

ERRATA

Approval Date: April 25, 2016

Code Cases will remain available for use until annulled by the applicable Standards Committee.

Case N-661-3
Alternative Requirements for Wall Thickness
Restoration of Class 2 and 3 Carbon Steel Piping for Raw
Water Service
Section XI, Division 1

Inquiry: As an alternative to replacement or internal weld repair, what requirements may be applied for wall thickness restoration of Class 2 and 3 carbon steel raw water¹ piping systems that have experienced internal wall thinning from localized erosion, corrosion, cavitation, or pitting?

Reply: It is the opinion of the Committee that areas of Class 2 and 3 carbon steel raw water piping experiencing internal wall thinning from localized erosion, corrosion, cavitation, or pitting may have the wall thickness restored externally by means of a weld-deposited carbon or low-alloy steel overlay on the outside surface of the piping in accordance with the following requirements. Excluded from these provisions are conditions involving corrosion-assisted cracking or any other form of cracking.

1 GENERAL REQUIREMENTS

(a) The wall thickness overlay shall be performed in accordance with a Repair/Replacement Plan satisfying the requirements of IWA-4150.²

(b) The wall thickness overlay shall meet the requirements of Article IWA-4000, except as stated in this Case.

(c) If the minimum required thickness of deposited weld metal necessary to satisfy the requirements of is greater than the nominal thickness for the size and schedule of the piping, the provisions of this Case shall not apply.

(d) Weld overlay shall only be performed once in the same location.

¹ Raw water is defined as water such as from a river, lake, or well or brackish or salt water used in plant equipment, area coolers, and heat exchangers. In many plants it is referred to as "Service Water."

² Design thickness as prescribed by the Construction Code.

2 INITIAL EVALUATION

The material beneath the surface to which the weld overlay is to be applied shall be ultrasonically examined in accordance with Section V, Article 5, to verify no crack-like indications exist. The existing average wall thickness and the rate, extent, and configuration of degradation to be reinforced by the weld overlay shall be determined. The adjacent area shall be examined to verify that the overlay will encompass the entire unacceptable area. Consideration shall be given to the cause of degradation. The extent of degradation in the piping, shall be evaluated to ensure that there are no other unacceptable locations within the surrounding area that could affect the integrity of the overlaid piping. The dimensions of the surrounding area to be evaluated shall be determined by the Owner, considering the type of degradation present. The effect of the overlay on the piping, and any remaining degradation shall be evaluated in accordance with IWA-4160.

3 DESIGN

3.1 GENERAL DESIGN REQUIREMENTS

(a) Unless otherwise established by theoretical or experimental analysis, or by proof testing as provided for in 3.3 or 3.4, the full thickness of the weld overlay shall extend a distance of at least *s* in each direction beyond the area predicted, over the design life of the overlay to infringe upon the required thickness³ where

$$s \geq 0.75 \sqrt{Rt_{nom}}$$

where

R = outer radius of the component

t_{nom} = nominal wall thickness of the component

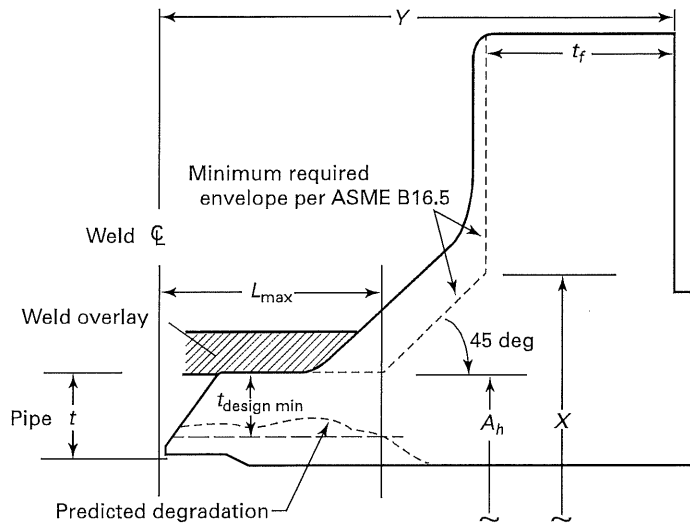
Edges of the weld overlay shall be tapered to the existing piping surface at a maximum angle ("α" in Figure 1) of 45 deg. Final configuration of the overlay shall permit the

The Committee's function is to establish rules of safety, relating only to pressure integrity, governing the construction of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations or other relevant documents.

