

# **White Paper RPV Nozzle-to-Shell Examination Coverage and Scan Directions**

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## **Objective**

The objective of this White Paper is to clarify a difference of opinion regarding the scanning and coverage requirements for RPV Nozzle-to-Shell welds.

## **Problem Statement**

In discussions with NRC staff, an opinion has been stated that the outer 85% of the nozzle-to-shell weld must be examined for flaws perpendicular to the weld centerline. The position is based on an interpretation of the Final Rule 10CFR50.55a(b)(2)(xv)(K), September 22, 1999. This position is based on the interpretation that Paragraph (K) states that radial scan procedures shall be qualified to Appendix VIII supplement 6 as modified by Paragraph G. Paragraph G requires that the outer 85% be scanned in two orthogonal directions.

PDI disagrees with this interpretation based on previous agreement and understandings with the NRC, Supplement 6 is not appropriate for the detection of flaws perpendicular to the weld, and that Paragraph K is specifically directed at the complex geometry of the nozzle to shell welds. Supplement 5 would be the appropriate reference for circumferential scans to detect flaws perpendicular to the weld. Supplement K does specify Supplement 5 qualifications and scans for the inner 15% of the examination volume. This interpretation would place an undue burden on the industry as well as require increased radiation exposure with no technical benefit or increase in safety. The orthogonal scans required by Paragraph G would not detect flaws perpendicular to the weld due to the complex geometry of the weld. Supplement 6 procedures are only qualified for scans parallel and perpendicular to the axial and circumferential welds of the RPV. Supplement 6 procedures are not appropriate for the complex geometry presented by flaws perpendicular to the nozzle-to-shell weld. Procedures qualified to Supplement 6 are appropriate for the radial scans, to detect flaws parallel to the weld, performed from the outside surface.

We believe this interpretation is not consistent with previous NRC statements and agreements with PDI. The technical basis for the PDI interpretation is

provided below. Several instances where NRC has taken a position on this subject are listed.

## **Background**

Coverage issues regarding nozzle to shell welds have been a topic of discussion since 1994. Several actions are listed below that indicate NRC agreement of the coverage issues. Each is described below.

### ***Organization of the ASME Code Section XI***

- **IWA-2232** states, "Ultrasonic examinations shall be conducted in accordance with Appendix I".
- **IWB-2500** lists the examination requirements by component category.
- **IWB-3500** lists the acceptance criteria for flaw indications.
- **Appendix I** describes the extent of examination and coverage requirements. It is also the place where personnel and procedures are required to be qualified to the requirements of Appendix VIII. Appendix I describes scanning directions and extent of coverage, e.g., scanning of the outer 85% is required in one radial direction.
- **Appendix VIII** describes the qualification requirements for procedures, personnel and equipment to be used in examinations performed required by Appendix I. Appendix VIII does not address the examination of components, e.g., scanning directions and coverage issues.

## **Technical Basis**

### ***Code Case N-622***

NRC requested that the contents of the PDI Program be incorporated into the ASME Code Section XI. This was requested so that they would not need to include all the differences contained in the PDI Program into 10CFR 50.55a. A concerted effort by PDI staff, members of the ASME Code, NRC staff and NRC consultants arrived at an agreed version of the document. Code Case N-622 was approved February 29, 1999. Unfortunately it was not published until September of that year.

Code Case N-622, A-1300 (b)(2) requires that the outer 85% be examined in at least on radial direction. PDI met with NRC on several occasions to assure the Final Rule would incorporate the provisions of the PDI Program and the Code Case. Until recently we felt that an agreement was in place.

## **10CFR50.55a Rule dated September 22, 1999**

Paragraph (b)(2)(xv)(K) discusses in detail the qualification of procedures, personnel and equipment for the examination of reactor pressure vessel (RPV), nozzle-to-vessel welds.

### **Vessels Scanned from the Inside of the Vessel**

Subparagraph (K)(1)(i) specifically states that for examinations performed from the bore, flaws perpendicular to the weld centerline are not required. Subparagraph (K)(4) references Table VIII-S7-1, which excludes flaws perpendicular to the weld centerline in the outer 85% of the weld. Subparagraph (K)(2)(iii) addresses the outer 85% of the weld and requires that the examination be performed from the bore using a procedure and personnel qualified in accordance with subparagraph (K)(1). Subparagraph (K)(1) states that flaws perpendicular to the weld are not required. Alternatively the outer 85% may be examined from the vessel shell using procedures and personnel qualified to Supplement 6 as modified by paragraphs (D), (E), (F) and (G). Supplement 6 qualifications are performed on flaws both parallel and perpendicular to the weld and meet the requirements of paragraphs (D), (E), (F) and (G). It is clear that for examinations performed from the bore it is not required to search for flaws perpendicular to the weld, except in the inner 15%. All PWR vessels are examined from the bore and therefore would not require scanning for flaws perpendicular to the weld *centerline in the outer 85% of the weld*.

