U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.6.3 LEAK-BEFORE-BREAK EVALUATION PROCEDURES

REVIEW RESPONSIBILITIES

Primary - Organization responsible for review of material engineering issues related to flaw evaluation and welding

Secondary - None

I. AREAS OF REVIEW

10 CFR 50, Appendix A, General Design Criterion (GDC) 4 allows the use of analyses reviewed and approved by the Commission to eliminate from the design basis the dynamic effects of the pipe ruptures postulated in Standard Review Plan (SRP) Section 3.6.2. The staff reviews and approves the plant-specific piping system submitted from licensees and applicants to eliminate these dynamic effects. A staff approved leak-before-break (LBB) analysis permits licensees to remove protective hardware such as pipe whip restraints and jet impingement barriers, redesign pipe connected components, their supports and their internals, and other related changes in operating plants. Likewise, requirements for plants under construction or being designed are similarly relaxed. The staff's review ensures that adequate consideration has been given to direct and indirect pipe failure mechanisms and other degradation sources which could challenge the integrity of piping. The staff reviews the direct pipe failure mechanisms and fracture mechanics analyses.

The specific areas of review are as follows:

1. An evaluation over the entire life of the plant of the following for the plant piping system:

   a. Water hammer
   b. Creep Damage
   c. Erosion
   d. Corrosion
   e. Fatigue
   f. Environmental Conditions

2. A deterministic fracture mechanics and leak rate evaluation.

   The staff reviews the factors which contribute to the initial quality of the piping and the provisions adopted to maintain this quality. In addition, leak detection methods for the reactor coolant are examined to ensure that adequate detection margins exist for the postulated through wall flaw used in the deterministic fracture mechanics evaluation.

   The staff also evaluates indirect failure mechanisms, as defined in the plant Safety Analyses Report (SAR), which could lead to pipe rupture. These include seismic events and system overpressurizations due to accidents resulting from human error, fires, or flooding which cause electrical and mechanical control systems to malfunction. Missiles from equipment, damage from moving equipment and failures of structures, systems or components in close proximity to the piping are evaluated as well. The results of prior analyses conducted to show compliance with Commission regulations can be applicable to potential sources of indirect pipe rupture.

3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

4. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

   For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. The organization responsible for mechanical engineering Review of the stress analyses of the piping that are considered for LBB in accordance with the requirements of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) is performed under SRP Section 3.9.3.

2. The organization responsible for balance of plant Review of the capability, reliability and sensitivity of the reactor coolant pressure boundary leakage detection systems inside the containment in accordance with Regulatory Guide (RG) 1.45 is performed under SRP Section 5.2.5.

The specific acceptance criteria and review procedures are contained in the reference SRP sections

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 4 as it relates to the exclusion of dynamic effects of the pipe ruptures that are postulated in SRP Section 3.6.2. The design basis for the piping means those conditions specified in the SAR, as amended, and which may include regulations in 10 CFR Part 50, applicable sections of the SRP, Regulatory Guides, and industry standards such as the ASME Code.

2. LBB should only be applied to high energy, ASME Code Class 1 or 2 piping or the equivalent. Applications to other high energy piping will be considered based on an evaluation of the proposed design and inservice inspection requirements as compared to ASME Code Class 1 and 2 requirements.

3. Approval of the elimination of dynamic effects from postulated pipe ruptures is obtained individually for particular piping systems at specific nuclear power units. LBB is applicable only to an entire piping system or analyzable portion thereof. LBB cannot be applied to individual welded joints or other discrete locations. Analyzable portions are typically segments located between piping anchor points. When LBB technology is applied, all potential pipe rupture locations are examined. The examination is not limited to those postulated pipe rupture locations determined from SRP Section 3.6.2.

4. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

5. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Compliance with GDC 4 requires that components important to safety be designed to accommodate the effects of, and be compatible with, environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. Safety-related components should be protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids that may result from equipment failure or events and conditions outside the nuclear power unit.

   Meeting the requirements of GDC 4 provides assurance that SSCs important to safety will be protected from the dynamic effects of pipe rupture and capable of performing their intended safety function.