2015 Edition

2 The references to Section XI in this Case refer to the 2017 Edition. For use of this Case with other Editions and Addenda, refer to Table 1 of the Guideline for Cross-Referencing Section XI Cases.

Figure 2
Overlay at Welding Neck Flange



Legend:

L_{max} = maximum length of corroded area with $t < t_{design\ min}$
 $= Y - t_f - (X - A_h)/2$

- A_h = diameter at beginning of chamfer
- t_f = minimum thickness of flange
- X = diameter of hub
- Y = welding neck length through hub

GENERAL NOTE: All as defined in ASME B16.5, Table II-8 or Table II-11, as applicable.

(d) The finished overlay shall be circular, oval, full-circumferential or rectangular in shape.

(1) For each repair, the maximum dimension compensated by a circular overlay shall not exceed $2/3$ the nominal outside diameter of the piping.

(2) Rectangular overlays shall be aligned parallel with or perpendicular to the axis of the piping, and corners shall be rounded with radii not less than the overlay thickness.

(3) For oval overlays, the end radii shall not be less than $3/4 \sqrt{Rt_{nom}}$, and the axis of the overlay shall be aligned parallel with or perpendicular to the axis of the piping.

(e) The distance between toes of adjacent overlays shall not be less than t_{nom} , except as provided in (a)(1).

(f) Weld overlays on welding neck flanges shall be in accordance with Figure 2.

4 WATER-BACKED APPLICATIONS

(a) Manual application of overlays on water-backed piping shall be restricted to P-No. 1 base materials. Welding of such overlays shall use the SMAW process and low-hydrogen electrodes. In addition, the surface examination required in 6 shall be performed no sooner than 48 hr after completion of welding.

(b) Areas to be overlaid with wall thickness less than the diameter of the electrode shall be depressurized prior to welding. ³ ← 4

(c) If a weld overlay is made on a wet surface, the permitted life of the overlay shall be until the end of the next refueling outage.

5 INSTALLATION

(a) The entire surface area to which the weld overlay is to be applied shall be examined using the liquid penetrant or magnetic particle method, with acceptance criteria in

4 → ³ Testing has shown that piping with areas of wall thickness less than the diameter of the electrode may burn through during application of a water-backed weld overlay.

accordance with NC-2500 or ND-2500, or NC-5300 or ND-5300, for the product form (base metal or weld) involved.

(b) If through-wall repairs are necessary to satisfy the acceptance criteria, or to correct burn-through during application of the weld overlay, they may be accomplished by closing the gap with weld metal using a qualified welding procedure suitable for open-root welding. This weld shall be examined in accordance with (a). In addition, the first layer of overlay over the repaired area shall be examined in accordance with (a).

(c) Overlay weld metal shall be deposited using a groove-welding procedure qualified in accordance with Section IX and the Construction Code, or Section IX and Section XI, IWA-4610 and either IWA-4620 or IWA-4650. The qualified minimum thickness specified in the weld procedure does not apply to the weld overlay or associated base metal repairs.

(d) The surface of the weld overlay shall be prepared by machining or grinding, as necessary, to permit performance of surface and volumetric examinations required by 6. For ultrasonic examination, a surface finish of 250 RMS or better is required.

6 EXAMINATION

(a) The completed weld overlay shall be examined using the liquid penetrant or magnetic particle method and shall satisfy the surface examination acceptance criteria for welds of the Construction Code, or NC-5300 or ND-5300, as applicable.

(b) The weld overlay, including the existing piping upon which it is applied, shall be examined to verify acceptable wall thickness.

(c) Weld overlays shall be volumetrically examined as base metal repairs when required by the Construction Code, except as follows:

(1) Class 3 weld overlays are exempt from volumetric examination when the Construction Code does not require that full-penetration butt welds in the same location be volumetrically examined.

(2) Weld overlays not exceeding 10 in.² (6 500 mm²) surface area are exempt from volumetric examination.

