

Repair of Pressure Equipment and Piping in Nuclear Power Plants *Navigating ASME XI Repairs with PCC-2 as a Roadmap*

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Summary - This article is meant to help engineers select ASME XI options for the repair of ASME III nuclear components. In summary, the repair options in ASME XI are dispersed throughout Section XI and Code Cases, while, in contrast, the ASME PCC-2 repair standard (for non-safety related components) lists repair options in a well-structured manner. So, we are going to use the structure of ASME PCC-2 as a road map to cross-correlate the equivalent ASME XI repair, where it exists. Therefore, the Table can be used as a checklist to remind engineers of the many repair options.

On one hand ASME XI: The repair of safety-related Class 1, 2, and 3 nuclear components is addressed in ASME Boiler & Pressure Vessel Code Section XI and in a series of ASME XI Code Cases. The use of ASME XI and its Code Cases to select a repair technique poses two challenges:

- (1) The repair techniques are dispersed in the body of IWA-4000, in ASME XI Appendices, and in several Code Cases.
- (2) ASME XI dedicates considerable space to the documentation of the repairs, and the roles and responsibilities of the parties involved. This adds to the plant engineer's challenge of zeroing-in on the technical requirements.

On the other hand ... ASME PCC-2: The repair techniques for non-safety related pressure equipment and piping is addressed in several codes, standards, and guides; for example, those published by the National Board, EPRI, API, STP, etc. Of particular interest is ASME PCC-2 "Repair of Pressure Equipment and Piping". One of the strengths of PCC-2 is its clear structure: The repair techniques are listed sequentially, each article (chapter) of PCC-2 being a repair technique. As such, the PCC-2 Table of Contents can be used as a checklist, to quickly go down the repair options listed.

Following the introductory Chapter, ASME PCC-2 is divided into the three general groups of repair methods:

Part 2 Welded Repairs
Part 3 Mechanical Repairs
Part 4 Nonmetallic and Bonded Repairs

Finally, PCC-2 Part 5 addresses the general question of pressure or leak testing a repair.

Note that, technically, PCC-2 has benefited from the work done in the nuclear industry, within Section XI. Some of the PCC-2 repairs were first drafted by nuclear power plant engineers.

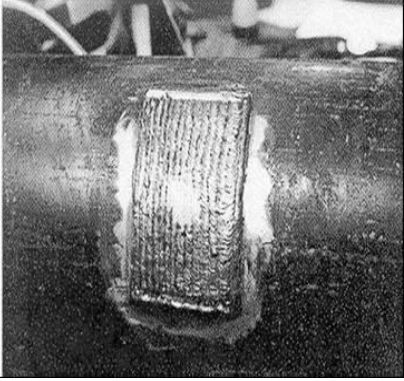

ASME XI Repairs with PCC-2 as a Roadmap


This article is meant to use the strength of PCC-2, its clear and logical structure, to list the PCC-2 repair options and weave-through the corresponding ASME XI repair techniques. In this roadmap, the statement "*No explicit ASME XI*


equivalent” is not a criticism, it simply reflects that some of the repair techniques are either not practical for a safety-related component (for example, pipeline welded sleeves), or have not yet been brought forward to Section XI.



ASME PCC-2 Part 2 Welded Repairs


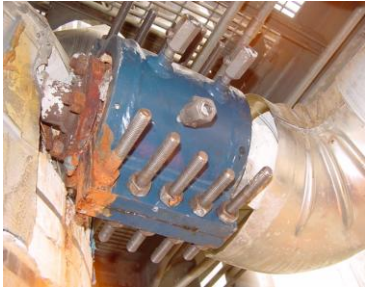
ASME PCC-2	ASME Section XI (with excerpt)
Article 2.1 Butt-Welded Insert Plates in Pressure Components	<i>No explicit ASME XI equivalent</i>
Article 2.2 External Weld Overlay to Repair Internal thinning 	<i>ASME XI CC N-504 Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping <u>Inquiry:</u> Under the rules of IWA-4120, in Editions and Addenda up to and including the 1989 Edition with the 1990 Addenda, in IWA-4170(b) in the 1989 Edition with the 1991 Addenda up to and including the 1995 Edition, and in IWA-4410 in the 1995 Edition with the 1995 Addenda and later Editions and Addenda, a defect may be reduced to an acceptable flaw in accordance with the provisions of either the Construction Code or Section XI. As an alternative, is it permissible to reduce a defect to a flaw of acceptable size by increasing the pipe wall thickness by deposition of weld reinforcement material on the outside surface of the pipe?</i>
Article 2.3 Seal-Welded Threaded Connections and Seal Weld Repairs	<i>No explicit ASME XI equivalent</i>
Article 2.4 Welded Leak Box Repair	<i>ASME XI IWA-4340 MITIGATION OF DEFECTS BY MODIFICATION Modification of items other than Class 1 may be performed to contain or isolate a defective area without removal of the defect, provided the following requirements are met ...</i>
Article 2.6 Full Encirclement Steel Reinforcing Sleeves for Piping 	<i>No explicit ASME XI equivalent</i>
Article 2.7 Fillet Welded Patches with Reinforcing Plug	<i>No explicit ASME XI equivalent</i>

