UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 15, 1990

TO: ALL HOLDERS OF OPERATING LICENSES FOR NUCLEAR POWER PLANTS

SUBJECT: GUIDANCE FOR PERFORMING TEMPORARY NON-CODE REPAIR OF ASME CODE CLASS 1, 2, AND 3 PIPING (GENERIC LETTER 90-05)

INTRODUCTION

Section XI of the ASME Boiler and Pressure Vessel Code (hereafter called the code) specifies code-acceptable repair methods for flaws that exceed code acceptance limits in piping that is in service. A code repair is required to restore the structural integrity of flawed ASME Code piping, independent of the operational mode of the plant when the flaw is detected. Those repairs not in compliance with Section XI of the ASME Code are non-code repairs. However, the required code repair may be impractical for a flaw detected during plant operation unless the facility is shut down. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission will evaluate determinations of impracticality, and may grant relief and may impose alternative requirements. The staff has developed a position on temporary non-code repairs depending on the ASME Code class of the piping. The staff continues to find temporary non-code repairs of code Class 1, 2 and 3 piping unacceptable without specific written relief granted by the NRC. However, this generic letter provides guidance that will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of code Class 3 piping.

Temporary non-code repairs are applicable until the next scheduled outage exceeding 30 days, but no later than the next scheduled refueling outage. This guideline applies when a flaw is detected during plant operation. If a flaw is detected during a scheduled shutdown, a code repair is required before plant restart.

Code Repair Versus Temporary Non-Code Repair

Article IWA-4000 of Section XI of the ASME Code describes the code repair procedures. A code repair requires the removal of the flaw and a subsequent weld repair. The repair weld is subject to post-repair nondestructive examination and a post-repair pressure test may also be required. A code repair is practical during a scheduled shutdown. If a flaw is detected during plant operation, the plant may have to be shut down to perform a code repair. To avoid a plant shutdown and to limit the leakage from a through-wall flaw, some licensees have used temporary non-code repairs such as clamps with rubber gasketing, encapsulation of leaking pipes in cans using liquid sealants, or weld overlays. Temporary non-code repairs are not permitted on ASME Code piping without prior relief from the NRC.

STAFF POSITION

This staff guidance on temporary non-code repairs depends on the ASME Code class of the piping. Safety-related piping for recent plants is classified as code Class 1, 2, and 3, according to Regulatory Guide 1.26. For older plants, safety-related piping is reclassified as code Class 1, 2, and 3 for the purpose of inservice inspection specified in Section XI according to Regulatory Guide 1.26. Piping in the reactor coolant pressure boundary is code Class 1. Typical examples of code Class 2 piping are those in engineered safety feature systems connected to the reactor coolant pressure boundary that are designed for emergency core cooling, residual heat removal, reactor shutdown, and containment heat removal. Typical examples of code Class 3 piping are those in the cooling water, seal water, and auxiliary feedwater systems.

ASME Code Class 1 and 2 Piping

For code Class 1 and 2 piping, a licensee is required to perform code repairs or request NRC to grant relief for temporary non-code repairs on a case-by-case basis regardless of pipe size. Temporary non-code repairs of code Class 1 and 2 piping must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff.

Engineered weld overlays or engineered mechanical clamps are designed to meet the load-bearing requirements of the piping, assuming that the flaw is completely through the wall for 360°, that is, all around the pipe circumference, at the location of the flaw. Engineered weld overlays and engineered mechanical clamps are discussed in Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping."

ASME Code Class 3 Piping

For code Class 3 piping, a licensee is also required to perform code repairs or request NRC to grant relief for temporary non-code repairs on a case-by-case basis regardless of pipe size. Because of the rather frequent instances of small leaks in some Class 3 systems, such as service water systems, the staff is providing guidance in Enclosure 1 that will be considered by the staff in evaluating relief requests for temporary non-code repairs of code Class 3 piping. The guidance for code Class 3 piping in Enclosure 1 consists of assessing the structural integrity of the flawed piping by a flaw evaluation and assessing the overall degradation of the system by an augmented inspection. In addition, licensee evaluation should consider system interactions such as flooding, spraying water on equipment, and loss of flow. Furthermore, temporary non-code repairs should be evaluated for design loading conditions.