(3) Other weld overlays shall be exempt from volumetric examination when the finished applied thickness (w in Figure 1) does not exceed:

(-a) $\frac{1}{3}t$ for $t \leq \frac{3}{4}$ in. (19 mm)

(-b) $\frac{1}{4}$ in. (6.4 mm) for $\frac{3}{4}$ in. (19 mm) $< t \leq 2\frac{1}{2}$ in. (64 mm)

(-c) The lesser of $\frac{3}{8}$ in. (9.5 mm) or 10% of t for $t > 2\frac{1}{2}$ in. (64 mm)

t is finished full-section thickness of compensated area (e.g., $w + u$ in Figure 1)

(4) When volumetric examination is required, the full volume of the finished overlay, excluding the tapered edges, but including the volume of base metal required for the service life of the overlay, shall be examined in accordance with the Construction Code or Section III, using either the ultrasonic or radiographic method, and shall, to the depth at the surface of the existing piping, satisfy the acceptance criteria for weldments of the Construction Code, or NC-5300 or ND-5300, as applicable. Any volume of existing piping beneath the weld overlay that is taken credit for in the design, shall satisfy the volumetric acceptance criteria of NC-2500 or ND-2500, or NC-5300 or ND-5300, as applicable.

7 INSERVICE EXAMINATION

(a) Examinations shall be performed to characterize the thinning of the underlying pipe wall as a benchmark for subsequent examinations of the overlay.

(b) The Owner shall prepare a plan for additional examination to verify that minimum wall thickness is not violated over the life of the overlay. The frequency and method of examination shall be determined based on an evaluation of the degradation mechanism.

(c) Except as required by 4(c), the maximum permitted life of the overlay shall be two fuel cycles, unless examinations during each of the two fuel cycles are performed to establish the permitted life of the overlay. If the cause of the degradation is not determined, the maximum permitted life of the overlay shall be until the end of the next refueling outage.

8 DOCUMENTATION

Use of this Case shall be documented on an NIS-2 Form.

5 → ⁴ Exception to IWA-4000.

**Table 1
Cross-Reference List for Section XI Cases (Cont'd)**

E15	E10-E13	A09	A08	E07	A06	A05	E04	A03	A02	E01	A00	A09	E98	A97	A96
...	...	...	...	...	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)	B-2412(b)
B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)	B-2420(b)
B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430	B-2430
TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1	TB-2500-1
B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140	B-3140
B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514	B-3514
B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517	B-3517
B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523	B-3523
B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600	B-3600
B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630	B-3630
B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640	B-3640
...
B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000	B-5000
C-2430(a)(1)	C-2430(a)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)	C-2430(b)
(b)	(1)(b)														
C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600	C-3600
C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640	C-3640
...
D-2430(a)	D-2430(a)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)	D-2430(b)
(1)(b)	(1)(b)														
D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600	D-3600
D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640	D-3640

N-661-3

Legend:
A = IWA
B = IWB
C = IWC
D = IWD
TB = Table IWB

GENERAL NOTES:

- (a) This table is for use with Cases N-532-4, N-576-1, N-576-2, N-638-4, N-638-5, N-638-6, N-638-7, N-666, N-666-1, N-730, N-730-1, N-733, N-754-1, N-769, N-769-1, N-769-2, N-771, N-786-1, N-786-2, N-789-2, N-829, N-839, N-847, and N-853.
- (b) When using Case N-532-4 with Code Editions and Addenda later than the 2005 Addenda, the paragraph references listed in Table 1 shall apply.
- (c) When using Cases N-638-4, N-638-5, N-638-6, or N-666 with Code Editions and Addenda later than the 2004 Edition, the paragraph references listed in Table 1 shall apply.
- (d) When using Cases N-576-1 with Code Editions and Addenda later than the 2000 Addenda, the paragraph references listed in Table 1 shall apply. Enter Table 1 in the 2000 Addenda column.
- (e) When using Cases N-730, N-730-1, N-769, N-769-1, or N-769-2 with Code Editions and Addenda later than the 2009 Addenda, the paragraph references listed in Table 1 shall apply. Enter Table 1 in the 2009 Addenda column.
- (f) When using Case N-733 with Code Editions and Addenda later than the 2006 Addenda, the paragraph references listed in Table 1 shall apply. Enter Table 1 in the 2006 Addenda column.
- (g) When using Case N-771 with Code Editions and Addenda later than the 2009 Addenda, the paragraph references listed in Table 1 shall apply. Enter Table 1 in the 2009 Addenda column.

