November 21, 2001

Mr. Alex Marion, Director
Engineering
Nuclear Energy Institute
1776 I Street, N.W., Suite 400
Washington, D.C. 20006-3708

SUBJECT: FLAW EVALUATION GUIDELINES

Dear Mr. Marion:

Thank you for your October 22, 2001 response to our request for comments on the flaw evaluation guidelines that I sent to you on September 24, 2001. The comments in your response contained some good observations. The disposition of the industry's technical comments are provided in Enclosure 1 and the revised flaw evaluation guidelines are included in Enclosure 2. Regarding the regulatory comments in your letter, I would remind you that at the August 15, 2001, meeting to discuss NRC's expectations concerning licensees' responses to Bulletin 2001-01, members of the industry requested that the NRC staff issue proposed clarifications to the flaw evaluation guidelines associated with the Generic Letter 97-01 effort. We followed up on this request in the spirit of continuing a cooperative approach to dealing with the CRDM penetration nozzle cracking issue. Since Section XI of the ASME Code does not provide rules for evaluating flaws in these nozzles, it was our expectation, and we believe the industry's as well, that having a set of agreed upon flaw evaluation guidelines will provide greater predictability and consistency in the regulatory process. In the absence of those guidelines or an effort by the industry to develop and incorporate such guidance in the applicable consensus standards, individual licensees would have to develop their own plant-specific flaw evaluation guidelines. In regard to the former, it is our intent to transmit these guidelines to the newly formed ASME Code Section XI task group that will address CRDM nozzle cracking issues. This guidance can constitute the framework of rules for eventual incorporation into the ASME Code.

I would also point out to you that I spoke to you by telephone prior to sending my September 24, 2001, letter to you in order to make sure our intent was clear, that is, to use the proposed guidelines in any reviews that came up in the current outage season and that we would consider any industry comments that were received in time.

As indicated above, we plan to pursue codification of these guidelines via the ASME Code process. Therefore, I suggest that any additional modifications be pursued via that process. Until such codification is complete, the attached guidelines can be used by licensees. Any plant specific considerations can be discussed with the staff as appropriate. The staff contact for flaw evaluation issues is Keith Wichman at 301-415-2757. Your continued cooperation is appreciated.

Sincerely,

/ra/

Jack Strosnider, Director
Division of Engineering
Office of Nuclear Reactor Regulation

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Jack Strosnider, Director
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DISPOSITION OF TECHNICAL COMMENTS IN ENCLOSURE 1 TO NEI LETTER DATED OCTOBER 22, 2001

a) Comments 1, 2, 4, 6, 9 and 10 have been accepted and incorporated into the revised flaw evaluation guidelines.

b) Comments 3 and 5 are not accepted for the same reason and that is, currently there are no qualified NDE methods that are capable of reliably detecting and sizing the flaw locations in question. The assertion that, “.........flaw sizing and categorization will be performed on a best effort basis using available methods” is not sufficient.

c) Comments 7 and 8 are not accepted for the same reason(s) specified for Comments 3 and 5. In addition, Comment 7 states, “Penetration’s OD surfaces wetted with reactor coolant could result in OD cracking. If leaks and/or flaws are detected in the CRDM nozzle, the leak may be stopped with a qualified repair.” Acceptance of this comment could be interpreted as preapproval of a non-Code repair.

FLAW EVALUATION GUIDELINES

The scope of these guidelines is limited at present to PWR control rod drive mechanism (CRDM) penetrations since smaller vessel head penetrations such as vents and thermocouple nozzles are not amenable to volumetric inspection. Flaws are defined in IWA-9000, "Glossary" of Section XI of the ASME Code. As a prerequisite for flaw evaluation, flaws must be reliably detected and sized within specified uncertainty bounds by qualified NDE methods. The other necessary information is the availability of accepted crack growth rates. In the following guidelines, if either of these elements is missing, repair is specified.