Temporary non-code repairs of code Class 3 piping in high energy systems, that is, the maximum operating temperature exceeds 200°F or the maximum operating pressure exceeds 275 psig, must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests for high energy Class 3 piping based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff. For temporary non-code repairs of code Class 3 piping in moderate energy systems, that is, other than high energy systems, the licensee may consider non-welded repairs. Furthermore, the structural integrity of the temporary non-code repair of code Class 3 piping should be assessed periodically.

For code Class 3 piping, two specific flaw evaluation approaches as discussed in Enclosure 1 should be considered, namely, the "through-wall flaw" and the "wall thinning" approaches. If the flaw is found acceptable by the "through-wall flaw" approach, a temporary non-code repair may be proposed. If the flaw is found acceptable by the "wall thinning" approach, immediate repair is not required but the licensee should comply with the guideline for repair and monitoring. An augmented inspection is a part of the relief acceptance criteria. The extent of the augmented inspection is more stringent for high energy lines than for moderate energy lines because of the potential for more severe failure consequences.

CONCLUSIONS

The staff concludes that adherence to the guidance provided in this generic letter will reasonably assure structural integrity and protect public health and safety. The staff has determined that an ASME Code repair is required for code Class 1, 2 and 3 piping unless specific written relief has been granted by the NRC. However, the staff has determined that temporary non-code repair of Class 3 piping that cannot be isolated without a plant shutdown is justified in some instances. The rather frequent instances of small leaks in some Class 3 systems, such as service water systems, could lead to an excessive number of plant start-up and shutdown cycles with undue and unnecessary stress on facility systems and components if the facilites were to perform a code repair when the leakage is identified. For the purpose of this generic letter, impracticality is defined to exist if the flaw detected during plant operation is in a section of Class 3 piping that cannot be isolated for completing a code repair within the time period permitted by the limiting condition for operation (LCO) of the affected system as specified in the plant Technical Specifications, and performance of code repair necessitates a plant shutdown. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission may grant relief for temporary non-code repair of code Class 3 piping, where impracticality exists in performing an ASME Code repair while the facility is operating, based on a staff evaluation considering the guidance in this generic letter.

Backfit Discussion

The objective of this generic letter is to maintain structural integrity of repaired ASME Code piping. The staff is not imposing a new or different position. However, this generic letter provides guidance that will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of code Class 3 piping. Compliance with the staff guidance is not required. Because the implementation of the guidance for Class 3 piping is voluntary, 10 CFR 50.109 does not apply.

This generic letter consists of guidance and does not require a response. Therefore, an OMB clearance number is not necessary.

If you have any questions about this matter, please contact one of the NRC technical contacts listed below.

Sincerely,

James G. Partlow
Associate Director for Projects
Office of Nuclear Reactor Regulation

Enclosures:
1. Staff Guidance in Evaluating Relief Requests for Temporary Non-Code Repair of ASME Code Class 3 Piping
2. Listing of Recently Issued Generic Letters

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STAFF GUIDANCE IN EVALUATING RELIEF REQUESTS FOR TEMPORARY NON-CODE REPAIR OF ASME CODE CLASS 3 PIPING

A. INTRODUCTION

The guidance provided herein will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of ASME Code Class 3 piping. The guidance is restricted in scope and has limitations and specific considerations. The guidance consists of assessing the structural integrity of the flawed piping by a flaw evaluation and assessing the overall degradation of the system by an augmented inspection. For a relief request prepared according to criteria different from those set out in this guidance, the staff will evaluate case-by-case the basis provided by the licensee.

B. SCOPE, LIMITATIONS, AND SPECIFIC CONSIDERATIONS

1. Scope

Only ASME Code Class 3 piping fabricated from ferritic steel or austenitic stainless steel are within the scope of this guidance. However, leakage through a flange gasket is not considered to be a flaw in the piping by Section XI of the ASME Code and is excluded. Furthermore, pumps, valves, heat exchangers, and components other than piping are excluded. For materials other than ferritic steel and austenitic stainless steel, a licensee should justify the material properties used in the flaw evaluation of Section C.3.a below.

2. Limitations

This guideline for temporary non-code repair of code Class 3 piping applies when a flaw, which originates in the inner diameter of the pipe, is detected during plant operation. If a flaw is detected during a scheduled shutdown, a code repair is required before plant restart. A temporary non-code repair is applicable until the next scheduled outage exceeding 30 days, but no later than the next scheduled refueling outage. The temporary non-code repair should then be replaced with a code repair.

