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U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 3.9.2 DYNAMIC TESTING AND ANALYSIS OF MECHANICAL SYSTEMS AND COMPONENTS

REVIEW RESPONSIBILITIES

Primary - Mechanical Engineering Branch (MEB)

Secondary - Reactor Systems Branch (RSB)

I. AREAS OF REVIEW

MEB reviews the criteria, testing procedures, and dynamic analyses employed to assure the structural and functional integrity of piping systems, mechanical equipment, and reactor internals under vibratory loadings, including those due to fluid flow and postulated seismic events. The staff review covers the following specific areas:

1. Preoperational piping vibrational and dynamic effects testing should be conducted during startup functional testing on all safety-related piping systems designated as Class 1, 2, or 3 under the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III (hereafter "the Code"), and the supports and restraints for these systems. The purpose of these tests is to confirm that these piping systems, restraints, components, and supports have been adequately designed to withstand flow-induced dynamic loadings under operational transient conditions anticipated during service. The test program description should include a list of different flow modes, a list of selected locations for visual inspections and other measurements, the acceptance criteria, and possible corrective actions if excessvie vibration occurs.

2. Seismic qualification testing of safety-related mechanical equipment is required to assure its ability to function during and after a postulated seismic occurrence. At the construction permit (CP) stage, the staff review cover the following specific areas:

   a. The criteria for seismic qualification such as the deciding factors for choosing test or analysis, the considerations defining the input motion, and the steps to demonstrate adequacy of the seismic qualification program.

   b. The methods and procedures used to assure seismic Category I mechanical equipment operability during and after the safe shutdown earthquake (SSE), and to assure structural and functional integrity of the equipment after several occurrences of the operating basis earthquake. Included are mechanical equipment such as fans, pump drives, heat exchanger tube bundles, valve actuators, battery and instrument racks, control consoles, cabinets, panels, and cable trays.

c. The methods and procedures of analysis or testing for the supports for the seismic Category I mechanical equipment listed above, and the procedures used to account for the possible amplification of loads (amplitude and frequency content) under seismic conditions.

At the operating license (OL) stage, the staff reviews the results of tests and analyses to assure the proper implementation of the criteria established in the CP review, and to demonstrate adequate seismic qualification.

3. Dynamic responses of structural components within the reactor vessel caused by operational flow transients should be analyzed for prototype (first of a design) reactors. Generally, this analysis is not required for non-prototypes except that segments of an analysis may be necessary if there are substantial deviations from the prototype internals design. The purpose of this analysis is to predict the vibration behavior of the components, so that the input forcing functions and the level of response can be estimated before conducting the methods of analysis, the specific locations for calculated responses, the considerations in defining the mathematical models, the interpretation of analytical results, the acceptance criteria, and the methods of verifying predictions via tests. If the reactor internal structures are not a prototype design, reference should be made to the results of tests and analyses for the prototype reactor and a brief summary of the results should be given.

4. Flow-induced preoperational vibration testing of reactor internals should be conducted during the startup functional test program. The purpose of this test is to demonstrate that flow-induced vibrations similar to those expected during operation will not cause unanticipated flow-induced vibrations of significant magnitude or structural damage. The test program description should include a list of flow modes, a list of sensor types and locations, a description of test procedures and methods to be used to process and interpret the measured data, a description of the visual inspections to be made, and a comparison of the test results with the analytical predictions. If the reactor internal structures are not a prototype design, reference should be made to the results of tests and analyses for the prototype reactor and a brief summary of the results should be given.

5. Dynamic system analyses should be performed to confirm the structural design adequacy and ability, with no loss of function, of the reactor internals and unbroken loops of the reactor coolant piping to withstand the loads from a loss-of-coolant accident (LOCA) and the SSE. The staff review covers the methods of analysis, the considerations in defining the mathematical models, the descriptions of the forcing functions, the calculational scheme, the acceptance criteria, and the interpretation of analytical results.

6. A discussion should be provided which describes the methods to be used to correlate results from the reactor internals preoperational vibration test with the analytical results from dynamic analyses of the reactor internals under operational flow transients.

In addition, test results from previous plants of similar characteristics may be used to verify the mathematical models used for the faulted condition (LOCA and SSE) by comparing such dynamic characteristics as the natural frequencies. The staff review covers the methods to be used for comparison of test and analytical results and for verification of the analytical models.

Computer programs used in the analyses discussed in this plan are reviewed in accordance with Standard Review Plan 3.9.1.

