NRC Expectations for Eddy Current Inspections of Peened, Inlayed, and Onlayed Dissimilar Metal Welds

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Surface Testing of Inlays, Onlays, and Peened Surfaces

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Currently, inspection credit is limited or under review for dissimilar metal welds with inlays, onlays or peening

The NRC staff recognizes that effective implementation of these methods would greatly reduce the susceptibility of a surface to stress corrosion cracking

The operational experience has identified various fabrication issues with the welding of alloy 52 which has limited the generic credit for inlays and onlays

The OE for upper head CRDM cracking shows that shallow service induced cracks and subsurface fabrication defects may be present in the J-groove welds which could limit the effectiveness of peening.

Issues with Inlays, Onlays, and Peened Surfaces

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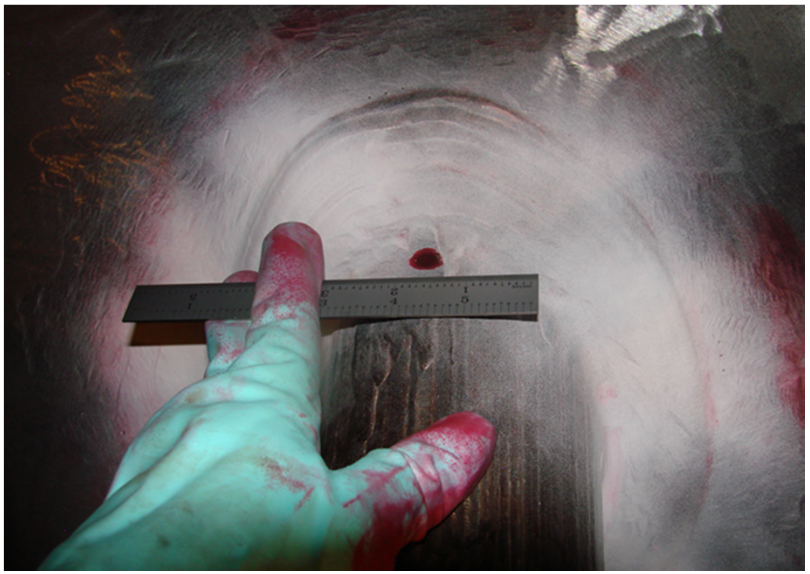
Alloy 52 welds are challenging to weld and can have small welding defects such as cracks and subsurface defects

The NRC staff have seen instances of an Alloy 52 overlays of CRDMs that passed a PT test when installed but failed after one or two cycles

Alloy 52 welds can contain cracks with a shallow ligament covering the crack that can break with the heat up-cool down cycle

The NRC staff would have increased confidence for the effectiveness of inlays, onlays, and peening if surfaces were inspected for these small cracks and near surface defects



Alloy 52 Overlay passed PT exam in 2006, failed in 2008

Small Cracks can Challenge These Mitigation Techniques

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The compressive zone of a peened area may be < 0.5 mm

A 3 mm-thick alloy 52 weld inlay/onlay with a diluted region at the interface between the 52 and the 82/182 metals may have a very shallow region (0.5-1.5 mm) with chromium >24%

Volumetric inspections such as UT may not be able to detect these small flaws given the thicknesses, metals, and geometries involved

Surface techniques such as eddy current and penetrant testing have been proposed in N-770-X

N-770-X

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(d) Preservice surface examinations shall be performed on the modified dissimilar metal weld after inlay or onlay application. Liquid penetrant examination in accordance with IWA-2222 or eddy current examination in accordance with IWA-2223 shall be performed. *The acceptance standards of NB-5352 shall apply for the inlay or onlay, except that rounded indications with dimensions larger than the smaller of 1⁄16 in. (1.5 mm) or 50% of the thickness of the inlay or onlay are unacceptable.* The balance of the surface examination area shall comply with the inservice examination standards of IWB-3514.