3. Specific Considerations

System interactions such as the consequences of flooding and spraying water on equipment should be considered. The potential significance of a loss of flow to the system should also be considered. Furthermore, temporary non-code repairs should be evaluated for design loading conditions, such as deadweight, pressure, thermal expansion, and seismic loads.

The integrity of the temporary non-code repair of code Class 3 piping should be assessed at least every 3 months by a suitable nondestructive examination (NDE) method. This examination should involve the application of ultrasonic testing (UT) or radiographic testing (RT). Furthermore, a qualitative assessment of leakage through the temporary non-code repair should be performed at least every week during plant walkdown inspections to determine any degradation of structural integrity. The licensee should perform an engineering evaluation to assess the rate and extent of the degradation to determine what remedial measures are required. A temporary non-code repair is no longer valid if the structural integrity is not assured.

ASME Code Class 3 piping encompasses both high energy systems, that is, the maximum operating temperature exceeds 200°F or the maximum operating pressure exceeds 275 psig, and moderate energy systems, that is, other than high energy systems. Temporary non-code repairs of code Class 3 piping in high energy systems must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff.

Engineered weld overlays or engineered mechanical clamps are designed to meet the load-bearing requirements of the piping, assuming that the flaw is completely through the wall for 360°, that is, all around the pipe circumference, at the location of the flaw. The staff position on engineered weld overlays is provided in Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping." For engineered weld overlays of ferritic steel piping, the calculation method described in ASME Code Case N-463 is recommended. Furthermore, overlay welding on ferritic piping may be performed according to the "half bead" technique described in Section XI or the "temper bead" technique described in ASME Code Case N-432 without the specified post-weld heat treatment (PWHT) requirements of Article NB-4622 of Section III of the ASME Code. The staff position on engineered mechanical clamps is also provided in Generic Letter 88-01, and such devices require staff review on an individual case basis.

For temporary non-code repairs of code Class 3 piping in moderate energy systems, the licensee may consider (1) non-welded repairs, and (2) leaving the piping as-is if there is no leakage and the flaw is found acceptable by the "through-wall flaw" approach discussed in Section C.3.a below.

C. EVALUATION GUIDELINE

Figure 1 shows a flow chart for the staff evaluation guideline on temporary non-code repairs of code Class 3 piping. The flow chart consists of (1) flaw detection during plant operation and impracticality determination, (2) root cause determination and flaw characterization, (3) flaw evaluation, and (4) augmented inspection.

1. Flaw Detection During Plant Operation and Impracticality Determination

The initiating event is the detection of a flaw in code Class 3 piping during plant operation. An example would be the discovery of a leak in a service water system pipe by maintenance personnel during plant operation. The licensee should determine the existence of any impracticality in performing a code repair. If practical, that is, if the affected section of piping can be isolated for completing a code repair within the time period permitted by the limiting condition for operation (LCO) without a plant shutdown, the licensee is required to perform a code repair.

2. Root Cause Determination and Flaw Characterization

The root cause of the piping degradation should be determined. The flaw evaluation criteria in the staff guidance assume a localized flaw. The flaw geometry should be characterized by a suitable NDE method for subsequent flaw evaluation. This examination should involve the application of UT or RT techniques. The flaw geometry should be suitably bounded to account for NDE uncertainties and limitations. Figure 2a shows a schematic of a generalized flaw in a pipe wall originating in the inner diameter of the pipe. The flaw may or may not be through-wall.

3. Flaw Evaluation

The structural integrity of the flawed piping should be assessed by a flaw evaluation. Two specific flaw evaluation approaches as discussed below should be considered, namely, the "through-wall flaw" and the "wall thinning" approaches. The flawed piping should satisfy the criteria of either of these two approaches. The licensee may select either approach for flaw evaluation, except that the "wall thinning" approach is not applicable to (1) a through-wall flaw, including a pinhole leaking flaw, and (2) a crack-like flaw. It is noted that the "through-wall flaw" approach may be applied to a flaw that is not through-wall.

a. "Through-Wall Flaw" Approach

This approach assumes a through-wall flaw and evaluates the flaw stability by a linear elastic fracture mechanics methodology. Figure 2b shows some geometric parameters used in the evaluation. The code-required minimum wall thickness "t_{min}" should be determined. The maximum length of the portion of the flaw that extends beyond "t_{min}", independent of orientation with respect to the pipe, is the through-wall flaw length "2a". As shown in Figure 2b, the flaw does not have to be through-wall for the application of this approach. The length "2a" can be determined according to Figure 2b for a flaw that may or may not be through-wall.

