Entergy Operations, Inc.
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

Bryan S. Ford
Senior Manager,
Fleet Regulatory Assurance

CNRO-2015-00018

August 20, 2015

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Relief Request Number RR EN-15-2 - Proposed Alternative to Use ASME Code Case N-786-1, "Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping, Section XI, Division 1"

Arkansas Nuclear One, Units 1 & 2
Docket Nos. 50-313 & 50-368
License Nos. DPR-51 & NPF-6

Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

James A. Fitzpatrick Nuclear Power Plant
Docket No. 50-333
License No. DFR-59

Indian Point Energy Center, Units 2 & 3
Docket Nos. 50-247 & 50-286
License Nos. DPR-26 & DPR-64

Palisades Nuclear Plant
Docket 50-255
License No. DPR-20

Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

River Bend Station, Unit 1
Docket No. 50-458
License No. NPF-47

Waterford 3 Steam Electric Station
Docket No. 50-382
License No. NPF-38

Dear Sir or Madam:

Pursuant to 10 CFR 50.55a(z)(2), Entergy Operations, Inc. and Entergy Nuclear Operations, Inc. (hereafter referred to collectively as "Entergy") request NRC approval of a relief request to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," on the basis that the current code requirements result in hardship and/or unusual difficulty. The proposed relief request is provided in the attachment to this letter.

Specifically, this request is for application of ASME Boiler and Pressure Vessel Code, Code Case N-786-1, for Class 2 and Class 3 moderate energy piping system repairs resulting from degradation mechanisms such as localized erosion, corrosion, cavitation and pitting at the Entergy nuclear plants listed above. The information provided in the attachment demonstrates that the proposed request provides an acceptable level of quality and safety and that compliance with the specified requirements of ASME Section XI would result in a hardship and/or unusual difficulty without a compensating increase in the level of quality and safety.

This relief request is proposed for the 10-year Inservice Inspection (ISI) intervals for the facilities as identified in Section 2 of the attached relief request.

Since this relief request could be needed at any time to address an emergent condition, Entergy requests NRC approval as soon as possible or by August 20, 2016.

This letter contains no new commitments.

If you have any questions, please contact Mr. Guy Davant at (601) 368-5756.

Sincerely,

BSF/ghd/aye

Attachment: Relief Request RR EN-15-2

cc: J. Forbes (ECH)
T. Mitchell (ECH)
J. Ventosa (WPO)
D. Jacobs (ECH)
M. Perito (ECH)
J. Kowalewski (ECH)
M. Woodby (ECH)
J. Browning (ANO)
K. Mulligan (GGNS)
E. Olson (RBS)
M. Chisum (WF3)
B. Sullivan (JAF)
L. Coyle (IPEC)
J. Dent (PIL)
T. Vitale (PAL)
D. Mannai (WPO)
G. H. Davant (ECH)
All above w/o attachments

NRC Region I Administrator
NRC Region III Administrator
NRC Region IV Administrator
NRC Project Manager (ANO)
NRC Project Manager (GGNS)
NRC Project Manager (RBS)
NRC Project Manager (WF3)
NRC Project Manager (IPEC)
NRC Project Manager (JAF)
NRC Project Manager (PIL)
NRC Project Manager (PAL)
NRC Senior Resident Inspector (ANO)
NRC Senior Resident Inspector (GGNS)

NRC Senior Resident Inspector (RBS)
NRC Senior Resident Inspector (WF3)
NRC Senior Resident Inspector (IPEC)
NRC Senior Resident Inspector (JAF)
NRC Senior Resident Inspector (PIL)
NRC Senior Resident Inspector (PAL)

ATTACHMENT

CNRO-2015-00018

RELIEF REQUEST RR EN-15-2

RELIEF REQUEST RR EN-15-2

1. American Society of Mechanical Engineers (ASME) Code Component(s) Affected

This relief request applies to all ASME Class 2 and 3 moderate energy carbon steel piping systems. Moderate energy is defined as less than or equal to 200°F (93°C) and less than or equal to 275 psig (1.9 MPa) maximum operating conditions.

2. Applicable Code Edition and Addenda

The following table identifies the ASME Section XI Code of Record for performing Inservice Inspection (ISI) activities at each Entergy site.