2. LBB analyses should demonstrate that the probability of pipe rupture is extremely low under conditions consistent with the design basis for the piping. A deterministic evaluation of the piping system that demonstrates sufficient margins against failure, including verified design and fabrication and an adequate inservice inspection program, can be assumed to satisfy the extremely low probability criterion.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 4 states that dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. The staff approved LBB analyses allows licensees to remove existing pipe whip restraints and structures which are installed to protect safety systems from pipe jet impingement. Also, the approved analyses allows applicants the options of not installing pipe whip restraints and jet impingement structures.

2. Specific guidance regarding the piping systems that are qualified to be considered for the LBB application, fracture mechanics analyses of postulated pipe cracks, and leak detection system capability are provided to ensure that the probability of pipe rupture is extremely low. Meeting the requirements of GDC 4 provides assurance that LBB analyses approved by the staff will provide extremely low probability of piping rupture.

III. REVIEW PROCEDURES

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

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The reviewer should verify the applicant's or licensee's LBB analysis with the following factors necessary for an acceptable LBB submittal.

1. The reviewer should verify that the licensee's or applicant's LBB evaluation uses design basis loads and is based on the as-built piping configuration, as opposed to the design configuration. Correct location of supports and their characteristics (such as gaps) are verified, as are the weights and locations of components such as valves. Particular attention is given to the reliability of snubbers whose failure could invalidate the stresses used in the fracture mechanics evaluations.

   Compliance with the technical specifications can be used to demonstrate that snubber failure rates are maintained at a low level.

2. The reviewer should evaluate the potential for degradation by erosion, erosion/corrosion, and erosion/cavitation due to unfavorable flow conditions and water chemistry. Industry experience for specific piping systems plays an important role in the evaluation of these degradation mechanisms. Additionally, an evaluation of wall thinning of elbows and other fittings is undertaken to ensure that ASME Code minimum wall requirements are met. These evaluations must demonstrate that these mechanisms are not potential sources of pipe rupture.

3. The review should evaluate the material susceptibility to corrosion, the potential for high residual stresses, and environmental conditions that could lead to degradation by stress corrosion cracking. Primary water stress corrosion cracking (PWSCC) is considered to be an active degradation mechanism in Alloy 600/82/182 materials in pressurized water reactor plants. Alloy 690/52/152 material is not currently considered susceptible to PWSCC for the purposes of LBB application. Industry experience for specific piping systems plays an important role in the evaluation of this degradation mechanism. It is recommended that Alloy 82/182 materials not be used in advanced pressurized water reactor plants and that, if an applicant wishes to use Alloy 82/182, that the applicant address the methods that will be used to mitigate PWSCC. These evaluations must demonstrate that PWSCC is not a potential source of pipe rupture.

4. The reviewer should evaluate the adequacy of the leakage detection systems associated with the reactor coolant system. Determination of leakage from a piping system under pressure involves uncertainties and, therefore, margins are needed. Sources of uncertainties include plugging of the leakage crack with particulate material over time, leakage prediction, measurement techniques, personnel, and frequency of inspections. Leakage detection systems are evaluated to determine whether they are sufficiently reliable, redundant, and sensitive so that a margin on the detection of unidentified leakage exists for through-wall flaws to support the deterministic fracture mechanics evaluation. The specifications for plant-specific leakage detection systems inside the containment should be equivalent to those in RG 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems." Application of LBB to piping systems outside containment would require that the applicant demonstrate that leakage detection

system are available that provide equivalent reliability, redundancy, and sensitivity to systems. RG 1.45 provides guidance on the capability of the leakage detection systems. Leak detection methods that have been shown to be acceptable include local leak detection, for example, visual observation or through leak detection instrumentation.

Unless a detailed justification that accounts for the effects of these sources of uncertainties in the leakage measurement can be presented, a margin of 10 on the predicted leakage rate will be required for determining the leakage size flaw.