The RSB verifies that (1) the various flow modes to be used to conduct the preoperational vibration test are representative of the operational transients anticipated for the reactor during its service, and (2) the LOCA forcing functions used to conduct the system dynamic analysis are representative of the most adverse LOCA loadings.

II. ACCEPTANCE CRITERIA

To fulfill in part the design requirements for safety-related structures, systems, and components set forth in General Design Criteria 1, 2, 4, 14, and 15, the acceptance criteria for the areas of MEB review are as follows:

1. Preoperational vibrational and dynamic effects testing should be conducted during startup functional testing for safety-related piping classified as Code Class 1, 2, and 3, and for piping and component supports. The purpose of these tests is to confirm that the piping, components, and supports have been designed to withstand the dynamic loadings from operational transient conditions that will be encountered during service, as required by the Code. An acceptable test program to confirm the adequacy of the designs should consist of the following:
   a. A listing of the different flow modes of operation and transients such as pump trips, valve closures, etc. to which the components will be subjected during the test. (For additional guidance see Reference 8.) For example, the transients associated with the reactor coolant system heatup tests should include, but not necessarily be limited to:
      (1) Reactor coolant pump start.
      (2) Reactor coolant pump trip.
      (3) Operation of pressure-relieving valves.
   b. A list of selected locations in the piping system at which visual inspections and measurements (as needed) will be performed during the tests. For each of these selected locations, the deflection (peak-to-peak) criteria that will be used to show that the stress and fatigue limits are within the design levels should be provided.
   c. If vibration is noted beyond the acceptance levels set by the criteria of (b) above, corrective restraints should be designed, incorporated in the piping system analysis, and installed. If, during the test, piping systems restraints are determined to be inadequate or are damaged, corrective restraints should be installed and another test should be performed to determine that the vibrations have been reduced to an acceptable level.
2. A test program is required to confirm the ability of all seismic Category I mechanical equipment to function as needed during and after an earthquake of magnitude up to and including the SSE.

a. Analysis without testing is acceptable if structural integrity alone can assure the intended function. When a complete seismic test is impracticable, a combination of test and analysis is acceptable.

b. Equipment should be tested in the operational condition. Loadings simulating those of plant normal operation, such as thermal and flow-induced loadings, if any, should be concurrently superimposed upon the seismic loading. Operability should be verified during and after the test.

c. The characteristics of the seismic input motion should be specified by one of the following:

   (1) Response spectrum.

   (2) Power spectral density function.

   (3) Time history.

   Such characteristics, as derived from the structure or system seismic analysis, should be reprentative of the seismic input motion at the equipment mounting locations.

d. The test input motion should be characterized in the same manner as the seismic input motion, and the conservatism in amplitude and frequency content should be demonstrated.

e. Seismic excitations generally have a broad frequency content. Random vibration input motion should be used in the testing. However, single frequency input, such as sine "beats," may be applicable provided one of the following conditions are met:

   (1) The characteristics of the seismic input motion indicate that the motion is dominated by one frequency (e.g., by structural filtering effects).

   (2) The anticipated response of the equipment is adequately represented by one mode.

   (3) The test input motion has sufficient intensity and duration to excite all modes to the required amplitudes, such that the testing response spectra will envelope the corresponding response spectra will envelope the corresponding response spectra of the individual modes.

f. The test input motion should be applied to one vertical axis and one principal horizontal axis (or two orthogonal horizontal axes) simultaneously unless it can be demonstrated that the equipment response in the vertical direction is not sensitive to the vibratory motion in the horizontal direction, and vice versa. The time phasing of the inputs in the vertical and horizontal directions must be such that a purely rectilinear resultant input is avoided. An acceptable alternative is to have vertical and horizontal inputs in-phase, and then repeated with inputs 180 degrees out-of-phase. In addition, the test must be repeated with the equipment rotated 90 degrees horizontally.

g. Dynamic coupling between the equipment and related sytems, if any, such as connected piping and other mechanical components, should be considered.

h. The fixture design should meet the following requirements:

   (1) Simulate the actual service mounting.

   (2) Cause no extraneous dynamic coupling to the test item.

i. The in situ application of vibratory devices to superimpose the seismic vibratory loadings on a complex active device for operability testing is acceptable if it is shown that a meaningful test can be made in this way.

j. The test program may be based upon selectively testing a representative number of mechanical components according to type, load level, size, etc., on a prototype basis.

k. Analyses or tests should be performed for all supports of mechanical equipment to assure their structural capability to withstand seismic excitation. The analytical results must include the following:

   (1) The required input motions to the mounted equipment should be obtained and characterized in the manner as stated in 2.c, above.