Issues with N-770-X

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NB-5352 describes penetrant acceptance standards, not eddy current acceptance standards

(1) any cracks or linear indications;

(2) rounded indications with dimensions greater than 3/16 in. (5 mm);

(3) four or more rounded indications in a line separated by 1/16 in. (1.5 mm) or less edge to edge;

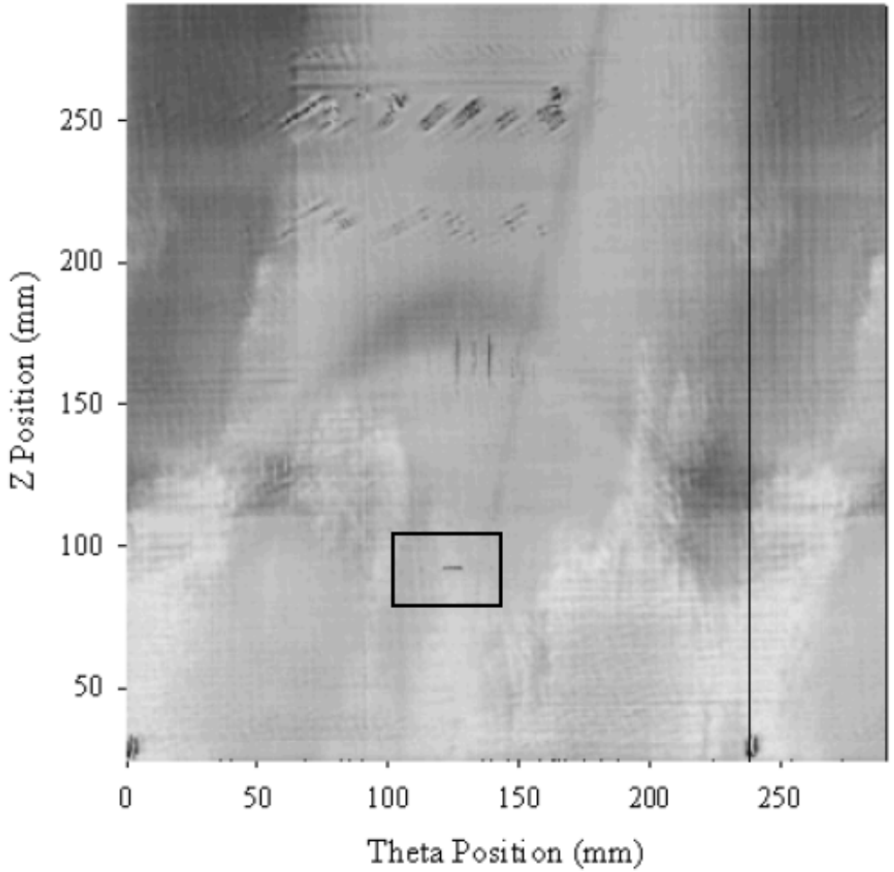
(4) ten or more rounded indications in any 6 in.^{2} (4,000 mm^2) of surface with the major dimension of this area not to …

These standards are not very useful for eddy current examinations

Problems with Using Penetrant Standards with Eddy Current

Scratches, grind marks, and weld passes can produce linear indications

Eddy current examinations do not typically produce rounded indications



Eddy Current Scan of Control Rod Drive Penetration Tube

Issues with Appendix IV

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N-770 described the use of IWA-2223, which references Appendix IV

The Appendix IV specimens uses IWB-3514 and IWC-3514 to determine the flaw sizes in the qualification specimens

- The allowable flaws in IWB-3514 and IWC-3514 are based on the wall thickness, not the overlay thickness or peened compressive thickness

Appendix IV has no requirements for subsurface flaws in the qualification specimens

What is Needed

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Eddy Current acceptance standards that have a technical basis given the sizes and depths of flaws that can challenge a peened surface and/or an alloy 52 inlay or onlay

Eddy current qualification requirements that provide confidence that the procedure can reliably detect shallow and near surface flaws and be able to discriminate between shallow flaws and scratches and weld passes

Alternate inspection methods or programs to determine if the mitigation process is functioning as intended

Include or refer to these standards in N-770-X