5. The reviewer should verify that the potential for water hammer in the candidate piping systems is very low. Water hammer is a generic term, which includes various unanticipated high frequency hydrodynamic events such as steam hammer and water slugging. To demonstrate that water hammer is not a significant contributor to pipe rupture, reliance on historical frequencies of water hammer events in specific piping systems coupled with reviews of operating procedures and conditions may be used for this evaluation. Alternatively, design changes such as the use of J-tubes, vacuum breakers, and jockey pumps coupled with improved operating procedures can be used to reduce concerns from water hammer. The reviewer should establish that any measures needed to abate water hammer frequency and magnitude will be effective for the life of the plant.

6. The reviewer should verify that the candidate piping is not susceptible to creep and creep-fatigue. Operation below 700°F in ferritic steel piping and below 800°F in austenitic steel piping can alleviate concerns of creep.

7. The reviewer should evaluate the corrosion resistance of piping, which can be demonstrated by the frequency and degree of corrosion in the specific piping systems. Modifications to operating conditions (e.g., controlling water chemistry) or design changes (e.g., replacing piping material) are measures that can be taken to improve corrosion resistance in piping. The reviewer should recognize that remedial residual stress improvement treatments are effective in reducing susceptibility to stress corrosion cracking. Other regulatory guidance on LBB specifies that two mitigation methods are needed to address materials susceptible to an active stress corrosion cracking degradation mechanism. The reviewer would review such evaluations on a case-by-case basis. For example, in boiling water reactors (BWR) hydrogen water chemistry may be proposed as an additive measure with remedial stress improvement treatments. The licensees' or applicants' practices with regard to BWR water chemistry would be an additional factor considered in the review. Non-conforming piping with planar flaws in excess of the standards in the ASME Code, Section XI, Tables IWB-3514-1 and -2, would not be permitted to be qualified for LBB approval. However, non-conforming piping that has been treated by two mitigating methods may qualify for LBB if the piping contains no flaws larger than those permitted by the ASME Code Section XI. The NRC is re-evaluating the position on mitigation measures and plans to revise SRP 3.6.3, as necessary, when the evaluation is completed.

8. The reviewer should assess the potential for indirect sources of pipe ruptures to ensure that indirect failure mechanisms defined in the plant SAR are negligible causes of pipe rupture. Compliance with the snubber surveillance requirements of the technical specifications ensures that snubber failure rates are acceptably low.

9. The reviewer should determine that the piping material will not become susceptible to brittle cleavage-type failures over the full range of system operating temperatures (that is, the material is on the upper shelf of the Charpy Impact energy versus test temperature curve).

10. The reviewer should determine that the candidate piping does not have a history of fatigue cracking or failure. An evaluation to ensure that the potential for pipe rupture due to thermal and mechanical induced fatigue is unlikely should be performed. Licensees and applicants must demonstrate that (a) adequate mixing of high and low temperature fluids occurs in the piping so that there is no potential for cyclic thermal stresses, and (b) there is no potential for vibration-induced fatigue cracking or failure.

11. The following steps constitute an acceptable deterministic LBB evaluation procedure:

    A. <u>Material Specifications</u>

       i. Identify the types of materials and materials specifications used for base metal, weldments, nozzles, and safe ends. Provide the materials properties including toughness and tensile data, long-term effects such as thermal aging.

       ii The piping materials toughness (J-R curves) and tensile (stress-strain curves) properties from the actual material heats should be determined at temperatures near the upper range of normal plant operation.

    B. <u>Materials Properties and Testing</u>

       i. The specimens used to generate the J-R curves should be large enough to provide crack extensions up to an amount consistent with J/T condition determined by the applicant's or licensee's analysis. Because practical specimen size limitations exist, the ability to obtain the desired amount of experimental crack extension may be restricted. In this case, extrapolation techniques may be used as described in NUREG-1061, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks," Volume 3, or in NUREG/CR-4575, Papaspyropoulos, V., and others, "Predictions of J-R Curves with Large Crack Growth from Small Specimen Data," September 1986.

       ii. The stress-strain curves should be obtained over the range from the proportional limit to maximum load.

