the regulatory position should also be provided. Note 6 suggests appropriate testing, analysis, or combinations of those measures that should be implemented to demonstrate the operability of active pumps and valves under all design loading combinations. However, Note 6 states that the design limits for non-active pumps and valves designed by analysis may be used if assurance is provided by detailed stress and deformation analyses that operability is not impaired when designed to these limits.

Active ASME Code Class 1 Valves (Designed by Standard or Alternative Design Rules)

To provide greater assurance of operability, the primary pressure rating (P_r) for Code Class 1 active valves designed by standard or alternative rules should not be exceeded when the valve is subjected to the combination of loadings delineated in regulatory positions 5.a.(1), 5.a.(2), and 5.a.(3). This design limit is selected on the same basis as that designated for active pumps and valves that are designed by analysis and is analogous to design limits specified for the normal operating condition category of Section III of the ASME Code. Note 6 to the regulatory position also applies. However, in the case of pressure-related valves, Note 6 states that the primary-pressure ratings (P_r) for non-active valves designed by standard or alternative design rules may be used for the applicable loading combinations if appropriate testing demonstrates that operability is not impaired when the valve is so rated. Since detailed analytical techniques are not used to design pressure-temperature rated valves, demonstration of operability by test is indicated.

ASME Code Class 2 and 3 Components

With one exception, no distinction is made between Code Class 2 and 3 components since the design requirements of Section III of the ASME Code are the same for both classes of components. The design rules for Code Class 2 and 3 components do not provide for design by analysis (except for Code Class 2 vessels designed in accordance with Section VIII, Division 2, of the ASME Code) and do not yet provide any design rules for pumps. Furthermore, no design limits for other than the normal plant condition are available (the one exception to this is piping). Generally, Class 2 and 3 components are of somewhat lower quality as related to material, fabrication, and nondestructive examination requirements than Code Class 1 components. Because of less stringent design requirements and a lower quality level in comparison to Code Class 1 components, the design limits selected for Code Class 2 and 3 non-active components are, on a comparable basis, lower for the combination of loadings associated with the emergency and faulted plant conditions than for Code Class 1 non-active components. The same considerations that apply to Code Class 1 active pumps and valves apply to Code Class 2 and 3 active pumps and valves.

ASME Code Class 2 and 3 Vessels (Designed to Division 1 of Section VIII)

To provide assurance of pressure-retaining integrity for Code Class 2 and 3 vessels, the allowable stress value S should not be exceeded by more than 10 percent for the combination of loadings delineated in regulatory positions 6.a.(1), and 6.a.(2), and S should not be exceeded by more than 50 percent for the combination of loadings specified by regulatory position 6.b. One hundred ten percent of S is analogous to the upset operating condition category design limits specified for Code Class 1 components, while 150 percent of S is comparable to the membrane stress that would occur in a cylindrical or spherical shell during hydrostatic testing. Both limits are within the elastic stress range for ferritic materials. If a more detailed analysis is performed, note 9 to the regulatory position provides limits for primary membrane and primary bending stresses.

ASME Code Class 2 Vessels (Designed to Division 2 of Section VIII)

Section III of the ASME Code allows Code Class 2 vessels to be designed in accordance with the rules of Division 2 to Section VIII of the ASME Code. Division 2 to Section VIII provides rules for design by analysis that are equivalent to those of Section III for Code Class 1 vessels. In addition, the quality level for Division 2 vessels is comparable to that for Code Class 1 vessels of Section III. Therefore, the design limits for the loading combinations delineated in regulatory position 7. should be the same as those for Code Class 1 vessels in regulatory position 1.

ASME Code Class 2 and 3 Piping

NC-3600 of Section III of the ASME Code (and by reference ND-3600) provides design limits for piping under "Upset Conditions" and "Emergency Conditions" which are analogous to the upset and emergency operating condition category design limits specified in NB-3600 for Code Class 1 piping. In utilizing these design limits for assurance of pressure-retaining integrity, the "Upset Condition" limits should not be exceeded for the combination of loadings delineated in regulatory positions 8.a.(1), and 8.a.(2), and the "Emergency Condition" limits should not be exceeded for the combination of loadings specified in regulatory position 8.b. However, only equation 9 of NC-3651 need be met for the loadings designated in regulatory position 8.a.(2) since thermal expansion effects of piping are not usually evaluated for these loadings.