Plant	ISI Interval	ASME Section XI Edition/Addenda	Interval Start	Interval End
Arkansas Nuclear One Unit 1 (ANO-1) (Note 1)	4 5	2001 Edition / 2003 Addenda 2007 Edition/2008 Addenda (Note 3)	5/31/08 5/31/17	5/30/17 5/30/27
Arkansas Nuclear One Unit 2 (ANO-2)	4	2001 Edition / 2003 Addenda	3/26/10	3/25/20
Grand Gulf Nuclear Station (GGNS) (Note 1)	3 4	2001 Edition / 2003 Addenda 2007 Edition/2008 Addenda (Note 3)	5/31/08 6/2/17	6/1/17 6/1/27
Indian Point Energy Center Unit 2 (IPEC-2) (Note 2)	5	2007 Edition / 2008 Addenda	6/1/16	5/31/26
Indian Point Energy Center Unit 3 (IPEC-3)	4	2001 Edition / 2003 Addenda	7/21/09	7/20/19
James A. FitzPatrick (JAF) (Note 1)	4 5	2001 Edition / 2003 Addenda 2007 Edition/2008 Addenda (Note 3)	3/1/07 1/1/17	12/31/16 12/31/26
Palisades (PLP) (Note 2)	5	2007 Edition / 2008 Addenda	12/13/15	12/12/25
Pilgrim Nuclear Power Station (PNPS)	5	2007 Edition / 2008 Addenda	7/1/15	6/30/25
River Bend Station (RBS) (Note 1)	3 4	2001 Edition / 2003 Addenda 2007 Edition/2008 Addenda (Note 3)	5/31/08 12/1/17	11/30/17 11/30/27
Waterford Unit 3 (WF3) (Note 1)	3 4	2001 Edition / 2003 Addenda 2007 Edition/2008 Addenda (Note 3)	5/31/08 7/1/17	6/30/17 6/30/27

Notes:

1) The 3rd ISI intervals for GGNS, RBS, and WF3 and the 4th ISI intervals for ANO-1 and JAF end within 1-1/2 years of the requested relief request approval date. Therefore, Entergy requests the NRC to approve this alternative for the 3rd and 4th GGNS, RBS, and WF3 intervals and 4th and 5th ANO-1 and JAF intervals.

2) The 4th ISI intervals for IPEC-2 and PLP end prior to the requested relief request approval date. Therefore, Entergy requests the NRC to approve this alternative for the 5th IPEC-2 and PLP ISI intervals.

3) ANO-1, GGNS, JAF, RBS, and WF3 will update to the 2007 Edition/2008 Addenda except as otherwise required by the NRC in 10 CFR 50.55a(g)(4)(ii).

The table above identifies the ASME Section XI Code of Record for performing ISI activities at each Entergy nuclear plant. However, it should be noted that ASME Section XI repair/ replacement activities at all Entergy nuclear plants are performed in accordance with a standardized Repair/Replacement Program that is based on a common Edition/Addenda of ASME Section XI which, at present, is the 2001 Edition/ 2003 Addenda. As Entergy nuclear sites update their ISI Programs in accordance with 10 CFR 50.55a(g)(4)(ii), Entergy will also update the Code bases of the Repair/Replacement Program to a later Edition/Addenda of ASME Section XI. The planned update to the Repair/Replacement Program is scheduled for 2017 and no later than December 31, 2017. The Repair/Replacement Program update must comply with 10 CFR 50.55a and, where appropriate, in accordance with 10 CFR 50.55a(g)(4)(iv) and 10 CFR 50.55a(z). (See Reference 2.)

3. Applicable Code Requirements

The Editions/Addenda of ASME Section XI for which the alternative is requested are specified in Section 2, above. Subsection IWA-4000 of these Editions and Addenda provide requirements for welding, brazing, metal removal, and installation of repair/replacement activities.

4. Reason for Request

IWA-4000 requires replacement or internal weld repair of wall thinning conditions resulting from degradation to be in accordance with the Owner's Requirements and the original or later Construction Code. However, the repair and replacement provisions of IWA-4000 cannot always be utilized when degradation or leakage is identified during plant operations. Other approved alternative repair or evaluation methods are not always practicable because of wall thinness and/or moisture issues.

One reason for this request is to permit installation of technically sound repairs to provide adequate time for evaluation, design, material procurement, planning, and scheduling of an appropriate permanent repair or replacement of the defective piping, considering the impact on system availability, maintenance rule applicability, and availability of replacement materials.

The other reason is to permit installation of long-term repairs in the form of full-structural Type B reinforcing sleeves for locally degraded portions of piping systems. The design, construction, and inservice monitoring of such sleeves provide a technically sound equivalent replacement for the segment of piping that is encompassed, comparable to or exceeding the level of quality and safety associated with a permanent ASME Code repair or replacement.