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Record No. 15-668

Approved SG-RRA Nov. 4, 2015 10-0-1

Case N-661-23

Alternative Requirements for Wall Thickness Restoration of Class 2 and 3 Carbon Steel Piping for Raw Water Service

Section XI, Division 1

Inquiry:

As an alternative to replacement or internal weld repair, what requirements may be applied for wall thickness restoration of Class 2 and 3 carbon steel raw water¹ piping systems that have experienced internal wall thinning from localized erosion, corrosion, cavitation, or pitting?

Reply:

It is the opinion of the Committee that areas of Class 2 and 3 carbon steel raw water piping experiencing internal wall thinning from localized erosion, corrosion, cavitation, or pitting may have the wall thickness restored externally by means of a weld-deposited carbon or low-alloy steel overlay on the outside surface of the piping in accordance with the following requirements. Excluded from these provisions are conditions involving corrosion-assisted cracking or any other form of cracking.

1 GENERAL REQUIREMENTS

(a) The wall thickness overlay shall be performed in accordance with a Repair/Replacement Plan satisfying the requirements of IWA-4150.²

(b) The wall thickness overlay shall meet the requirements of IWA-4000,³ except as stated in this Case.

¹ Raw water is defined as water such as from a river, lake, or well or brackish/ or salt water used in plant equipment, area coolers, and heat exchangers. In many plants it is referred to as "Service Water."

(c) If the minimum required thickness of deposited weld metal necessary to satisfy the requirements of 3 is greater than the nominal thickness for the size and schedule of the piping, the provisions of this Case shall not apply.

(d) Weld overlay shall only be performed once in the same location.

2 INITIAL EVALUATION

The material beneath the surface to which the weld overlay is to be applied shall be ~~evaluated~~~~examined~~ ultrasonically examined in accordance with Section V, Article 5, to verify no crack-like indications exist. ~~to establish~~ ~~†~~ The existing average wall thickness and the rate, extent, and configuration of degradation to be reinforced by the weld overlay shall be determined. The adjacent area shall be examined to verify that the overlay will encompass the entire unacceptable area. Consideration shall be given to the cause of degradation. The extent of degradation in the piping, shall be evaluated to ensure that there are no other unacceptable locations within the surrounding area that could affect the integrity of the overlaid piping. The dimensions of the surrounding area to be evaluated shall be determined by the Owner, considering the type of degradation present. The effect of the overlay on the piping, and any remaining degradation, shall be evaluated in accordance with IWA-4160.⁴

3 DESIGN

3.1 GENERAL DESIGN REQUIREMENTS

(a) Unless otherwise established by theoretical or experimental analysis, or by proof testing as provided for in 3.3 or 3.4, the full thickness of the weld overlay shall extend a distance of at least s in each direction beyond the area predicted, over the design life of the overlay to infringe upon the required thickness.⁵²

where

R = outer radius of the component

s = $\geq \frac{3}{4} \sqrt{R t_{nom}}$

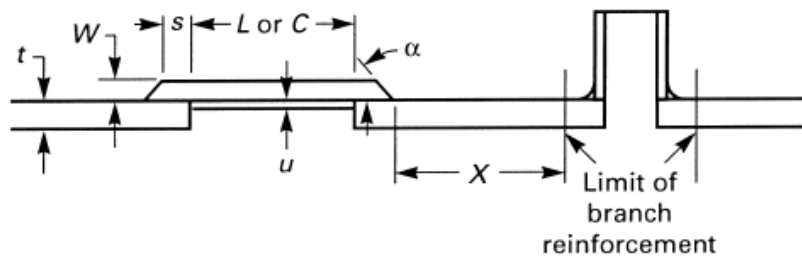
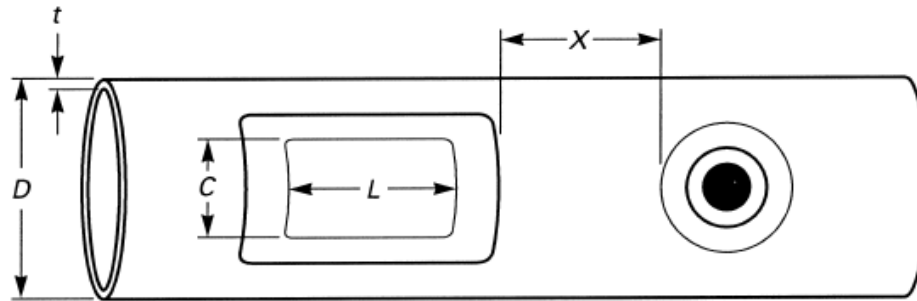
t_{nom} = nominal wall thickness of the component

² Design thickness as prescribed by the Construction Code.