If the length "2a" exceeds either 3 inches or 15 percent of the length of the pipe circumference, the flaw is not acceptable by this approach.

The stress "s" at the flawed location should be determined from the combination of deadweight, pressure, thermal expansion, and safe-shutdown earthquake (SSE). For evaluation purposes, the through-wall flaw length "2a" should be conservatively assumed to be in the circumferential direction and the stress "s" should be assumed to be a bending stress. A safety factor of 1.4 should be applied to the stress as shown in equation (1) below. This safety factor is consistent with the factor of a square root of two on the stress intensity for flaw evaluation under faulted loads in Article IWB-3600 of Section XI of the ASME Code.

Based on linear elastic fracture mechanics and assuming a pipe thickness of "t_{min}", the stress intensity factor "K" resulting from the flaw under the applied load is given in Reference 1 as

$$K = 1.4 \; s \; F \; (3.1416 \; a)^{0.5} \qquad (1)$$

where the geometry factor "F" is

$$F = 1 + A \; c^{1.5} + B \; c^{2.5} + C \; c^{3.5} \qquad (2)$$

where

$$c = a / (3.1416 \; R) \qquad (3)$$

R = mean pipe radius

$$A = -3.26543 + 1.52784 \; r - 0.072698 \; r^2 + 0.0016011 \; r^3 \qquad (4)$$

$$B = 11.36322 - 3.91412 \; r + 0.18619 \; r^2 - 0.004099 \; r^3 \qquad (5)$$

$$C = -3.18609 + 3.84763 \; r - 0.18304 \; r^2 + 0.00403 \; r^3 \qquad (6)$$

$$r = R / t_{min} \qquad (7)$$

For flaw stability, linear elastic fracture mechanics methodology specifies "K" to be less than the critical stress intensity factor which represents the fracture toughness of the material.

For ferritic steel, the value of "K" from equation (1) should be less than 35 ksi$(in)^{0.5}$, which is consistent with the lower-bound fracture toughness property in ASME Code Case N-463.

For austenitic stainless steel, the value of "K" from equation (1) should be less than 135 ksi$(in)^{0.5}$, which is consistent with the lower-bound fracture toughness property used in Article IWB-3640 of Section XI of the ASME Code.

If the flaw satisfies the criteria of this evaluation approach, a temporary non-code repair of the code Class 3 piping may be proposed. It is noted that the rate of degradation is not considered in this approach because the flaw is assumed to have grown through the pipe wall and the temporary non-code repair is applicable, at maximum, until the next scheduled refueling outage.

b. "Wall Thinning" Approach

This approach assumes wall thinning and evaluates the structural strength of the flawed piping based on the acceptance standards in Article 3000 of ASME Code Case N-480. Although ASME Code Case N-480 addresses wall thinning as a result of erosion/corrosion, the acceptance standards in ASME Code Case N-480 are extended by the staff to all wall thinning mechanisms such as microbiologically induced corrosion (MIC) for applications within the scope of this generic letter.

Figure 2c shows some geometric parameters used in the evaluation. The code-required minimum wall thickness "t_{min}" should be determined. The minimum measured wall thickness "t_{meas}" should be determined by NDE. Based on an estimated wall thinning rate and "t_{meas}", the minimum predicted wall thickness "t_p" projected to the next inservice examination should be determined. ASME Code Case N-480 provides rules for determining the allowable local wall thickness "t_{aloc}" for the measured length of the flaw. Local wall thinning is acceptable if "t_p" exceeds "t_{aloc}".

If the flaw satisfies the criteria of this evaluation approach, immediate repair of the code Class 3 piping is not required. However, the licensee should comply with the repair and monitoring guideline in ASME Code Case N-480.

c. Single Versus Multiple Flaws

If multiple proximate flaws are detected, they may have to be considered in the flaw evaluation as a single flaw. The guideline discussed in this section is based on Article IWA-3330 of Section XI of the ASME Code.