In either case, without this repair option, compliance with the specified requirements of IWA-4000 could in some cases necessitate taking a system out of service, resulting in extended technical specification actions and higher risks associated with loss of safety system availability. In other cases, plant shutdown could be necessary, resulting in higher risks associated with an unnecessary plant transient and loss of safety system availability as compared to maintaining the plant online.

All other ASME Code Section XI requirements for which relief is not specifically requested will remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

5. Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(z)(2), Entergy proposes to implement the requirements of Code Case N-786-1 for repair of degradation in Class 2 and 3 moderate energy carbon steel piping systems resulting from mechanisms such as localized erosion, corrosion, cavitation, or pitting, but excluding conditions involving any form of cracking. These types of defects are typically identified by small leaks in the piping system or by pre-emptive, non-code required examinations performed to monitor the degradation mechanisms.

The alternative repair technique described in Code Case N-786-1 involves the application of Type A and Type B full encirclement sleeve halves welded together with full penetration longitudinal seam welds to reinforce the structural integrity in the degraded area. In the case of Type B reinforcing sleeves, the ends are also welded to the piping in order to restore or maintain pressure integrity. This repair technique will be used when it is determined that the repair method is suitable for the particular defect or degradation being resolved without flaw removal. Code Case N-786-1 is included in Enclosure 1 of this Attachment.

The Code Case requires that the cause of the degradation be determined, and that the extent and rate of degradation in the piping be evaluated to ensure there are no other unacceptable locations within the surrounding area that could affect the integrity of the repaired piping. Any areas showing signs of degradation will be included in the Owner's plan for thickness monitoring of full-structural Type B reinforcing sleeves. The area of evaluation will be dependent on the degradation mechanism present, but will extend at least $0.75\sqrt{RT_{nom}}$ ("R" and "T_{nom}" are the radius and nominal thickness of the pipe, respectively) beyond the edge of any sleeve attachment weld, as required by the Code Case. If the cause of the degradation is not determined, the maximum permitted service life of any reinforcing sleeve will be the time until the next refueling outage.

"Full-structural Type B" means the sleeve and attachment welds alone maintain full capability to withstand structural (mechanical) and pressure loading for which the piping is presently designed without need for additional support or reinforcement, and without reliance on any of the piping that is encased by the sleeve. Type A and partial-structural Type B sleeves rely on the encased underlying piping to provide some structural (mechanical) and/or pressure retaining integrity.

Type B reinforcing sleeves may be applied to leaking systems by installing a gasket or sealant between the sleeve and the pipe as permitted by the Code Case, and then clamping the reinforcing sleeve halves to the piping prior to welding. If welding of any type of sleeve occurs on a wet surface, the maximum permitted life of the sleeve will be the time until the next refueling outage.

A baseline thickness examination will be performed for completed full-structural Type B reinforcing sleeves, attachment welds, and surrounding areas, followed by similar thickness monitoring at a minimum of every refueling outage after installation. Full-structural Type B sleeves shall be removed prior to infringing upon design minimum wall thickness.

Type A and partial-structural Type B reinforcing sleeves completely encompass the degraded areas, are designed to accommodate predicted maximum degradation, and must be removed no later than the next refueling outage. The Code Case requires that these temporary sleeves be visually monitored for evidence of leakage at least monthly. If the areas containing the sleeves are not accessible for direct observation, monitoring shall be

accomplished by visual assessment of surrounding areas or ground surface areas above reinforcing sleeves on buried piping, or by monitoring of leakage collection systems, if available.

Entergy implementation of Code Case N-786-1 will include the following additional restrictions and clarifications:

1) When gasket material is used in accordance with paragraph 4(b) of the Code Case (water-backed applications), Entergy will also require removal of any residual moisture by heating prior to welding.

2) Regarding paragraph 8(c) and 8(c)(1) of the Code Case, Entergy will implement the thickness monitoring inspections of full-structural Type B sleeves at every refueling outage, and will schedule more frequent thickness monitoring, when appropriate, based on degradation rates that are calculated using the reductions in thicknesses observed between scheduled thickness monitoring inspections.

3) Sections 1, 3, 5, and 6 of the Code Case specify that materials, design, installation, and examination of reinforcement sleeves shall be performed in accordance with the Construction Code or ASME Section III applicable to each Entergy plant. As allowed by IWA-4200 and IWA-4411, later Editions and Addenda of the Construction Code or ASME Section III may be used provided any required reconciliations are performed. However, only Editions/Addenda of ASME Section III that have been approved by the NRC in 10 CFR 50.55a will be used.