Edges of the weld overlay shall be tapered to the existing piping surface at a maximum angle (“ α ” in Figure 1) of 45 deg. Final configuration of the overlay shall permit the examinations and evaluations required herein, including any required preservice or inservice examinations of encompassed or adjacent welds.

Figure 1
Overlay Configuration

placeholder for graphic BPVC-CC-NC-N-661-001



$$X \geq 2^{1/2} \sqrt{Rt_{\text{nom}}}$$

(b) The thickness shall be sufficient to maintain required thickness for the predicted life of the overlay, and, except for the tapered edges, the overlay shall have a uniform thickness.

(c) The tensile strength of the weld filler metal for the overlay shall be at least that specified for the base metal to which it is applied.

(d) The predicted maximum degradation of the overlaid piping and the overlay over the design life of the overlay shall be considered in the design. The predicted degradation of the piping shall be based on in situ inspection and established data for similar base metals. If the weld overlay is predicted to become exposed to the corroding medium, the predicted degradation of the overlay shall be based upon established data for base metals or weld metals with similar chemical composition to that of the filler metal used for the weld overlay.

(e) The effect of weld overlay application on interior coatings shall be addressed in the Repair/Replacement Plan (~~previously Repair Program~~).

3.2 Design.

The design of weld overlays not prequalified by 3.3, 3.4, or 3.5 shall be in accordance with the applicable requirements of the Construction Code or NC-3100, ND-3100 and NC-3600, ND-3600 (including Appendix II), and shall consider the weld overlay as an integral portion of the piping or component upon which it is applied (not as a weld). The allowable stress values of the base metal shall apply to the design of the deposited weld metal. The following factors shall be considered, as applicable, in the design and application of the overlay:

(a) The shrinkage effects, if any, on the piping;

(b) Stress concentrations caused by application of the overlay or resulting from existing and predicted piping internal surface configuration;

(c) If flexibility analysis was required by the original Construction Code, the effect of the weld overlay shall be reconciled with the original analysis. For rectangular-shaped overlays on piping designed to NC-3650, ND-3650 and aligned parallel or perpendicular to the axis of the piping, unless a lower stress intensification factor (SIF or *i*) is established, an SIF (*i*) of 2.1 shall be applied for overlays on straight pipe and adjacent welds. Also, a stress *multiplier* of 1.7 shall be applied to the SIF (*i*) for standard elbows; and an SIF (*i*) of 2.1 shall be applied for tees and branch

connections when the toe of the overlay is not less than $2\frac{1}{2}\sqrt{Rt_{nom}}$ from any branch reinforcement in Figure 1.

3.3 Proof Test Qualification as a Piping Product.

As an alternative to design, the configuration of weld overlays may be qualified by performance of proof testing of a mockup in accordance with the following requirements:

(a) A satisfactory mockup burst test shall qualify the design or configuration for application in the same orientation on the same type of item, and the same location on fittings, when the following conditions are satisfied (see Figure 1).

(1) The base metal is of the same P-No. and Group Number when impact properties are applicable, as the base metal tested.

(2) The specified minimum tensile strength of the item does not exceed that specified for the base metal tested.

(3) The average thickness of the overlay areas is at least the thickness of the mockup plug, u .

(4) The overlap on the full thickness of base metal, s , is at least that of the mockup.

(5) The transition angle at the outer edges of the overlay, α , is not greater than that of the mockup.

(6) The overlay surface finish is similar to or smoother than that tested.

(7) The maximum proportionate axial dimension, L/D , is not more than that tested.

(8) The maximum proportionate circumferential dimension, C/D , is not more than that tested.

(9) The nominal diameter is not less than one-half nor more than two times the diameter tested.