Figure 3a shows the geometric parameters used in the evaluation for the "wall thinning" approach. The minimum spacing "S", independent of orientation relative to the pipe, between two flaws of depths "d_1" and "d_2" are shown. For "d_2" larger than "d_1", the two flaws should be treated as a single flaw if "S" is less than or equal to two times "d_2".

Figure 3b shows the geometric parameters used in the evaluation for the "through-wall flaw" approach. The difference between Figure 3a and Figure 3b is that the parameters are measured from "t_{min}" in Figure 3b. The minimum spacing "S^*", independent of orientation relative to the pipe, between two flaws of depths "d_1^*" and "d_2^*" is shown. For "d_2^*" larger than "d_1^*", the two flaws should be treated as a single flaw if "S^*" is less than or equal to two times "d_2^*".

4. Augmented Inspection

If the flaw is evaluated and found acceptable by one of the above evaluation approaches, the licensee should perform an augmented inspection via UT or RT to assess the overall degradation of the affected system. The augmented inspection, performed within 15 days of detection of the flaw which results in a temporary non-code repair, is a part of the relief acceptance criteria of the temporary non-code repair of code Class 3 piping.

From the root cause determination, the most susceptible locations should be identified. The extent of the augmented inspection depends on whether the line is high energy or moderate energy. The failure of a high energy line may have more severe consequences than the failure of a moderate energy line because of the energy content. Thus, a more extensive augmented inspection should be performed for high energy lines. As shown in Figure 1, the inspection of at least 10 most susceptible (and accessible) locations for high energy lines and at least 5 most susceptible (and accessible) locations for moderate energy lines should be performed. Flaws detected in the augmented inspection should be characterized and evaluated. If any flaw is detected having a minimum measured wall thickness "t_{meas}" less than the code-required minimum wall thickness "t_{min}" in the augmented inspection sample, inspection of an additional sample of the same size should be performed. This process should be repeated within 15 days of each other until no flaw having "t_{meas}" less than "t_{min}" is detected in the additional inspection sample or until 100 percent of susceptible (and accessible) locations have been inspected.

D. REFERENCES

1. "NRC Leak-Before-Break (LBB.NRC) Analysis Method for Circumferentially Through-Wall Cracked Pipes Under Axial Plus Bending Loads," NUREG/CR-4572, May 1986.