4) Entergy performs repair/replacement activities in accordance with a fleet-wide, standardized Repair/Replacement Program based on the 2001 Edition/ 2003 Addenda of ASME Section XI. Therefore, this Edition/Addenda of ASME Section XI will be used by all plants whenever the Code Case refers to IWA-4000 until the Code bases of the Repair/ Replacement Program is updated as explained in Section 2 of this request.

5) If a buried piping system carrying radioactive fluid is repaired using this alternative, Entergy will monitor for radioactive fluid leakage in accordance with the standard plant monitoring practices for all buried piping containing radioactive fluids. Entergy is committed to implementation of Nuclear Energy Institute (NEI) 07-07, “Industry Ground Water Protection Initiative – Final Guidance Document,” dated August 2007, in addition to monitoring in accordance with ASME Code Case N-786-1.

Code Case N-786-1 includes requirements for incorporating actual measured or estimated corrosion rates in the design of all reinforcing sleeves. For all sleeves, the initial degradation rate selected for design shall be equal to or greater than two (2) times the maximum rate observed at the location of the repair. If the degradation rate for that location is unknown, an initial degradation rate of four (4) times the estimated maximum degradation rate for that or a similar system at the same plant site for the same degradation mechanism shall be applied. If both the degradation rate for that location and the cause of the degradation are not conclusively determined, an initial degradation rate of four (4) times the maximum degradation rate observed for all degradation mechanisms for that system or a similar system at the same plant site shall be applied. In addition, the Code Case imposes compensatory measures to account for any uncertainties in the corrosion rates used, thus providing reasonable assurance that structural integrity and leakage integrity will be maintained. These measures include limiting the design life of Type A and partial-structural Type B sleeves to a

maximum of one refueling cycle, and requiring on-going monitoring of full-structural Type B sleeves as follows:

- For full-structural Type B reinforcing sleeves including their partial penetration attachment welds and surrounding areas, the Code Case requires that a baseline thickness examination be performed followed by similar thickness monitoring inspections at a minimum of every refueling outage for the life of the repair. More frequent thickness monitoring examinations will be scheduled if maximum degradation rates observed during these inspections indicate that the design thickness required by the Construction Code or ASME Section III will be infringed upon prior to the next scheduled monitoring activity.

- Type A and partial-structural Type B reinforcing sleeves completely encompass the degraded areas, are designed to accommodate maximum predicted degradation, and must be removed no later than the next refueling outage. The Code Case requires that they be visually observed at least once per month to monitor for evidence of leakage. If the areas containing these types of sleeves are not accessible for direct observation, then monitoring will be accomplished by visual assessment of surrounding areas, or ground surface areas above such sleeves on buried piping, or by monitoring of leakage collection systems, if available.

When used on buried piping, the area of full-structural Type B reinforcing sleeves must be physically accessible for the required examinations which could necessitate installation of removable barriers at the repair location in lieu of backfilling the pipe at that location. For Type A and partial-structural Type B reinforcing sleeves installed on buried piping, the monitoring will be based on visual assessment as discussed above.

Code Case N-786-1 restricts application of reinforcing sleeves to pipe and welded fittings, prohibiting their application on pumps, valves, expansion joints, vessels, heat exchangers, tubing, flanges, flanged joints, socket welded or threaded joints, or branch connection welds. In addition, the Code Case only permits branch connections to be installed on Type B reinforcing sleeves when required for filling or venting purposes during installation or leakage testing of the sleeve, and restricts such connections to Nominal Pipe Size (NPS) 1” or smaller in size.

Code Case N-786-1 was approved by ASME Board on Nuclear Codes and Standards in January, 2015. However, it has not been incorporated into Regulatory Guide 1.147, “Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1,” and, thus, is not available for application at nuclear power plants without specific NRC approval.

6. Duration of Proposed Alternative

Use of the proposed alternative is requested for the duration of the ISI intervals identified in Section 2. In the case of GGNS, RBS, WF3, ANO-1, and JAF, approval of this relief request is anticipated within 1-1/2 years prior to the end of the current ISI intervals; therefore, this request also includes the 4th ISI intervals for GGNS, RBS, and WF3 and 5th ISI intervals for ANO-1 and JAF.