<p>Welds</p> 	
<p>Article 2.8 Alternatives to Traditional Welding Preheat</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 2.9 Alternatives to Postweld Heat Treatment</p>	<p><i>ASME XI CC N-432</i> <i>Repair Welding Using Automatic or Machine Gas Tungsten-Arc Welding (GTAW) Temper Bead Technique</i> <u><i>Inquiry:</i></u> <i>May the automatic or machine GTAW process be used as an alternative to the SMAW process for performing the temper bead technique on Class 1 components?</i></p> <p><i>ASME XI CC N-606</i> <i>Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique for BWR CRD Housing/Stub Tube Repairs.</i> <u><i>Inquiry:</i></u> <i>May the automatic or machine GTAW temper bead technique be used without use of preheat or postweld heat treatment on Class 1, BWR CRD housing or stub tube repairs?</i></p> <p><i>ASME XI CC N-762</i> <i>Temper Bead Procedure Qualification Requirements for Repair/Replacement Activities Without Postweld Heat Treatment.</i> <u><i>Inquiry:</i></u> <i>Under what conditions may the provisions for procedure qualification of temper bead welding of QW-290 be used in lieu of the procedure qualification requirements of IWA-4600, when postweld heat treatment will not be performed?</i></p>
<p>Article 2.10 In-Service Welding onto Carbon Steel Pressure Components or Pipelines</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 2.11 Weld Buildup, Weld Overlay, and Clad Restoration</p>	<p><i>ASME XI CC N-740</i> <i>Full Structural Dissimilar Metal Weld Overlay for Repair or Mitigation of Class 1, 2, and 3 Items</i> <u><i>Reply:</i></u> <i>It is the opinion of the Committee that, in lieu of the requirements of IWA-4410 and IWA-4611, a defect in austenitic stainless steel or austenitic nickel alloy piping, components, or associated welds may be reduced to a flaw of acceptable size in accordance with</i></p>

	<p><i>IWB-3640 by addition of a repair weld overlay. In addition, for these materials, in lieu of IWA-4410, a mitigative weld overlay may be applied. All Section XI references are to the 2007 Edition with the 2008 Addenda. For the use of this Case with other editions and addenda, refer to Table 1. The weld overlay shall be applied by deposition of weld reinforcement (weld overlay) on the outside surface of the piping, component, or associated weld, including ferritic materials when necessary, provided the following requirements are met.</i></p> <p>ASME XI CC N-576 <i>Repair of Classes 1 and 2 SB-163, UNS N06600 Steam Generator Tubing</i> <u>Inquiry:</u> <i>In lieu of meeting the requirements of the Construction Code, as required by IWA-4411, 1 may SB-163, UNS N06600, steam generator tubing be repaired by applying a laser beam weld (LBW) deposit on the inside surface of the steam generator tubing?</i></p> <p>ASME XI Appendix Q <i>Weld Overlay Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping Weldments</i> <i>This Nonmandatory Appendix provides an alternative to the requirements of IWA-4420, IWA-4520, IWA-4530, and IWA-4600 for making repairs to, and subsequent examination of Class 1, 2, and 3 austenitic stainless steel pipe weldments [with an internal ID flaw] by deposition of weld reinforcement (weld overlay) on the outside surface of the pipe.</i></p>
<p>Article 2.12 Fillet Welded Patches</p> 	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 2.13 Threaded or Welded Plug Repairs</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 2.14 Field Heat Treating of Vessels</p>	<p><i>No explicit ASME XI equivalent</i></p>


ASME PCC-2 Part 3 Mechanical Repairs

ASME PCC-2	ASME Section XI (with excerpt)
Article 3.1 Replacement of Pressure Components	<i>IWA-4000 Repair Replacement Activities</i>
Article 3.2 Freeze Plugs	<i>No explicit ASME XI equivalent</i>

	
<p>Article 3.3 Damaged Threads in Tapped Holes</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 3.4 Flaw Excavation and Weld Repair</p>	<p><i>ASME XI IWA-4420</i> DEFECT REMOVAL REQUIREMENTS <i>IWA-4421 General Requirements</i> <i>Defects shall be removed or mitigated in accordance with the following requirements:</i> <i>(a) Defect removal by mechanical processing shall be in accordance with IWA-4462.</i> <i>(b) Defect removal by thermal methods shall be in accordance with IWA-4461.</i> <i>(c) Defect removal or mitigation by welding or brazing shall be in accordance with IWA-4411.</i> <i>(d) Defect removal or mitigation by modification shall be in accordance with IWA-4340.</i></p>
<p>Article 3.5 Flange Repair and Conversion</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 3.6 Mechanical Clamp Repair</p> 	<p><i>ASME XI IWA-4133 Mechanical Clamping Devices Used as Piping Pressure Boundary</i></p>
<p>Article 3.7 Pipe Straightening or Alignment Bending</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 3.8 Damaged Anchors in Concrete (Post-installed Mechanical Anchors)</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 3.11 Hot and Half Bolting Removal Procedures</p>	<p><i>No explicit ASME XI equivalent</i></p>
<p>Article 3.12 Inspection and Repair of Shell and Tube Heat Exchangers</p>	<p><i>IWA-4700 Heat Exchanger Tubing [repair]</i> <i>IWA-4710 Plugging</i> <i>IWA-4720 Sleeving</i></p>