       iii. Preferably, the materials tests should be conducted using archival material for the pipe being evaluated. If archival material is not available, plant-specific or industry-wide generic material data bases can be assembled and used to define the required material tensile and toughness properties. Test material should include base and weld metals.

       iv. To provide an acceptable level of reliability, plant-specific generic data bases must show reasonable lower bounds for compatible sets of material tensile and toughness properties associated with materials at the plant. To ensure that the plant-specific generic data base is adequate, a determination must be made to demonstrate that the generic data base represents the range of plant materials to be evaluated. This determination is based on a comparison of the plant material properties identified in (subparagraph 11.1.b.) above with those of the materials used to develop the generic data base. The number of material heats and weld procedures tested must be adequate to cover the strength and toughness range of the actual plant materials. Reasonable lower bound tensile and toughness properties from the plant-specific generic data base are to be used for the stability analysis of individual materials, unless otherwise justified.

Industry generic data bases must provide a reasonable lower bound for the population of material tensile and toughness properties associated with any individual specification (e.g., A106, Grade B), material type (e.g., austenitic steel) or welding procedures.

If the data are being developed from an archival heat of material, three stress-strain curves and three J-resistance curves from that one heat of material is sufficient. The tests should be conducted at temperatures near the upper range of normal plant operation. Tests should also be conducted at a lower temperature, which may represent a plant condition (e.g., hot standby) where pipe break would present safety concerns similar to normal operation. These tests are intended only to determine if there is any significant dependence of toughness on temperature over the temperature range of interest. The lower toughness should be used in the fracture mechanics evaluation. One J-R curve and one stress-strain curve for one base metal and weld metal are considered adequate to determine temperature dependence.

(C) Analysis

(i) Demonstrate the accuracy of both the fracture mechanics and the leak rate computational methods by comparison with other acceptable computational procedures or with experimental data.

(ii) Specify the type and magnitude of the loads applied to the piping system (forces, bending and torsional moments), their sources (thermal, deadweight, seismic, and seismic anchor movement), and method of combination. For each pipe size in the piping system, identify the location(s) that have the least favorable combination of stress and material properties for base metal, weldments, nozzles, and safe ends.

(iii) Postulate a throughwall flaw at the location(s) specified in subparagraph 11.(C)(ii) above. The size of the flaw should be large enough so that leakage from the flaw during normal operation would be 10 times greater than the minimum leakage the detection system is capable of sensing. If auxiliary leak detection systems are relied on, they should be described. For the estimation of leakage, the normal operating loads (i.e., deadweight, thermal expansion, and pressure) are to be combined based on the algebraic sum of individual values and applied to the leakage flaw size.

(iv) Using fracture mechanics stability analysis or limit load analysis based on subparagraph 11(C)(vi) below, determine the critical crack size for the postulated throughwall crack using loads from the normal plus safe shutdown earthquake (SSE). Determine the crack size margin by comparing the selected leakage crack size to the critical crack size. Demonstrate that there is a margin of 2 between the leakage crack size and critical crack size. The same load combination method selected in subparagraph 11(C)(v) below must be used to determine the critical crack size.

(v) Calculate the margin on the flaw size in terms of applied loads by a crack stability analysis. Demonstrate that the size of leaking cracks will not become unstable if 1.4 times the normal plus Safe Shutdown Earthquake (SSE) loads are applied. Demonstrate that the crack growth is stable and the final crack size is limited such that a double-ended pipe break will not occur. The 1.4 margin should be reduced to 1.0 if the deadweight, thermal expansion, pressure, SSE (inertial), and seismic anchor motion (SAM) loads are combined based on individual absolute values as follows:

$$F_{Combined} = | F_{Deadweight} | + | F_{thermal} | + | F_{Pressure} | + | F_{SSE} | + | F_{SAM} |$$

$$(M_i)_{Combined} = | (M_i)_{Deadweight} | + | (M_i)_{thermal} | + | (M_i)_{Pressure} | + | (M_i)_{SSE} | + | (M_i)_{SAM} |$$

$$(M)_{Combined} = \sqrt{(M_1)^2_{Combined} + (M_2)^2_{Combined} + (M_3)^2_{Combined}}$$

where F denotes the axial force, M_i denotes the i-th component of moment (i = 1, 2, 3), M denotes the total moment, and the subscripts denote the loads. An evaluation of seismic anchor motion loads at SSE conditions may be omitted when these are shown to be small at operating basis earthquake (OBE) conditions.