Code Case N-786-1, paragraphs 3.1(a) and 3.1(b)(2) require that Type A and partial-structural Type B reinforcing sleeves, including those installed during refueling outages or any time during an operating cycle, shall not remain in service beyond the next refueling outage, when a permanent repair or replacement must be performed. Entergy will comply with this requirement with the following clarifications:

- Reinforcing sleeves installed before the end of the 10-year ISI interval will be removed during the next refueling outage after installation, even if that refueling outage occurs after the end of the 10-year ISI interval. In this case, absent detrimental defects or degradation, duration of the proposed alternative would be until the first refueling outage after the end date of the ISI Interval for the applicable Entergy plant.

- Some piping systems are required to be functional and cannot be repaired during refueling outages. The repair of this piping can only be performed when the plant is operating. For this unique case, Type A and partial-structural Type B reinforcing sleeves will be removed prior to, but no later than, the refueling outage unless specific regulatory relief is obtained.

Full-structural Type B reinforcing sleeves may remain in-service for the design life of the repair as specified in Code Case N-786-1, paragraph 3.1(b)(1). Entergy commits to continued inservice thickness monitoring and evaluation in accordance with this alternative for any full-structural Type B sleeve remaining installed after the end of the ISI intervals identified in Section 2.

7. Precedents

A similar alternative was approved for application of Code Case N-786 for thirteen (13) Exelon nuclear power plants (a total of 22 units) on July 31, 2014. Differences between that Code Case and Code Case N-786-1 referenced in this relief request are as follows:

- General Requirements:

  Paragraph 1(f) was added to restrict sleeve repairs to pipe and welded fittings, excluding other items including branch connection welds.

- Initial Evaluation:

  Paragraph 2(a) was revised to require a minimum of $0.75\sqrt{RT_{nom}}$ of base metal beyond the attachment weld to be included in the evaluation.

  Paragraph 2(b) was revised to require that surrounding areas showing signs of degradation be included in the Owner's plan for thickness monitoring.

- Design General Requirements:

  Paragraph 3.2(a) references to NC-3100/3600 and ND-3100/3600 were corrected.

  Paragraph 3.2(k) was revised to include requirements to use two (2) times the actual or four (4) times the estimated maximum corrosion rates for the design.

Paragraph 3.2(o) was added to restrict installation of branch connections on reinforcing sleeves.

- Specific Requirements – Type B Sleeves:

  Paragraph 3.4(e) terminology was corrected to clarify its applicability to full structural sleeves.

- Water-backed Applications:

  Paragraph 4(b) was added to require precautions to be taken, such as installation of a gasket or sealant beneath the sleeve, to prevent welding on wet surfaces.

- Examination:

  Paragraph 6(e) was revised to correct references to NC-5320/5330 and ND-5320/5330.

- Pressure Testing:

  Paragraph 7 was revised to require installation of pressure test taps on Type B reinforcing sleeves for piping that has not been breached.

- Inservice Examination:

  Paragraph 8(b) was revised to clarify requirements for obtaining baseline thickness measurements for full-structural Type B reinforcing sleeves.

  Paragraph 8(c) was revised to require similar thickness inspections of full-structural Type B reinforcement sleeves to be performed at least every refueling outage.

  Paragraph 8(c)(1) was added to clarify that more frequent thickness inspections shall be scheduled when warranted by observed degradation rates.

  Paragraph 8(c)(2) was added to address accessibility for full-structural sleeves on buried piping to accommodate scheduled inspections.

  Paragraph 8(d) was added to require monthly leakage monitoring of Type A and partial-structural Type B sleeves.

  Paragraph 8(e) was revised to clarify when a temporary Type A or partial-structural Type B reinforcing sleeve is required to be removed.
  Paragraph 8(f) was clarified to permit removal of reinforcement sleeves, for which the degradation method was not determined, any time prior to the end of the next refueling outage.

8. References

1) Exelon Generation Company, LLC, *Safety Evaluation for Use of Code Case N-786*, July 31, 2014; Adams Accession No. ML14175B593.

2) Entergy letter to NRC; *Request for Approval of Pilgrim Relief Request (PRR)-26, Proposed Alternative in Accordance with 10 CFR 50.55a(a)(3)(i) to Maintain ISI Related Activities on the 2001E through 2003A*; November 26, 2014; Adams Accession No. ML14342B001

9. Enclosure

1. Code Case N-786-1, *Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping, Section XI, Division 1*

CNRO-2015-00018

RELIEF REQUEST RR EN-15-2

ENCLOSURE

ASME Code Case N-786-1,

Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping, Section XI, Division 1

(15) **Approval Date: December 31, 2014**

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

Case N-786-1
Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping Section XI, Division 1

Inquiry: As an alternative to replacement or internal weld repair in accordance with IWA-4400,[1] what requirements may be applied for wall reinforcement of Class 2 and 3 moderate-energy carbon steel piping systems that have experienced internal wall thinning from localized erosion, corrosion, and cavitation or pitting?