FLAW CHARACTERIZATION

Flaws must be characterized by both their length and depth within the specified sizing uncertainties. Currently, there is insufficient data available to assume an aspect ratio if only the flaw length has been determined.

- The proximity rules of ASME Code Section XI for considering flaws as separate may be used (Figure IWA 3400-1, attached).
- When a flaw is detected, its projections in both the axial and circumferential directions shall be determined. Note that the axial direction is always the same for each nozzle head penetration, but that the circumferential direction will vary depending on the angle of intersection of the penetration with the head. The circumferential direction of interest is along the top of the attachment weld as illustrated in Figure 1. It is this angle along which separation of the nozzle penetration from the head could occur.
- Flaws that are equal to or greater than 45-degrees from the vertical centerline of the CRDM nozzle, or those that are within plus or minus 10-degrees of the angle (if less than 45-degrees) that the plane of the partial-penetration attachment weld (J-groove weld) makes with the vertical centerline of the CRDM nozzle, are considered to be circumferential flaws.
- The location of the flaw relative to the top and bottom of the J-groove weld shall be determined since the potential exists for development of a leak path if a flaw progresses up the nozzle past this weld. The flaw acceptance criteria are as specified below depending on whether the flaw is in the pressure boundary or in the portion of the nozzle below the J-groove weld.

FLAW ACCEPTANCE CRITERIA

<u>CRDM Nozzle Pressure Boundary</u>

The CRDM nozzle pressure boundary includes the J-groove weld and the portion of the nozzle projecting above the weld. While the CRDM nozzle is an integral part of the reactor vessel, no flaw evaluation rules exist for non-ferritic vessels or parts thereof in Section XI. Therefore, the following rules shall be applied:

- The allowable flaw standards for austenitic piping in Section XI, IWB-3514.3 may be applied for inside diameter (ID) initiated axial flaws only.

- Crack growth shall be evaluated for the period of service until the next inspection. The maximum flaw depth allowed is 75-percent of the nozzle thickness (refer to crack growth rate below).
- All outside diameter (OD) initiated flaws, regardless of orientation (axial or circumferential), shall be repaired.
- All ID-initiated circumferentially oriented flaws shall be repaired.
- Any flaw detected in the J-groove weld, its heat affected zone (or adjacent base material) must be repaired.
- Alternatives to Code required repairs will be considered for approval if justified.

CRDM Nozzle Below the J-Groove Weld

- Axially oriented flaws (either ID- or OD-initiated) are acceptable regardless of depth as long as their upper extremity does not reach the bottom of the weld during the period of service until the next inspection.
- Circumferential flaws (either ID- or OD-initiated) are acceptable provided that crack growth is evaluated for the period of service until the next inspection. In no case shall the projected end of cycle circumferential flaw length exceed 75-percent of the nozzle circumference.
- Intersecting axial and circumferential flaws shall be removed or repaired because of the greater propensity to develop into loose parts. Note: while flaws below the J-groove weld have no structural significance, loose parts must be avoided.

CRACK GROWTH RATE

CRDM Nozzle Pressure Boundary[1]

- Crack growth to be used for axial ID initiated flaws shall be determined from the following equation as a function of the applied stress intensity:

$$\frac{da}{dt} = 1.80x10^{-11}(K-9)^{1.16}\ e^{-\frac{Q}{R}\left(\frac{1}{T+273.16}-\frac{1}{598.16}\right)} \quad m / sec.$$

  where K is the applied stress intensity in MPa$\sqrt{m}$, Q is the activation energy [32.4 kcal/mole (135 kJ/mole)], R is the universal gas constant [1.987 cal/mol-°K (8.314 J/mol-°K)], and T is the head operating temperature (°C).

- There is currently no accepted crack growth rate for the Alloy 182 J-groove weld material.

[1] The industry, as represented by the Materials Reliability Project (MRP), is engaged in an ongoing effort to define crack growth rates.

CRDM Nozzle Below the J-Groove Weld

- The crack growth rate to be used for the flaws in this region of the nozzle, shall be the same as that used for ID initiated axial flaws within the CRDM nozzle pressure boundary.