(10) The nominal thickness/diameter ratio, t/D , is not less than one-half nor more than three times the t/D , ratio tested.

(b) The mockup base shall consist of new base material of similar configuration, or type of item, as the item to be overlaid. A rounded-corner segment of the base material shall be removed to represent the maximum proportionate size (axial dimension of L and circumferential dimension of C) and location of thinning or pitting to be compensated for by the weld overlay. A plug of the same base metal and of uniform thickness, u , which shall not exceed the smallest average thickness on which the overlays will be permanently applied, shall be full-penetration welded around the opening and flush with the outside surface of the piping. Alternatively, an equivalent volume of base metal may be removed from the inside surface of the mockup by machining or grinding, without need for welding in a closure plug.

(c) The mockup weld overlay shall be applied in accordance with the design or specified configuration using the specified weld filler metal. Maximum section thickness at the overlaid opening (weld metal plus base metal plug, or $u + w$) shall not exceed 87½% of the nominal thickness of the piping.

(d) Straight pipe equivalent to a minimum of one pipe diameter, or one-half diameter for piping over NPS 14 (DN 350), shall be provided (butt-welded to the mockup, if necessary) beyond both ends of the overlay. The piping shall be capped, and the completed mockup assembly shall be

thoroughly vented and hydrostatically pressure tested to bursting. To qualify the design for general application within the limits of (a), burst pressure shall not be less than:

$$P = \frac{2tS_{act}}{D_o}$$

where

D_o = outside diameter of the pipe

P = minimum acceptable burst pressure

S_{act} = reported actual tensile strength of the base metal being tested

t = minimum specified thickness (excluding manufacturing tolerances) of the base metal being tested

(e) If flexibility analysis was required by the original Construction Code, the effect of the weld overlay shall be reconciled in accordance with 3.2(c).

3.4 Proof Test Qualification for Specific Applications.

As an alternative to design by analysis or proof test qualification as a piping product, the design or configuration of weld overlays may be qualified for limited service conditions using the provisions of NC-6900 and ND-6900, "Proof Tests to Establish Design Pressure," except that component hydrostatic testing is not required (other than as required by IWA-4000³). The mockups shall be fabricated and tested in accordance with the provisions of 3.3(b), 3.3(c), and 3.3(d), and shall be applied in accordance with the provisions and conditions of 3.3(a). The provisions of 3.3(e) shall be met.

3.5 Prequalified Design.

Application of weld overlays on straight pipe, portions of tees not less than $2\frac{1}{2}\sqrt{Rt_{nom}}$ from any branch reinforcement in Figure 1, standard elbows, welding neck flanges, and associated welds to correct limited degradation shall be exempt from the requirements of 3.2 through 3.4 provided all of the following conditions are satisfied.

(a) All the requirements of 3.1 apply, with the following exceptions:

(1) When the required “s” dimension cannot be achieved due to close proximity of an existing weld overlay, two weld overlays may be combined provided the resultant shape and size complies with all of the requirements of 3.5(b) through 3.5(f). This provision may not be applied to mitigate expansion of degradation beneath an existing overlay.

(2) The “s” dimension does not apply to portions of weld overlays extending in the axial direction to the reinforced area of welding neck flanges, as shown in Figure 2.

(b) The provisions of 3.3(e) shall be met.

(c) The full thickness of weld overlay shall not exceed a maximum axial length of the greater of 6 in. (150 mm) or the outside diameter of the piping.

(d) The finished overlay shall be circular, oval, full-circumferential or rectangular in shape.

(1) For each repair, the maximum dimension compensated by a circular overlay shall not exceed $\frac{2}{3}$ the nominal outside diameter of the piping.