### **Vessels Scanned from the Outside**

All BWR vessels are normally scanned from the outside surface. Subparagraph (K)(3) addresses the examination from the outside surface. Specifically (K)(3)(ii) addresses the outer 85% of the weld and requires:

1. Examination in at least one radial direction
2. Personnel and Procedures are to be those that have been qualified to the requirements of Appendix VIII, Supplement 6.
3. Table VIII-S7-1 removes from consideration flaws perpendicular to the weld in the outer 85% of the weld.

The procedures used are qualified to the requirements of Supplement 6 for the single radial direction. They are not qualified to detect flaws at large deviations relative to the scan direction. Supplement 5 and Code Cases N-622 and N-552 address these conditions. If NRC desired scanning in the circumferential direction for the outer 85%, it would be expected that they would have include the same words that are included in (K)(3)(i) which does include circumferential scanning and qualifications to Supplement 5 for the inner 15%. Procedures qualified to Supplement 6 are not appropriate for circumferential scanning of the

nozzle to detect flaws perpendicular to the weld. Performing them would impose radiation exposure and cost burden with no increase to quality or safety. These examinations are conducted in a high radiation zone. Performing 6 to 8 additional scans would result in increased radiation exposure with no benefit to quality or safety.

Failure to perform circumferential scans would not require a notation of limited scanning nor a request for relief, as the examination meets the coverage requirements of (K)(3)(ii). The interpretation, in effect, requires more stringent requirements for BWR nozzle-to-shell welds while PWR units are exempt. It is recognized that the BWR have considerable more margin than PWR units.

### ***Code Case N-613 and N-613-1***

Code Case N-613 approved July 30, 1998 has been published. However, NRC has objected to the Case, as it only requires the examination to look for flaws parallel to the weld over the entire weld thickness. PDI and the ASME Code have agreed with NRC that the inner 15% of the weld be examined in four orthogonal directions. NRC made an alternative proposal, (N-613-1) in a letter from Wallace E. Norris to Ken Thomas, chairman of the ASME Code, Water Cooled Systems, dated October 30, 2000. The alternative Case required four directional coverage for the inner 15% of the volume. The proposed Case also specified that only flaws parallel to weld were required and the use of a procedure qualified in accordance with Supplement 6 single side access for the outer 85%. If NRC had wished to achieve coverage for flaws perpendicular to the weld in the outer 85%, it would seem unlikely that they would specify only flaws parallel to the weld were of interest. Qualifications according to Supplement 6 do not address flaws perpendicular to nozzle-to-shell welds.

### ***ASME Code Section XI, 2002 Addenda, Appendix I***

Appendix I provides instructions for examination coverage. After issuance of the September 22, 1999 Rule the Code resolved to clarify scanning and coverage requirements. The revisions completed the required review process, including NRC participation, and have now been published.

I-3400 describes the requirements for examination of RPV nozzle-to-shell welds. I-3410 and I-3420 describe examination requirements from the inside and outside surfaces. In both cases examination is required in one radial direction for the outer 85% of the weld.

## Summary

It is requested that NRC confirm its previous positions as stated in the Final Rule of September 22, 1999:

1. The contents of Table VIII-S7-1 referenced in 10CFR50.55a(b)(2)(xv)(K)(4) and proposed Code Case N-613-1.
2. The scanning and coverage requirements for the outer 85% of the nozzle to shell weld are as a minimum on radial direction, as per the requirements of 10CFR50.55a(b)(2)(K)(3)(ii).
3. The requirements of 10CFR50.55(b)(2)(xv)(G)(3) and (4) address the qualification of procedure, personnel and equipment. They do not require circumferential scanning of the outer 85% of the nozzle-to-shell weld. Subparagraph (K)(4) modifies the qualification requirements of (G)(3) and (G)(4) as they apply to nozzle-to-shell welds.
4. The orthogonal Scans of Supplement 6 are not qualified for the detection of flaws perpendicular to the nozzle-to-shell weld.

Application of an unqualified technique in the hope that it might detect something in an area of little interest is not a reasonable policy. Thank you for your consideration of our request.