ASME PCC-2 Part 4 Nonmetallic and Bonded Repairs

<p>ASME PCC-2</p>	<p>ASME Section XI (with excerpt)</p>
<p>Article 4.1 Nonmetallic Composite Repair Systems: High-Risk Applications</p>	<p>Section XI Code Case possibly later.</p>
<p>Article 4.2 Nonmetallic Composite Repair Systems:</p>	<p>Section XI Code Case possibly later.</p>

<p>Low-Risk Applications</p> 	
<p>Article 4.3 Nonmetallic Internal Lining for Pipe: Sprayed Form for Buried Pipe</p>	<p>Section XI Code Case possibly later.</p>

ASME PCC-2 Part 5 Examination and Testing

<p>ASME PCC-2</p>	<p>ASME Section XI</p>
<p>Article 5.1 Pressure and Tightness Testing of Piping and Equipment</p>	<p>See response to Article 5.2</p>
<p>Article 5.2 Nondestructive Examination in Lieu of Pressure Testing for Repairs and Alterations</p>	<p><i>ASME XI IWA-4540 PRESSURE TESTING OF CLASSES 1, 2, AND 3 ITEMS</i></p> <p><i>(a) Unless exempted by (b), repair/replacement activities performed by welding or brazing on a pressure retaining boundary shall include a hydrostatic or system leakage test in accordance with Article IWA-5000, prior to, or as part of, returning to service. Only brazed joints and welds made in the course of a repair/replacement activity require pressurization and VT-2 visual examination during the test.</i></p> <p><i>(b) The following are exempt from any pressure test:</i></p> <ul style="list-style-type: none"> <i>(1) cladding</i> <i>(2) heat exchanger tube plugging and sleeving</i> <i>(3) welding or brazing that does not penetrate through the pressure boundary</i> <i>(4) flange seating surface when less than half the flange axial thickness is removed and replaced</i> <i>(5) components or connections NPS 1 (DN 25) and smaller</i> <i>(6) tube-to-tubesheet welds when such welds are made on the cladding</i> <i>(7) seal welds</i> <i>(8) welded or brazed joints between non-pressure retaining items and the pressure-retaining portion of the components</i> <i>(9) valve discs or seat</i>

	<p>ASME XI CC N-416 <i>Alternative Pressure Test Requirement for Welded or Brazed Repairs, Fabrication Welds or Brazed Joints for Replacement Parts and Piping Subassemblies, or Installation of Replacement Items by Welding or Brazing, Classes 1, 2, and 3.</i> <u>Inquiry:</u> What pressure test may be performed in lieu of a hydrostatic pressure test for welded or brazed repairs, fabrication welds or brazed joints for replacement parts and piping subassemblies, or installation of replacement items by welding or brazing?</p> <p>ASME XI CC N-843 <i>Alternative Pressure Testing Requirements Following Repairs or Replacements for Class 1 Piping Between the First and Second Inspection Isolation Valves.</i> <u>Inquiry:</u> What alternative rules to the test pressure required by IWB-5221 may be applied following repair or replacement activities for that portion of Class 1 boundary between the first and second isolation valves in the injection path of Class 2 safety systems?</p> <p>ASME XI CC N-795 <i>Alternative Requirements for BWR Class 1 System Leakage Test Pressure Following Repair/Replacement Activities</i> <u>Inquiry:</u> What alternative to the pressure corresponding to 100% rated reactor power, of IWB-5221(a), may be used during a BWR Class 1 system leakage test following repair/replacement activities?</p>
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ASME XI Repair techniques that have no equivalent in PCC-2.

ASME XI CC N-569

Alternative Rules for Repair by Electrochemical Deposition of Classes 1 and 2 Steam Generator Tubing

Inquiry: As an alternative to IWA-4000, is it permissible to establish the acceptability of steam generator tubing by electrochemical deposition of material on the inside surface of the tube?

ASME XI CC N-666

Weld Overlay of Class 1, 2, and 3 Socket Welded Connections

Inquiry: As an alternative to the defect removal provisions of IWA-4420,1 may the structural integrity of a cracked or leaking socket weld, if the failure is a result of vibration fatigue, be restored by installation of weld overlay on the outside surface of the pipe, weld, fitting, or flange?