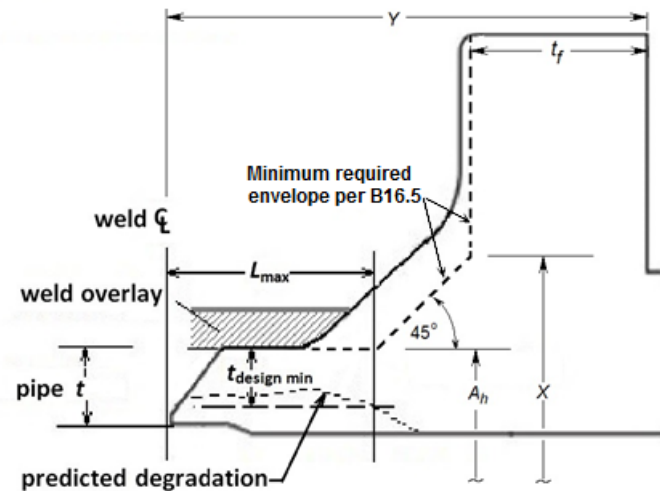
(2) Rectangular overlays shall be aligned parallel with or perpendicular to the axis of the piping, and corners shall be rounded with radii not less than the overlay thickness.

(3) For oval overlays, the end radii shall not be less than $\frac{3}{4}\sqrt{Rt_{nom}}$, and the axis of the overlay shall be aligned parallel with or perpendicular to the axis of the piping.

(e) The distance between toes of adjacent overlays shall not be less than t_{nom} , except as provided in 3.5(a)(1).

(f) Weld overlays on welding neck flanges shall be in accordance with Figure 2.

Figure 2
Overlay at Welding Neck Flange



$$L_{\max} = \text{maximum length of corroded area with } t < t_{\text{design min}} \\ = Y - t_f - (X - A_h)/2$$

where:

Y = welding neck length through hub,

t_f = minimum thickness of flange,

X = diameter of hub,

A_h = diameter at beginning of chamfer;

all as defined in ASME B16.5, Table II-8 or Table II-11, as applicable.

4 WATER-BACKED APPLICATIONS

(a) Manual application of overlays on water-backed piping shall be restricted to P-No. 1 base materials. Welding of such overlays shall use the SMAW process and low-hydrogen electrodes. In addition, the surface examination required in 6 shall be performed no sooner than 48 hr after completion of welding.

(b) Weld overlay areas to be overlaid with wall thickness less than the diameter of the electrode shall be depressurized prior to welding.³

3 Testing has shown that piping with areas of wall thickness less than the diameter of the electrode may burn through during application of a water-backed weld overlay.

~~(b)~~ If a weld overlay is made ~~in accordance with 5(b)~~ on a wet surface, the permitted life of the overlay shall be ~~one fuel cycle until the end of the next refueling outage.~~

5 INSTALLATION

(a) The entire surface area to which the weld overlay is to be applied shall be examined using the liquid penetrant or magnetic particle method, with acceptance criteria in accordance with NC-2500, ~~or~~ ND-2500, ~~or~~ NC-5300, ~~or~~ ND-5300 for the product form (base metal or weld) involved.

(b) If through-wall repairs are necessary to satisfy the acceptance criteria, or ~~result from to~~ ~~correct burn-through during~~ application of the weld overlay, ^{6 4} they ~~shall~~ ~~may~~ be accomplished by ~~sealing-closing the gap~~ with weld metal using a qualified welding procedure suitable for open-root welding. This weld shall be examined in accordance with (a). In addition, the first layer of overlay over the repaired area shall be examined in accordance with (a).

(c) Overlay weld metal shall be deposited using a groove-welding procedure qualified in accordance with Section IX and the Construction Code, or Section IX and Section XI, IWA-4610 and either IWA-4620 or IWA-4650. ^{7 4} ~~_____~~ The qualified minimum thickness specified in the weld procedure does not apply to the weld overlay or associated base metal repairs. ^{8 4}

(d) The surface of the weld overlay shall be prepared by machining or grinding, as necessary, to permit performance of surface and volumetric examinations required by 6. For ultrasonic examination, a surface finish of 250 RMS or better is required.

6 EXAMINATION

(a) The completed weld overlay shall be examined using the liquid penetrant or magnetic particle method and shall satisfy the surface examination acceptance criteria for welds of the Construction Code, ~~or~~ NC-5300 ~~and or~~ ND-5300, ~~as applicable.~~

(b) The weld overlay, including the existing piping upon which it is applied, shall be examined to verify acceptable wall thickness.

(c) Weld overlays shall be volumetrically examined as base metal repairs when required by the Construction Code, except as follows:

(1) Class 3 weld overlays are exempt from volumetric examination when the Construction Code does not require that full-penetration butt welds in the same location be volumetrically examined.