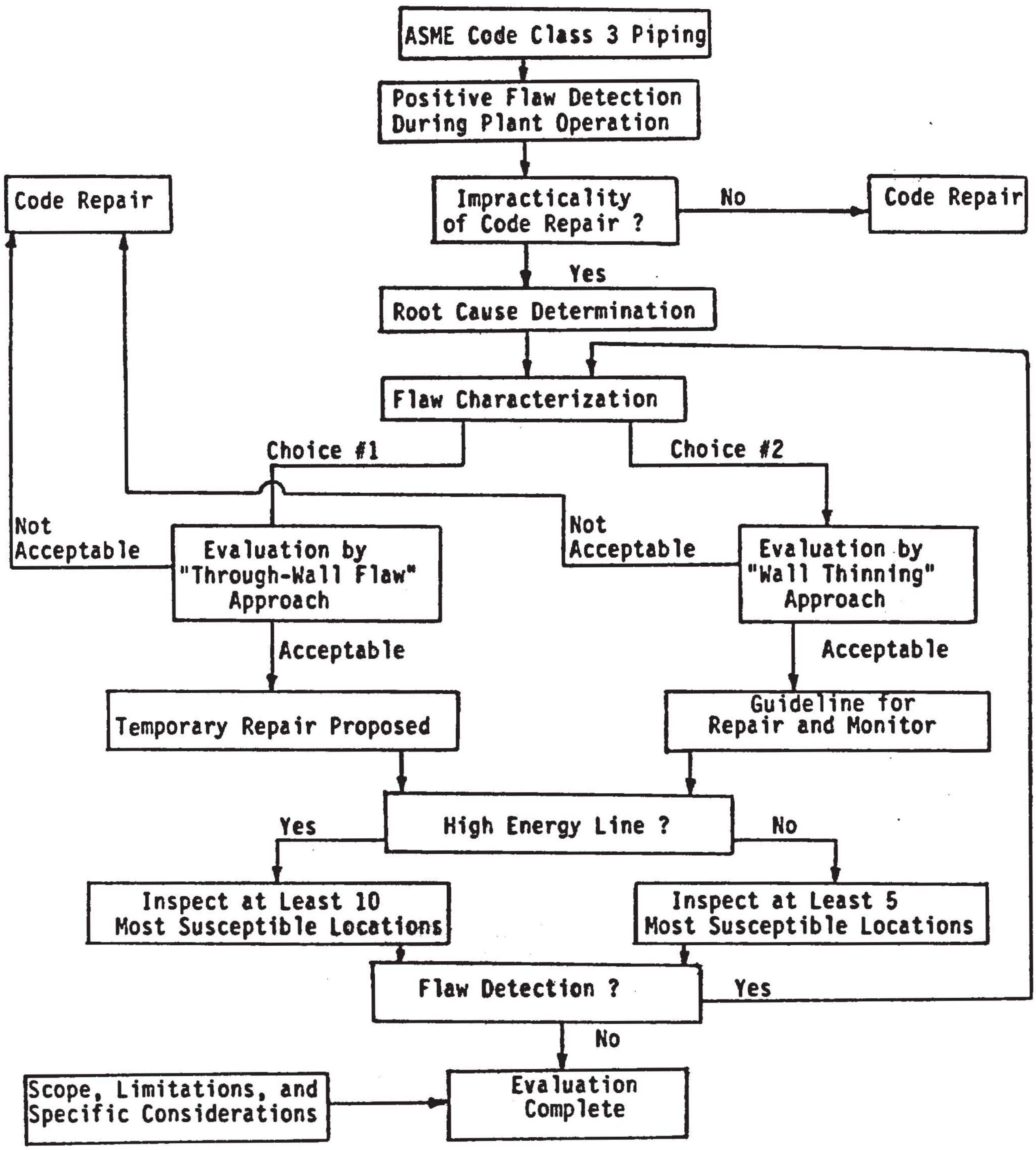

Fig. 1 Flow chart of staff guidance in evaluating relief requests for temporary non-code repair of ASME Code Class 3 piping.