   (2) The combined stresses of the support structures should be within the limits of the Code, Subsection NF, "Component Support Structures."

l. Supports should be tested with equipment installed or with an equivalent mass that simulates the equipment dynamic coupling to the support. If the equipment is installed in a nonoperating condition for the support test, the response at the equipment mounting location should be characterized in the manner as stated in 2.c, above. In such a case, the equipment should be tested separately for operability and the actual input to the equipment should be more conservative in amplitude and frequency content than the monitored response.

m. The requirements of 2.c, 2.d, 2.e, 2.f, and 2.h, above, are applicable when tests are conducted on equipment supports.

3. The following guidelines, in addition to Reference 7, apply to the analytical solutions to predict vibrations of reactor internals for prototype plants. Generally, this analysis is required only for prototype designs.

   a. The results of vibration calculations for a prototype reactor should consist of the following:

      (1) Dynamic responses to operating transients at critical locations of the internal structures should be determined and, in particular, at the locations where vibration sensors will be mounted on the reactor internals. For each location, the maximum response, the modal contribution to the total response, and the response causing the maximum stress amplitude should be calculated.

      (2) The dynamic properties of internal structures, including the natural frequencies, the dominant mode shapes, and the damping factors should be characterized. If analyses are performed on a component structural element basis, the existence of dynamic coupling among component structure elements should be investigated.

      (3) The response characteristics, such as the dependence on hydrodynamic excitation forces, the flow path configuration, coolant recirculation pump frequencies, and the natural frequencies of the internal structures, should be identified.

      (4) Acceptance criteria for allowable responses should be established, as should criteria for the location of vibration sensors. Such criteria should be related to the Code allowable stresses, strains, and limits of deflection that are established to preclude loss of function with respect to the reactor core structures and fuel assemblies.

   b. The forcing functions should account for the effects of transient flow conditions and the frequency content. Acceptable methods for formulating forcing functions for vibration prediction include the following:

(1) Analytical method: based on standard hydrodynamic theory, the governing differential equations for vibratory motions should be developed and solutions obtained with appropriate boundary conditions and parameters. This method is acceptable where the geometry along the fluid flow paths is mathematically tractable.

(2) Test-analysis combination method: based on data obtained from plant tests or scaled model tests, (e.g., velocity or pressure distribution data), forcing functions should be formulated which will include the effects of complex flow path configurations and wide variations of pressure distributions.

(3) Response-deduction method: based on a derivation of response characteristics from plant or scaled model test data, forcing functions should be formulated. However, since such functions may not be unique, the computational procedures and the basis for the selection of the representative forcing functions should be described.

c. Acceptable methods of obtaining dynamic responses for vibration predictions are as follows:

(1) Force-response computations are acceptable if the characteristics of the forcing functions are predetermined on a conservative basis and the mathematical model of the reactor internals is appropriately representative of the design.

(2) If the forcing functions are not predetermined, either a special analysis of the response signals measured from reactor internals of similar design may be performed to predict amplitude and modal contributions, or parameter studies useful for extrapolating the results from tests of internals or components of similar designs based on composite statistics may be used.

d. Vibration predictions should be verified by test results. If the test results differ substantially from the predicted response behavior, the vibration analysis should be appropriately modified to improve the agreement with test results and to validate the analytical method as appropriate for predicting responses of the prototype unit, as well as of other units where confirmatory tests are to be conducted.

4. The preoperational vibration test program for the internals of a prototype (first of a design) reactor should conform to the requirements for a prototype test, as specified in Reference 7, including vibration prediction, vibration monitoring, data reduction, and surface inspection. The test program should include, but not necessarily be limited to the following:

a. The vibration testing should be conducted with the fuel elements in the core or with dummy elements which provide equivalent dynamic effects and flow characteristics. Testing without fuel elements in the core may be acceptable if it can be demonstrated that testing in this mode is conservative.

b. A brief description of the vibration monitoring instrumentation should be provided, including instrument types and diagrams of locations, which should include the locations having the most severe vibratory motions or having the most effect on safety functions.

c. The planned duration of the test for the normal operation modes to assure that all critical components are subjected to at least 10^7 cycles of vibration should be provided. For instance, if the lowest response frequency of the core internal structures is 10 Hz, a total test duration of 12 days or more will be acceptable.

