September 24, 2001

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

SUBJECT: FLAW EVALUATION CRITERIA

Dear Mr. Marion:

On August 15, 2001, members of the U.S. Nuclear Regulatory Commission (NRC) staff participated in a public meeting held at the NRC offices in Rockville, Maryland, with representatives from the Nuclear Energy Institute (NEI), various operating nuclear reactor licensees, and members of the public to discuss NRC expectations regarding pressurized water reactor licensee responses to NRC's Bulletin 2001-01 on circumferential cracking of reactor pressure vessel head penetration nozzles. During this meeting, a request was made of the staff regarding flaw acceptance criteria. The following is our response, which is intended for appropriate use by the industry and the staff. At this time, we are forwarding these criteria to you for comment.

FLAW CHARACTERIZATION

Flaws must be characterized by both their length and depth. There is currently 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).
- 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 be different depending on the angle of intersection of the penetration with the head. The circumferential direction of interest here is along the top of the attachment weld as illustrated in Figure 1, enclosed. 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

CRDM Nozzle Pressure Boundary

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 nonferritic vessels or parts thereof in Section XI. Therefore, the rules for austenitic piping shall be applied with the following exceptions:

- The allowable flaw standards for austenitic piping in Section XI, IWB-3514.3 may be applied for inside diameter (ID) initiated axial flaws only.
- The rules of IWB-3640 shall apply and the margins maintained after crack growth is evaluated for the period of service until the next inspection. The maximum flaw depth allowed by IWB-3640 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

- Crack growth to be used for axial ID initiated flaws shall be determined from *Crack Growth and Microstructural Characterization of Alloy 600 Vessel Head Penetration Materials, by Bamford, W. H., and Foster, J. P.,* EPRI, Palo Alto, CA:1997. TR-109136 (Proprietary).

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

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.

Comments or questions should be directed to Keith Wichman of my staff at 301-415-2757.

Sincerely,

/ra/

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

Project No. 689

cc: See next page

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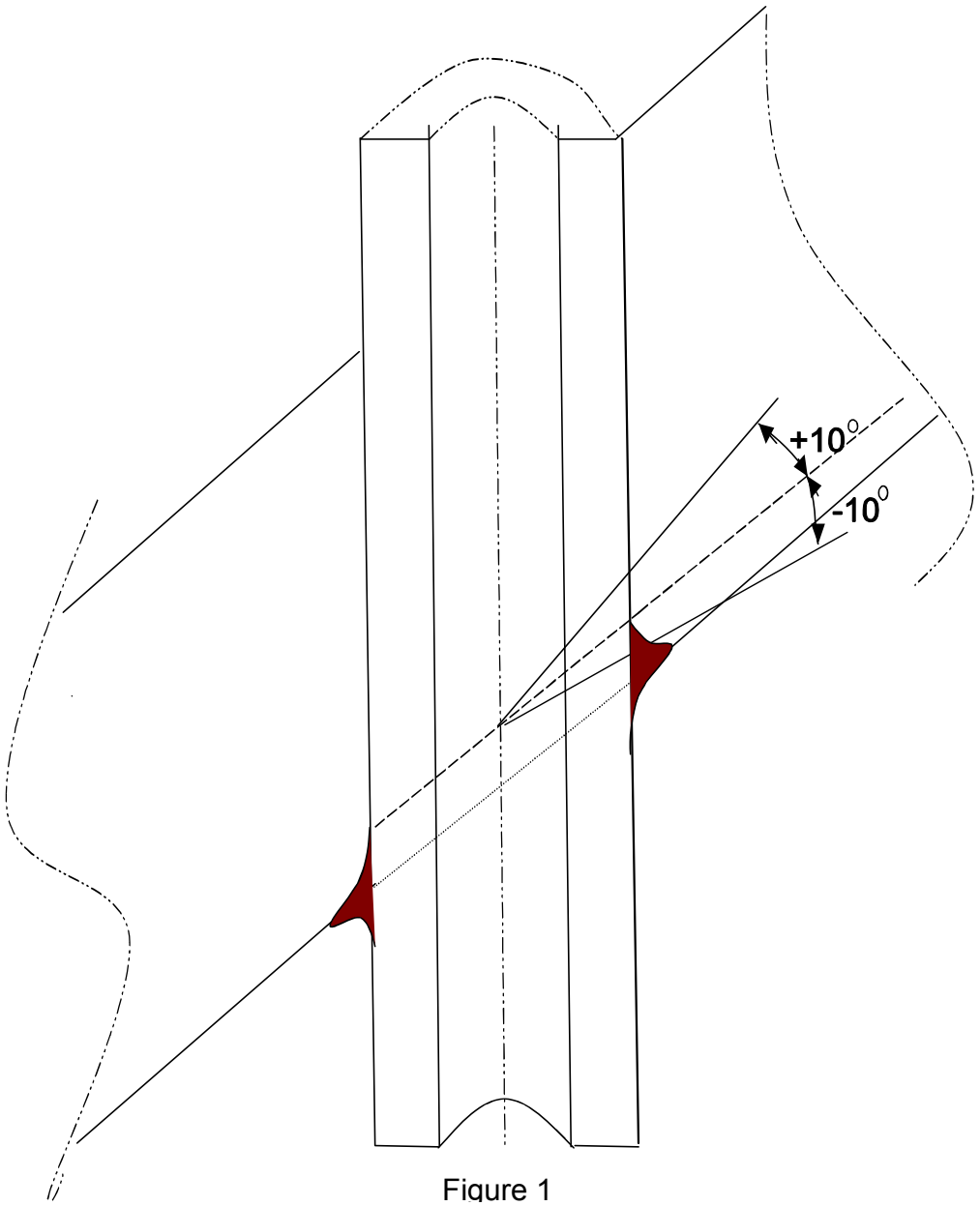

Figure 1

ENCLOSURE