Non-Active ASME Code Class 2 and 3 Pumps

Design limits were selected for Code Class 2 and 3 pumps in the absence of Section III of the ASME Code design rules for these components. These design limits relate to both primary membrane and primary bending stresses and are derived on a basis that is comparable to the design limits for Code Class 1 components designed by analysis. One hundred ten percent of S and 120 percent of S (and the limits for primary membrane plus primary bending) are analogous to the design limits for the upset operating condition category and the emergency operating condition category, respectively, given in NB-3200 of Section III. Therefore, to assure pressure-retaining integrity, the primary membrane stress should not be exceeded by more than 10 percent of S, and the sum of the primary membrane plus primary bending stresses should not be exceeded by more than 65 percent of S for the combination of loadings delineated in regulatory positions 9.a.(1), and 9.a.(2). The primary membrane stress and the sum of the primary membrane plus primary bending stresses should not be exceeded by more than 20 percent and 80 percent of S, respectively, for the combination of loadings delineated in regulatory position 9.b.

Active ASME Code Class 2 and 3 Pumps

For active Code Class 2 and 3 pumps the primary membrane stress should not exceed S, and the sum of the primary membrane plus primary bending stresses should not be exceeded by more than 50 percent of S for the combination of loadings delineated in regulatory positions 10.a.(1), 10.a.(2), and 10.a.(3). These limits are analogous to the normal operating condition category design limits of NB-3200 of Section III of the ASME Code and thus provide increased assurance that unacceptable deformations affecting operability of active Code Class 2 and 3 pumps will not result. In addition to compliance with the design limits specified, demonstration of operability as outlined by Note 11 to the regulatory position should also be provided. Note 11 is identical to Note 6 to the regulatory position except that the design limits for non-active pumps and valves may be used for the applicable loading combinations if appropriate analyses and/or testing confirms that operability will not be impaired when the component is designed to these limits.

Non-Active ASME Code Class 2 and 3 Valves

The design of Code Class 2 and 3 valves encompasses the use of pressure-temperature ratings. The design limits given herein are in terms of P_r which is the primary-pressure rating corresponding to the maximum transient temperature for each plant condition as specified in NC-3511 and ND-3511 for Code Class 2 and 3 valves, respectively. This definition of P_r differs from the Section III of the ASME Code definition of P_r in the same manner as that for Code Class 1 valves and the same considerations apply. To assure pressure-retaining integrity, the limits for P_r are lower than those given for Code Class 1 valves for the same loading combinations involving emergency and faulted plant conditions. P_r should not be exceeded by more than 10 percent for the combination of loadings delineated in regulatory positions 11.a.(1), and 11.a.(2), and P_r should not be exceeded by more than 20 percent for the combination of loadings delineated in regulatory position 11.b.

Active ASME Code Class 2 and 3 Valves

To provide greater assurance of operability for active valves of Code Class 2 and 3, P_r should not be exceeded for the combination of loadings delineated in regulatory positions 12.a.(1), 12.a.(2), and 12.a.(3). Note 11 to the regulatory position applies. However, as allowed by Note 11, if the design limits for non-active valves are used, appropriate testing should demonstrate operability in lieu of analysis since detailed analytical techniques are not applied to design pressure-temperature rated valves.

C. REGULATORY POSITION

Seismic Category I fluid system components should be designed to withstand the following loading combinations within the design limits[1] specified.

1. ASME Code[2] Class 1 vessels and piping:

a. The design limits specified in NB-3223 and NB-3654 of the ASME Code for vessels and piping, respectively, should not be exceeded when the component is subjected to concurrent loadings associated with either the normal plant condition or the upset plant condition[3] and the vibratory motion of 50 percent of the Safe Shutdown Earthquake (SSE).

b. The design limits specified in NB-3224 and NB-3655 of the ASME Code for vessels and piping, respectively, should not be exceeded when the component is subjected to loadings associated with the emergency plant condition.

c. The design limits specified in NB-3225 and NB-3656 of the ASME Code for vessels and piping, respectively, should not be exceeded when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

2. Non-active ASME Code Class 1 pumps and valves[4] that are designed by analysis:

a. The design limits specified in NB-3223[5] of the ASME Code should not be exceeded when the component is subjected to concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE.

b. The design limits specified in NB-3224 of the ASME Code should not be exceeded when the component is subjected to loadings associated with the emergency plant condition.

c. The design limits specified in NB-3225 of the ASME Code should not be exceeded when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