d. Testing should include all of the different flow modes of normal operation and upset transients.

e. The methods and procedures to be used to process the test data to obtain a meaningful interpretation of the core structure vibration behavior should be provided. Vibration interpretation should include the amplitude, frequency content, stress state, and the possible effects on safety functions.

f. Vibration predictions, test acceptance criteria and bases, and permissible deviations from the criteria should be provided before the test.

g. Visual and nondestructive surface inspections should be performed after the completion of the vibration tests. The inspection program description should include the areas subject to inspection, the methods of inspection, the design access provisions to the reactor internals, and the equipment to be used for performing such inspections. These inspections should be conducted preferably following the removal of the internals from the reactor vessel. Where removal is not feasible, the inspectons should be performed by means of equipment appropriate for in situ inspection. The areas inspected should include all load-bearing interfaces, core restraint devices, high stress locations, and locations critical to safety functions.

For internals of subsequent reactors that have the same design, size, configuration, and operating conditions as the prototype reactor internals, the preoperational vibration test program should conform to the requirements of a confirmatory test, as specified in Reference 7, which provides an option to choose either monitoring the vibration or conducting a visual inspection after testing.

5. Dynamic system analyses should be performed to confirm the structural design adequacy of the reactor internals and the reactor coolant piping (unbroken loops) to withstand the dynamic loadings of the most severe LOCA and the SSE. Where a substantial separation between the frequencies of the LOCA (or SSE) loading and the natural frequencies of the internal structures can be demonstrated, the analysis may treat the loadings separately.

The most severe dynamic effects from LOCA loadings are generally found to result from a postulated double-ended rupture of a primary coolant loop near a reactor vessel inlet or outlet nozzle with the reactor in the most critical normal operating mode.

Mathematical models used for dynamic system analysis for LOCA and SSE effects should include the following:

a. Modeling should include reactor internals and dynamically related piping, pipe supports, and components. Typical diagrams and the basis of modeling should be developed and described.

b. Mathematical models should be representative of system characteristics, such as the flexibility, mass inertia effect, geometric configuration, and damping (including possible coexistence of viscous and Coulomb damping).

c. Any system partitioning and directional decoupling employed in the dynamic system modeling should be justified.

d. The effects of flow upon the mass and flexibility properties of the system should be discussed.

Typical diagrams and the basis for postulating the LOCA-induced forcing function should be provided, including a description of the governing hydrodynamic equations and the assumptions used for mathematically tractable flow path geometries, tests for determining flow coefficients, and any semiempirical formulations and scaled model flow testing for determining pressure differentials or velocity distributions.

The methods and procedures used for dynamic system analyses should be described, including the governing equations of motion and the computational scheme used to derive results. Time domain forced-response computation is acceptable for both LOCA and SSE analyses. The response spectrum modal analysis method may be used for SSE analysis.

The stability of elements in compression, such as the core barrel and the control rod guide tubes under outlet pipe rupture loadings should be investigated.

Either response spectra or time histories may be used for specifying seismic input motions of the SSE at the reactor core supports.

The criteria for acceptance of the analytical results are as follows:

a. Deformations should not exceed the allowable limits to assure shutdown functions and adequate passage of core cooling water.

b. Stresses should not exceed the allowable limits of the Code, Subsection NG, "Core Support Structures." The applicable stress limits used should be consistent with those permitted for system components in the analytical stress analyses.

c. The loading combinations should be based on the loads of the faulted condition.

6. Regarding the correlation to be made of tests and analyses of reactor internals, a discussion covering the following items should be provided:

a. Comparison of the measured response frequencies with the analytically obtained natural frequencies of the reactor internals for possible verification of the mathematical model used in the analysis.

b. Comparison of the analytically obtained mode shapes with the shape of measured motion for possible identification of the modal combin... on or verification of a specific mode.

c. Comparison of the response amplitude time variation and the frequency content obtained from test and analysis for possible verification of the postulated forcing function.

d. Comparison of the maximum responses obtained from test and analysis for possible verification of stress levels.

e. Comparison of the mathematical model used for dynamic system analysis under operational flow transients and under the LOCA or SSE loadings, to note similarities.

III. REVIEW PROCEDURES

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

General Design Criteria 1, 2, 4, 14, and 15 state that all structures, system and components important to safety should be designed and tested to assure that safety functions can be performed in the event of operational transients, earthquakes, and LOCA loadings.