(vi) There are certain limitations that currently preclude generic use of limit load analyses to evaluate LBB conditions for eliminating pipe restraints. However, a modified limit-load analysis can be used for austenitic steel piping to demonstrate acceptable margins as indicated below.

A master curve is constructed where a stress index (SI), is plotted as a function of postulated total circumferential throughwall flaw length, L.

SI and L are expressed as

$$SI = S + M P_m, \tag{1}$$

$$L = 2 \theta R, \tag{2}$$

where

$S = 2\sigma_f [2\sin\beta - \sin\theta] / \pi,$ (3)

$\beta = 0.5 [(\pi - \theta) - \pi (P_m / \sigma_f)],$ (4)

θ = half angle in radians of the postulated throughwall circumferential flaw,

R = pipe mean radius (the average of the inner and outer radii),

P_m = the combined membrane stress, including pressure, deadweight, and seismic components,

M = the margin associated with the load combination method (absolute or algebraic sum) selected for the analysis, and

σ_f = flow stress for austenitic steel pipe material categories.

If $\theta + \beta$ from Equations (2) and (4) are greater than π, then

$S = 2\sigma_f [\sin\beta] / \pi,$ (5)

where

$\beta = -\pi (P_m / \sigma_f),$ (6)

When the master curve is constructed using Equations (1), (2), and (3) or (5), the allowable circumferential throughwall flaw length can be determined by entering the master curve at a SI value determined from the loads and austenitic steel piping material of interest. The allowable flaw size determined from the master curve at the appropriate SI value can then be used to determine if the required margins are met. Allowable values of θ are those that result in S being greater than zero from Equations (3) and (5). The flow stress used to construct the master curve, and the definition of SI used to enter the master curve are defined for each material category as follows.

(vii) Base Metal and TIG Welds:

The flow stress used to construct the master curve is expressed as

$\sigma_f = 0.5 (\sigma_y + \sigma_u),$

when the yield strength, σ_y, and the ultimate strength, σ_u, at temperature are known.

If the yield and ultimate strengths at temperature are not known, then ASME Code minimum values at temperature can be used, or alternatively

if (SI) / 17 M < 2.5, then σ_f = 51 ksi, or

If (SI) / 17 M $\geq$ 2.5, then σ_y = 45 ksi.

The value of SI used to plot the master curve for base metal and gas tungsten arc welds is

$$SI = M (P_m + P_b), \qquad (7)$$

where

P_b = the combined primary bending stress, including deadweight and seismic components.

(viii) Shielded Metal Arc (SMAW) and Submerged Arc (SAW) Welds:

The flow stress used to construct the master curve must be 51 ksi. The value of SI used to plot the master curve for SMAW and SAW is

$$SI = M (P_m + P_b + P_e) Z, \qquad (8)$$

where

P_e = combined expansion stress at normal operation,

$$Z = 1.15 [1.0 + 0.013 (OD-4)] \text{ for SMAW}, \qquad (9)$$

$$Z = 1.30 [1.0 + 0.010 (OD-4)] \text{ for SAW}, \qquad (10)$$

OD = pipe outer diameter in inches.

When the allowable flaw length is determined from the master curve at the appropriate SI value, it can be used to determine if the required margins on load and flaw size are met using the following procedure:

For an absolute sum load combination method, margin, M, is set to 1.0. If the allowable flaw length from the master curve is equal to at least twice the leakage size flaw, the margins on load and flaw size are met.

For the algebraic sum method of load combination, set margin M to 1.4 initially. If the allowable flaw length from the master curve is at least equal to the leakage size flaw, then the margin on load is met. Second, let M = 1.0 and if the allowable flaw length from the master curve is at least twice the leakage size flaw, then the margin on flaw size is met.