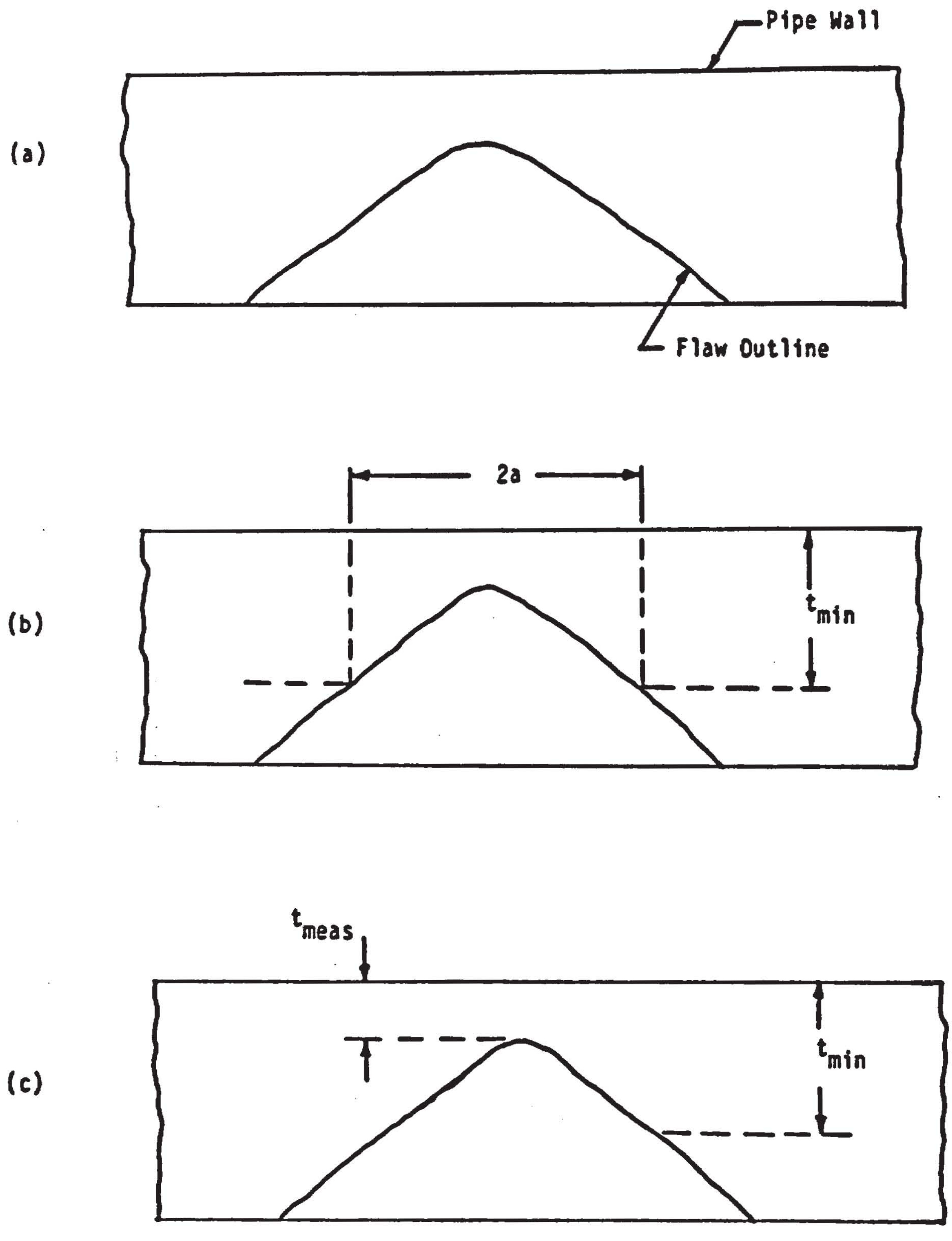

Fig. 2 Schematic of (a) generalized flaw, (b) parameters in "through-wall flaw" approach, and (c) parameters in "wall thinning" approach.