Under these guidelines, the staff reviews the treatment of dynamic responses of safety-related piping systems and reactor internal structures by the following procedures:

1. During the CP stage, the staff obtains a commitment from the applicant to conduct a preoperational piping vibrational and dynamic effects test program in accordance with II.1, above.

   During the OL stage, the staff reviews the program and verifies that the acceptance criteria have been met.

2. At the CP stage, the staff reviews the program which the applicant has described in the preliminary safety analysis report (PSAR) for the seismic qualification of all seismic Category I mechanical equipment. The program is measured against the requirements listed in the acceptance criteria section of this review plan. Of particular interest are the proper use of test and analytical procedures. Equipment which is too complex for reliable mathematical modeling should be tested unless the analytical procedures and corresponding design are convincingly conservative. Both the test and the analysis methods are reviewed for assurance that all important modes of response have been excited in tests or considered in analyses. Proper application of test input motions so as to envelop the required input, whether in terms of response spectra, power spectral density, or time history, and in all necessary directions, is verified. The use or treatment of supports is also reviewed.

   At the OL stage, the staff reviews the program again as described by the applicant in the final safety analysis report (FSAR). In addition, the FSAR is reviewed for documentation of successful implementation of the seismic qualification program, including test and analysis results. Also, the acceleration levels used in the tests and in the analyses are reviewed for assurance that they equal or exceed the acceleration at the equipment mounting locations derived from structural response studies of the plant structure as built or as designed.

3. At the CP stage, the applicant should commit to performing an analysis of the vibration of the reactor internal structures if they are designated as a prototype design. A brief description of the methods and procedures to be used for the analysis should be provided.

   At the OL stage, a detailed dynamic analysis should be provided for a prototype design, to be used for vibration prediction prior to the performance of preoperational vibration tests. Acceptance of the analysis is based on the technical soundness of the analytical methods and procedures used and the degree of conformance to the acceptance criteria listed above. In addition, the analysis is verified by correlation with the test results when these are available.

For both CP and OL stages, if the reactor internal structures are not a prototype design, then reference should be made to the reactor which is prototypical of the reactor being reviewed. A brief summary of test and analysis results for the prototype should be given. Alternatively, the information may be contained in another applicable document, such as a topical report, to which reference should be made.

4. At the CP stage, the staff review of the program for preoperational vibration testing of reactor internals for flow-induced vibrations includes the following matters:
   a. The applicant should clarify his intention to perform either a prototype test or a confirmatory test.
   b. If the plant is designated as a prototype, a brief description of the preoperational vibration test program should be provided. The staff review will be based on the conformance of this program to the requirements as listed in II.4, above.
   c. If the plant is not a prototype, the applicant should identify the existing plant of similar design that is the prototype plant. The staff reviews the validity of the designated prototype, including any design difference of reactor internal structures from the prototype plant to verify that any design modifications do not substantially alter the behavior of the flow transients and the response of the reactor internals. Additional detailed analysis, scaled model tests, or installation of some instrumentation during the confirmatory test may be required in order to complete the review. In addition, the applicant should commit to performing the prototype test if adequate test results are not obtained on a timely basis for the designated prototype.

   At the OL stage, the staff review includes the following procedures:
   a. A detailed preoperational vibration test program and the tentative schedule to perform the test are reviewed. If elements of the program differ substantially from the guidelines specified in Reference 7, discussion of the need and justification for the differences should be given.
   b. For a prototype plant, the review covers the acceptability of vibration prediction, the visual surface inspection procedures, the details of instrumentation for vibration monitoring, the methods and procedures to process the test results, and possible supplementary tests, such as component vibration tests, flow tests, and scaled model tests.
   c. For a non-prototype plant, the staff verifies the applicability of the designated prototype, including the design similarity of the reactor internal structures to the prototype. Additional detailed analysis, scaled model tests, or vibration monitoring in the confirmatory tests may be needed in order to complete the review.

5. In the CP stage review of the dynamic analysis of the reactor internals and unbroken loops of the reactor coolant piping under faulted condition loadings, the applicant commits to perform this analysis or identifies the applicable document, generally in form of a topical report, containing the required information. A brief description of the scope and methods of analysis should be provided.