Additional guidance on the fracture mechanics evaluation can be found in NUREG-1061, Volume 3.

12. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

    For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

    For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section..

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff evaluation concludes on a plant specific and piping system specific basis that the acceptance criteria are satisfied and, therefore, that dynamic effects of pipe rupture may be eliminated from design consideration. When dynamic effects of pipe rupture are eliminated, protective devices such as pipe whip restraints and jet impingement barriers are no longer needed. The staff determination is based on the following:

1. That water hammer, corrosion, creep, fatigue, erosion, environmental conditions, and indirect sources are remote causes of pipe rupture.

2. That a deterministic fracture mechanics evaluation has been completed and approved by the staff.

3. That leak detection systems are sufficiently reliable, redundant, diverse and sensitive, and that margin exists to detect the throughwall flaw used in the deterministic fracture mechanics evaluation.

For DC and COL reviews, the findings will also summarize the staff’s evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

Only dynamic effects of postulated pipe ruptures may be eliminated when LBB technology is shown to be applicable. Requirements for containment design, emergency core cooling system performance, and environmental qualification of electrical and mechanical equipment are not affected. The supplementary information to the final broad scope GDC-4 amendment permits an exception to this statement for equipment qualification under certain conditions.

Applicants for operating licenses seeking to modify design features to take advantage of LBB technology are required to reflect the revised design in an amendment to the pending Final Safety Analysis Report. If the design change modifies design criteria set forth in the Preliminary Safety Analysis Report, an amendment to the applicable construction permit may also be necessary.

After LBB technology results are accepted for specific piping systems at specific 10 CFR Part 50 or 10 CFR Part 52 plants, any proposed future plant modifications in operating conditions or plant features may require an assessment of the impacts on the original conclusions from the initial LBB evaluation.

When LBB is successfully approved, all postulated pipe ruptures are eliminated in the specific piping system under review. Ruptures in branch connections to the piping system under review are still postulated, unless these lines also have been processed to achieve LBB acceptance. An evaluation of dynamic effects at these branch connections is required, as for example, in heavy component support design or redesign.

When dynamic effects of pipe rupture are eliminated from the design basis, current NRC criteria and industry codes, such as the ASME Code, may be required for calculating the seismic loads in the heavy component support redesign of operating plants or plants under construction (for example, when snubbers are reduced in number or capacity in older operating plants; on the other hand, changing high strength fastener material would not require the use of current codes or NRC criteria). In heavy component support redesign, the already existing SSE loads may be used, and improved functional reliability must be demonstrated for any changes implemented. Structural capacity associated with the original steel and concrete, including struts, columns, pedestals, hangers, trusses, and skirts, cannot be diminished in the support system of operating plants or plants under construction. Redesign will be limited to replacing high strength fastener material and reducing the number and capacity of snubbers. Applicants and licensees undertaking heavy component support redesign, with dynamic effects of pipe rupture eliminated, should use in-dependent design and fabrication verification procedures to minimize the potential for design and construction errors. Displacements and rotations resulting from potential failure of redesigned lateral (horizontal) supports should not lead to the rupture of piping connected to the reactor coolant loop heavy components.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Dynamic Effects Design Bases."

2. NUREG-1061, Volume 3, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Potential for Pipe Breaks," November 1984.

3. Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems."

4. EPRI Report NT-4690-SR, "Evaluation of Flaws in Austenitic Steel Piping," April, 1986.

5. 52 Federal Register 41288, " 10 CFR Part 50 Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures." October 27, 1987.

6. NUREG/CR-4575, Papaspyropoulos, V., and Others, " Predictions of J-R Curves with Large Crack Growth from Small Specimen Data," September 1986.

7. Boiler and Pressure Vessel Code. Section III, "Rules for Construction of Nuclear Power Plant Components." American Society of Mechanical Engineers; New York, NY.

8. Boiler and Pressure Vessel Code. Section XI, "Rules of Inservice Inspection of Nuclear Power Plant Components." American Society of Mechanical Engineers; New York, NY.