3. Non-active ASME Code Class 1 valves that are designed by standard or alternative design rules:

a. The primary-pressure rating P_r should not be exceeded by more than 10 percent when the component is subjected to concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE.

b. P_r should not be exceeded by more than 20 percent when the component is subjected to the loadings associated with the emergency plant condition.

c. P_r should not be exceeded by more than 50 percent when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

4. Active ASME Code Class 1 pumps and valves[4] that are designed by analysis:

a. The design limits[6] specified in NB-3222[5,7,8] of the ASME Code should not be exceeded when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition, or (3) concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

5. Active ASME Code Class 1 valves that are designed by standard or alternative design rules:

a. The primary-pressure rating P_r[6] should not be exceeded when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition, or (3) concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

6. ASME Code Class 2 and 3 vessels designed to Division 1 of Section VIII of the ASME Code:

a. The allowable stress value S[9] should not be exceeded by more than 10 percent when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition.

b. S should not be exceeded by more than 50 percent when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

7. ASME Code Class 2 vessels designed to Division 2 of Section VIII of the ASME Code:

a. The design limits specified in NB-3223 of the ASME Code should not be exceeded when the component is subjected to concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE.

b. The design limits specified in NB-3224 of the ASME Code should not be exceeded when the component is subjected to loadings associated with the emergency plant condition.

c. The design limits specified in NB-3225 of the ASME Code should not be exceeded when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

8. ASME Code Class 2 and 3 piping:

a. The design limits specified in NC-3611.1(b)(4)(c)(b)(1) of the ASME Code should not be exceeded when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2)[10] loadings associated with the emergency plant condition.

b. The design limits specified in NC-3611.1(b)(4)(c)(b)(2) of the ASME Code should not be exceeded when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

9. Non-active ASME Code Class 2 and 3 pumps:

a. The primary membrane stress should not be exceeded by more than 10 percent of the allowable stress value S, and the sum of the primary membrane and primary bending stresses should not be exceeded by more than 65 percent of S when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition.

b. The primary membrane stress should not be exceeded by more than 20 percent of S, and the sum of the primary membrane and primary bending stresses should not be exceeded by more than 80 percent of S when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

10. Active ASME Code Class 2 and 3 pumps:

a. The primary membrane stress[11] should not exceed the allowable stress value S, and the sum of the primary membrane and the primary bending stresses[11] should not be exceeded by more than 50 percent of S when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition, or (3) concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

11. Non-active ASME Code Class 2 and 3 valves:

a. The primary-pressure rating P_r should not be exceeded by more than 10 percent when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition.

b. P_r should not be exceeded by more than 20 percent when the component is subjected to concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

12. Active ASME Code Class 2 and 3 valves:

a. The primary-pressure rating P_r[11] should not be exceeded when the component is subjected to either (1) concurrent loadings associated with either the normal plant condition or the upset plant condition and the vibratory motion of 50 percent of the SSE, or (2) loadings associated with the emergency plant condition, or (3) concurrent loadings associated with the normal plant condition, the vibratory motion of the SSE, and the dynamic system loadings associated with the faulted plant condition.

DEFINITIONS

Active Pumps and Valves. Components that must perform a mechanical motion during the course of accomplishing a system safety function.

Allowable Stress Value (S). As specified in Appendix I of Section III of the ASME Boiler and Pressure Vessel Code.

Design by analysis for Class 1 Pumps and Class 1 Valves. For Class 1 pumps, the design procedures specified in NB-3200 of the ASME Boiler and Pressure Vessel Code, Section III. For Class 1 valves, the requirements of Case 1552 of Interpretations of ASME Boiler and Pressure Vessel Code.

Dynamic System Loadings Associated with the Faulted Plant Condition. Refers to those dynamic loadings which result from the occurrence of a postulated rupture (e.g., complete severance or equivalent longitudinal break area) of any reactor coolant pressure boundary piping or of any other piping not a part of the reactor coolant pressure boundary.

Emergency Plant Condition. Those operating conditions which have a low probability of occurrence.

Faulted Plant Condition Those operating conditions associated with extremely-low-probability postulated events.

Normal Plant Condition. Those operating conditions in the course of system startup, operation, hot standby, and shutdown other than upset, emergency, or faulted plant conditions.

Plant Conditions. Operating conditions of the plant categorized as normal, upset, emergency, and faulted plant condtions.