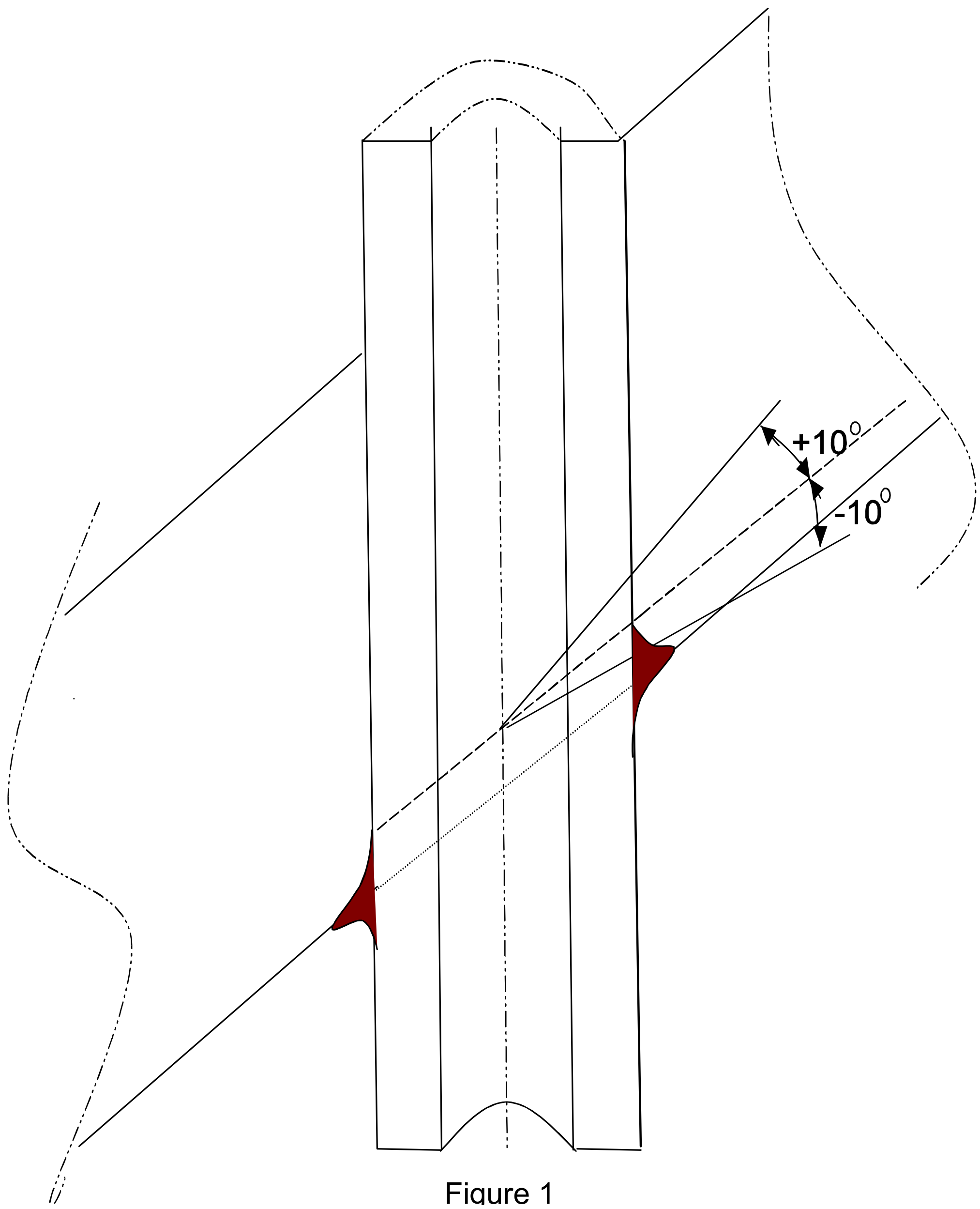

Figure 1