In the OL review, the staff reviews the detailed information to confirm that an adequate analysis has been made of the capability of reactor internal structures and unbroken loops to withstand dynamic loads from the most severe LOCA and the safe shutdown earthquake. The staff review covers the analytical methods and procedures, the basis of the forcing functions, the mathematical models to represent the dynamic system, and the stability investigations for the core barrel and essential compressive elements. Acceptance of the analysis is based on (1) the technical soundness of the analytical methods used, (2) the degree of conformance to the acceptance criteria listed above, and (3) verification that stresses under the combined loads are within allowable limits of the applicable code and deformations are within the limits set to assure the ability of reactor internal structures and piping to perform needed safety functions.

6. MEB reviews the program which the applicant has committed to implement as part of the preoperational test procedure, principally to correlate the test measurements with the anaytically predicted flow-induced dynamic response of the reactor internals. MEB reviews the applicant's statements in this areas to assure that there is a commitment to submit a report on a timely basis. The report should summarize the analyses and test results so that MEB can review the compatibility of the results from tests and analyses, the consistency between mathematical models used for different loadings, and the validity of the interpretation of the test and analysis results.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the review supports conclusions of the following type, to be included in the staff's safety evaluation report:

"The preoperational vibration test program which will be conducted during startup and initial operation on all safety-related piping systems, restraints, components, and component supports classified as ASME Class 1, 2, and 3 is an acceptable program. The tests provide adequate assurance that the piping and piping restraints of the system have been designed to withstand vibrational dynamic effects due to valve closures, pump trips, and other operating modes associated with the design basis operational transients. The planned tests will develop loads similar to those experienced during reactor operation. Compliance with this test program constitutes an acceptable basis for fulfilling, in part, the requirements of General Design Criterion 15.

"The capability of safety-related mechanical equipment to perform necessary protective actions in the event of a safe shutdown earthquake (SSE) is essential for plant safety. The qualification testing program which will be implemented for seismic Category I mechanical equipment provides adequate assurance that such equipment will function properly under the loads from vibratory forces imposed by the safe shutdown earthquake and under the conditions of post-earthquake operation. This program constitutes an acceptable basis for satisfying, in part, the requirements of General Design Criterion 2.

"The preoperational vibration program planned for the reactor internals provides an acceptable basis for verifying the design adequacy of these internals under test loading conditions comparable to those that will be experienced during operation. The combination of tests, predictive analysis, and post-test inspection provide adequate assurance that the reactor internals will, during their service lifetime, withstand the flow-induced vibrations of reactor operation without loss of structural integrity. The integrity of the reactor internals in service is essential to assure the proper positioning of reactor fuel assemblies and unimpaired operation of the control rod assemblies to permit safe reactor operation and shutdown. The conduct of the preoperational vibration tests is in conformance with the provisions of Regulatory Guide 1.20 and constitutes an acceptable basis for demonstrating design adequacy of the reactor internals, and satisfies the applicable requirements of General Design Criteria 1 and 4.

"The dynamic system analysis to be performed provides an acceptable basis for confirming the structural design adequacy of the reactor internals and unbroken piping loops to withstand the combined dynamic loads of postulated loss-of-coolant accidents (LOCA) and the safe shutdown earthquake (SSE) and the combined loads of a postulated main steam line rupture and SSE (for a BWR). The analysis provides adequate assurance that the combined stresses and strains in the components of the reactor coolant system and reactor internals will not exceed the allowable design stress and strain limits for the materials of construction, and that the resulting deflections or displacements at any structural elements of the reactor internals will not distort the reactor internals geometry to the extent that core cooling may be impaired. The methods used for component analysis have been found to be compatible with those used for the systems analysis. The proposed combinations of component and system analyses are, therefore, acceptable. The assurance of structural integrity of the reactor internals under LOCA conditions for the most adverse postulated loading event provides added confidence that the design will withstand a spectrum of lesser pipe breaks and seismic loading events. Accomplishment of the dynamic system analysis constitutes an acceptable basis for satisfying the applicable requirements of General Design Criteria 2 and 4."

For the FSAR, the review should provide justification for a finding similar to that stated above with the phrase "will be implemented" modified to read "has been implemented."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."

2. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

4. 10 CFR Part 50, Appendix A, General Design Criterion 14, "Reactor Coolant Pressure Boundary."

5. 10 CFR Part 50, Appendix A, General Design Criterion 15, "Reactor Coolant System Design."

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

7. Regulatory Guide 1.20, "Vibration Measurements on Reactor Internals."

8. Regulatory Guide 1.68, "Preoperational and Initial Startup Test Programs for Water-Cooled Power Reactors."

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SRP 3.9.5