Primary-Pressure Rating (P_r). The primary-pressure rating corresponding to the maximum transient temperature for each plant condition, as specified in Section III of the ASME Boiler and Pressure Vessel Code, Tables NB-3531-1 to NB-3531-7, for Code Class 1 valves or as specified in NC-3511 and ND-3511 for Code Class 2 and 3 valves, respectively.

Safe Shutdown Earthquake (SSE). That earthquake which produces the vibratory ground motion for which structures, systems, and components important to safety are designed to remain functional.

Seismic Category I. Those structures, systems, and components that are designed to remain functional if the SSE occurs.

Standard or Alternative Design Rules for Class 1 Valves. As specified in NB-3512 and NB-3513 of the ASME Boiler and Pressure Vessel Code, Section III.

Upset Plant Condition. Those deviations from the normal plant condition which have a high probability of occurrence.

NOTES

[1] Applies to all components (vessels, piping, pumps, and valves) that are relied upon to cope with the effects of specified plant conditions.

[2] Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code including the 1972 Winter Addenda thereto.

[3] Identification of the specific transients or events to be considered under each plant condition will be addressed in a future regulatory guide.

[4] The requirements of the Case 1552 (Interpretations of ASME Boiler and Pressure Vessel Code) should be met for all sizes of Code Class 1 valves designed by analysis.

[5] The provisions of NB-3411 and NB-3413 may be applied for all sizes of Code Class 1 pumps designed by analysis.

[6] In addition to compliance with the design limits specified, assurance of operability under all design loading combinations should be provided by an appropriate combination of the following suggested measures:

a. in situ testing (e.g., preoperational testing after the component is installed in the plant).

b. full-scale prototype testing.

c. reduced-scale prototype testing.

d. detailed stress and deformation analyses (includes experimental stress and deformation analyses).

In the performance of tests or analyses to demonstrate operability, the structural interaction of the entire assembly (e.g., valve-operator assembly and pump-motor assembly) should be considered. If superposition of test results for other than the combined loading condition is proposed, the applicability of such a procedure should be demonstrated. The design limits for non-active pumps and valves designed by analysis may be used for the applicable loading combinations if assurance is provided by detailed stress and deformation analyses that operability is not impaired when designed to these limits. Similarly, the primary-pressure ratings P_r for non-active valves designed by standard or alternative design rules may be used for the applicable loading combinations if appropriate testing demonstrates that operability is not impaired when the valve is so rated.

[7] Secondary effects (stresses and deformations) should be evaluated for the loading combinations designated by regulatory positions 4.a.(2) and 4.a.(3). Local effects (peak stresses) need not be considered for these loading combinations.

[8] Table I-3.0, "Permanent Strain Limiting Factors," of Appendix I of the ASME Boiler and Pressure Vessel Code, Section III, may be used as an aid in determining the relationship between design stress and deformation (see note 2 to Table I-1.2 of Section III of the ASME Code).

[9] Division 1 of Section VIII of the ASME Boiler and Pressure Vessel Code does not provide rules for design by analysis. If a detailed analysis is performed, Division 1 vessels should meet, as a minimum, equations a and b below, which are applicable to regulatory positions 6.a. and 6.b., respectively.

a. $\sigma_m \leqslant 1.1S \geqslant \frac{\sigma_m + \sigma_b}{1.5}$

b. $\sigma_m \leqslant 1.5S \geqslant \frac{\sigma_m + \sigma_b}{1.5}$

where:

σ_m = primary membrane stress;

σ_b = primary bending stress;

S = allowable stress value as specified in Appendix I of Section III of the ASME Boiler and Pressure Vessel Code.

[10] For the loadings designated in regulatory position 8.a.(2), only equation 9 of NC-3651 need be met.

[11] In addition to compliance with the design limits specified, assurance of operability under all design loading combinations should be provided by any appropriate combination of the following suggested measures:

a. in situ testing (e.g., preoperational testing after the component is installed in the plant).

b. full-scale prototype testing.

c. reduced-scale prototype testing.

d. detailed stress and deformation analyses (includes experimental stress and deformation analyses).

In the performance of tests or analyses to demonstrate operability, the structural interaction of the entire assembly (e.g., valve-operator and pump-motor assembly) should be considered. If superposition of test results for other than the combined loading condition is proposed, the applicability of such a procedure should be demonstrated. The design limits for non-active pumps and valves may be used for the applicable loading combinations if appropriate analyses and/or testing confirms that operability is not impaired when designed to these limits.