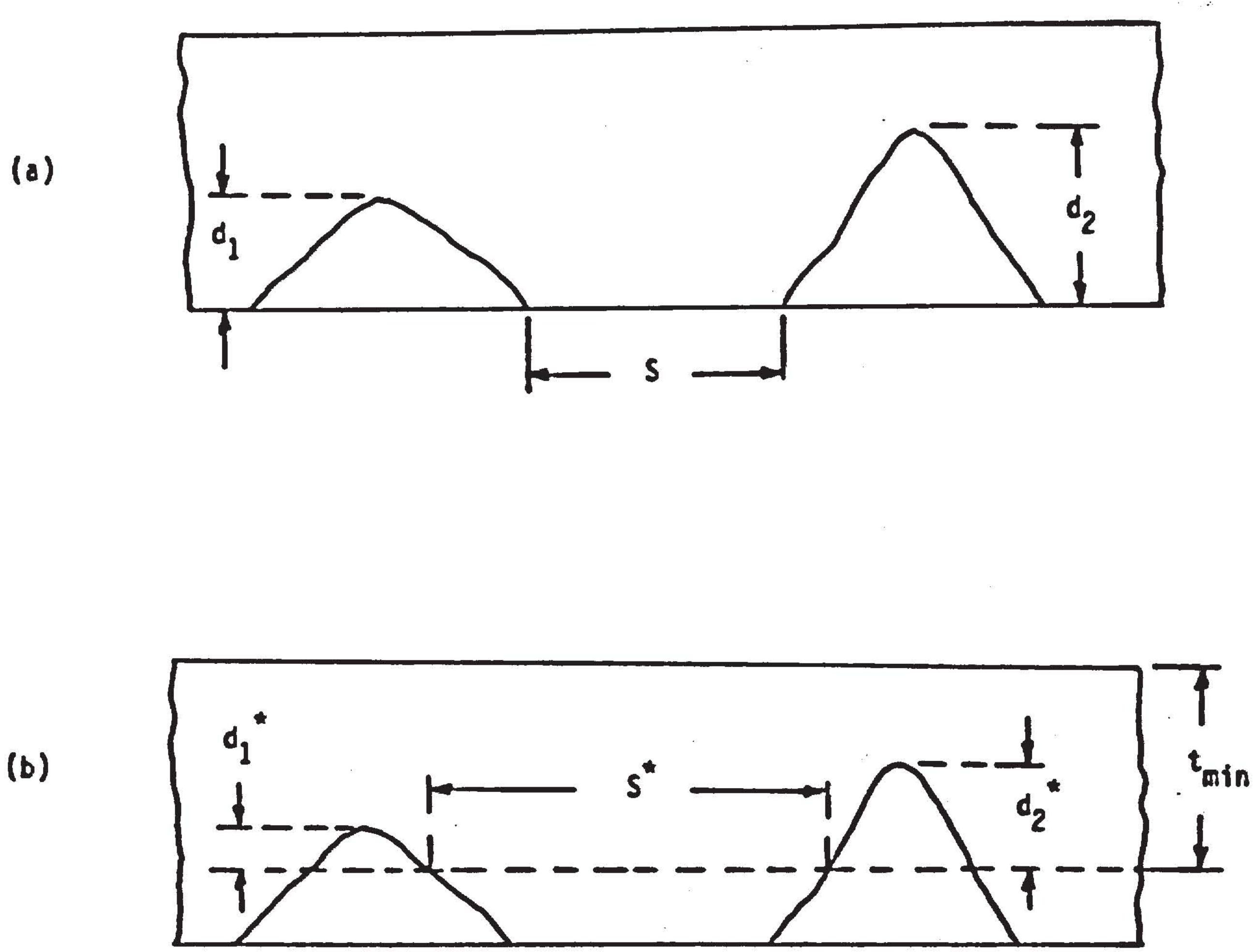

Fig. 3 Schematic indicating parameters in determining single versus multiple flaws for (a) "wall thinning" approach and (b)"through-wall flaw" approach.

Enclosure 2

LIST OF RECENTLY ISSUED GENERIC LETTERS

Generic Letter No.	Subject	Date of Issuance	Issued To
89-10 SUPP. 1	RESULTS OF THE PUBLIC WORK-SHOP	06/13/90	ALL LICENSEES OF OPERATING NPPs AND HOLDERS OF CPs
90-03 SUPP. 1	RELAXATION OF STAFF POSITION IN GL 83-28, ITEM 2.2 PART 2, "VENDOR INTERFACE FOR SAFETY-RELATED COMPONENTS"	05/14/90	ALL POWER REACTOR LICENSEES AND APPLICANTS
90-04	REQUEST FOR INFORMATION ON THE STATUS OF LICENSEE IMPLEMENTATION OF GENERIC SAFETY ISSUES RESOLVED WITH IMPOSITION OF REQUIREMENTS OR CORRECTIVE ACTIONS	04/25/90	ALL HOLDERS OF OLs AND CPs FOR NUCLEAR POWER PLANTS
89-13 SUPP. 1	SERVICE WATER SYSTEM PROBLEMS AFFECTING SAFETY-RELATED EQUIPMENT	04/04/90	ALL HOLDERS OF OLs OR CPs FOR NUCLEAR POWER PLANTS
88-20, SUPP. 2	ACCIDENT MANAGEMENT STRATEGIES FOR CONSIDERATION IN THE INDIVIDUAL PLANT EXAM PROCESS	04/04/90	ALL HOLDERS OF OLs AND CPs FOR NUCLEAR POWER REACTOR FACILITIES
90-03	RELAXATION OF STAFF POSITION IN GL 83-28, ITEM 2.2, PART 2 "VENDOR INTER-FACE FOR SAFETY-RELATED COMPONENTS"	03/20/90	ALL POWER REACTOR LICENSEES AND APPLICANTS
90-02	ALTERNATIVE REQUIREMENTS FOR FUEL ASSEMBLIES IN THE DESIGN FEATURES SECTION OF TECHNICAL SPECIFICATIONS	02/01/90	ALL LWR LICENSEES AND APPLICANTS
90-01	REQUEST FOR VOLUNTARY PARTICIPATION IN NRC REGULATORY IMPAC SURVEY	01/18/90	ALL LICENSEES OF OPERATING REACTORS & CONSTRUCTION PERMITS FOR LWR NUCLEAR POWER PLANTS

This generic letter consists of guidance and does not require a response. Therefore, an OMB clearance number is not necessary.

If you have any questions about this matter, please contact one of the NRC technical contacts listed below.

Sincerely,

Original signed by
James G. Partlow

James G. Partlow
Associate Director for Projects
Office of Nuclear Reactor Regulation

Enclosures:
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2. Listing of Recently Issued Generic Letters

Technical Contacts:
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NOTE:
Met with CRGR on March 14, 1990. A memo to E. Jordan enclosing the final letter will be issued as soon as the generic letter has been dated.

S. Lee*
05/24/90

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