4 [Exception to IWA-4000.](#)

(2) Weld overlays not exceeding 10 in.² (6 500 mm²) surface area are exempt from volumetric examination.

(3) Other weld overlays shall be exempt from volumetric examination when the finished applied thickness (w in [Figure 1](#)) does not exceed:

(-a) $1/3t$ for $t \leq 3/4$ in. (19 mm)

(-b) $1/4$ in. (6.4 mm) for $3/4$ in. (19 mm) $< t \leq 2 1/2$ in. (64 mm)

(-c) The lesser of $3/8$ in. (9.5 mm) or 10% of t for $t > 2 1/2$ in. (64 mm)

where

t = finished full-section thickness of compensated area (e.g., $w + u$ in [Figure 1](#))

(4) When volumetric examination is required, the full volume of the finished overlay, excluding the tapered edges, but including the volume of base metal required for the service life of the overlay, shall be examined in accordance with the Construction Code or Section III, using either the ultrasonic or radiographic method, and shall, to the depth at the surface of the existing piping, satisfy the acceptance criteria for weldments of the Construction Code, or NC-5300, or ND-5300, as applicable. Any volume of existing piping beneath the weld overlay that is taken credit for in the design, shall satisfy the volumetric acceptance criteria of NC-2500, or ND-2500, or NC-5300, or ND-5300, as applicable.

7 ~~IN-SERVICE~~ INSERVICE EXAMINATION

(a) Examinations shall be performed to characterize the thinning of the underlying pipe wall as a benchmark for subsequent examinations of the overlay.

(b) The Owner shall prepare a plan for additional examination to verify that minimum wall thickness is not violated over the life of the overlay. The frequency and method of examination shall be determined based on an evaluation of the degradation mechanism.

(c) Except as required by [4\(b,c\)](#), the maximum permitted life of the overlay shall be two fuel cycles, unless examinations during each of the two fuel cycles are performed to establish the permitted life of the overlay. If the cause of the degradation is not determined, the maximum permitted life of the overlay shall be ~~one fuel cycle~~ [until the end of the next refueling outage.](#)

8 DOCUMENTATION

Use of this Case shall be documented on an NIS-2 Form.

~~1—Raw water is defined as water such as from a river, lake, or well or brackish/salt water used in plant equipment, area coolers, and heat exchangers. In many plants it is referred to as “Service Water.”~~

END OF NOTE

~~2 IWA-4140 in the 1989 Edition with the 1991 Addenda through the 1995 Edition. IWA-4130 (Repair Program) in the 1989 Edition with the 1990 Addenda and earlier Editions and Addenda. The references to Section XI in this Case refer to the 2015 Edition. For use of this Case with other Editions and Addenda refer to Table 1 of the Code Case Applicability Index.~~

END OF NOTE

~~3—IWA-4000/7000 and IWC/IWD-4000/7000, as applicable, in the 1989 Edition with the 1990 Addenda and earlier Editions and Addenda.~~

END OF NOTE

~~4—IWA-4150 in the 1989 Edition with the 1991 Addenda through the 1995 Edition. IWA-4130 (Repair Program) in the 1989 Edition with the 1990 Addenda and earlier Editions and Addenda.~~

END OF NOTE

~~5—Design thickness as prescribed by the Construction Code.~~

END OF NOTE

~~6—Testing has shown that piping with areas of wall thickness less than the diameter of the electrode may burn through during application of a water-backed weld overlay.~~

END OF NOTE

~~7—IWA-4500 and either IWA-4510 or IWA-4540 in the 1989 Edition with the 1991 Addenda through the 1995 Edition. IWA-4510 or IWE-4200 in the 1986 Edition with the 1988 Addenda through the 1989 Edition with the 1990 Addenda. IWB-4320 or IWE-4320 in the 1986 Edition with the 1987 Addenda or earlier Editions and Addenda.~~

END OF NOTE

~~8—Exception to IWA-4000.~~

END OF NOTE

Add the following paragraphs to the Applicability Index Cross-reference Table

E15	E13	A12	A11	E10	A09	A08	E07	A06	A05	E04	A03	A02	E01	A00	A99	E98	A97	A96
IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610	IWA-4610
IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620	IWA-4620
IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650	IWA-4650

GENERAL NOTE: This table is for use with Cases ... **N-661-3**.