Reply: It is the opinion of the Committee that, in lieu of IWA-4400, Class 2 and 3 moderate-energy [i.e., less than or equal to 200°F (93°C) and less than or equal to 275 psig (1.9 MPa) maximum operating conditions] carbon steel piping experiencing internal wall thinning from localized erosion, corrosion, and cavitation or pitting may have the wall thickness reinforced by applying full-circumferential reinforcing sleeves to the outside surface of the piping in accordance with the following requirements. Excluded from these provisions are conditions involving any form of cracking.

1 GENERAL REQUIREMENTS

(a) Installation of the reinforcing sleeve shall be in accordance with a Repair/Replacement Plan satisfying the requirements of IWA-4150.

(b) The design, materials, and installation shall meet the requirements of the Construction Code and IWA-4000, except as stated in this Case.

(c) If the minimum required thickness of reinforcing sleeve necessary to satisfy the requirements of 3 is greater than 1.4 times the nominal thickness for the size and schedule of the piping, this Case may not be used.

(d) Additional reinforcement or repair is not permitted on top of an existing reinforcing sleeve.

(e) This Case may be applied only to piping not required to be ultrasonically examined for inservice inspection.

(f) This Case may not be applied to pumps, valves, expansion joints, vessels, heat exchangers, tubing, flanges, flanged joints, socket welded or threaded joints, or branch connection welds.

2 INITIAL EVALUATION

(a) The material beneath the surface to which the reinforcing sleeve is to be applied shall be ultrasonically measured to establish the existing wall thickness and the extent and configuration of degradation to be reinforced. The adjacent area shall be examined to verify that the repair will encompass the entire unacceptable area, and that the adjacent base material, including at least $0.75\sqrt{Rt_{\text{nom}}}$ base metal beyond the toe of the attachment welds, is of sufficient thickness to accommodate the attachment welds.

(b) The cause and rate of degradation shall be determined. The extent and rate of degradation in the piping shall be evaluated to ensure that there will be no other unacceptable locations within the surrounding area that could affect the integrity of the reinforced areas for the life of the repair. Surrounding areas showing signs of degradation shall be identified and included in the Owner's plan for thickness-monitoring inspections of full-structural reinforcing sleeves [see 8(c)]. The dimensions of the surrounding area to be evaluated shall be determined by the Owner, based on the type and rate of degradation present.

(c) The effects of the reinforcing sleeve and attachment welds on the piping and any remaining degradation shall be evaluated in accordance with IWA-4311.

3 DESIGN

3.1 Types of Reinforcing Sleeves.

(a) Type A reinforcing sleeves as shown in Figure 1 may be used for structural reinforcement of thinned areas which are not expected to penetrate the wall and cause leakage. The piping longitudinal stresses shall meet the

[1] The references to Section XI in this Case refer to the 2013 Edition. For use with other Editions and Addenda, refer to the Guideline for Cross-Referencing Section XI Cases, Table 1.

requirements of the Construction Code. Type A reinforcing sleeves shall have a maximum service life of the time until the next refueling outage.[2]

(b) Type B reinforcing sleeves as shown in Figure 2 may be used for pressure plus full- or partial-structural reinforcement of thinned areas that penetrate, or are expected to penetrate the wall and cause leakage.

(1) Full-structural reinforcement is designed to accommodate pressure plus axial and circumferential design loadings at the location for the design life of the repair without taking credit for any portion of the degraded segment. Full-structural reinforcement sleeves shall be removed and the piping repaired or replaced in accordance with IWA-4000 no later than the end of the design life of the repair.

(2) Partial-structural reinforcement is designed to accommodate design loadings at the segment being reinforced, taking partial credit for the degraded segment after factoring in predicted degradation over the life of the repair. Partial credit is considered taken if the design relies on any portion of the segment of piping beneath the sleeve, other than the base metal beneath the attachment welds, to provide structural or pressure integrity. Partial-structural reinforcing sleeves shall have a maximum service life of the time until the next refueling outage.

3.2 General Design Requirements — Type A and B Sleeves.

(a) The design of reinforcing sleeves shall be in accordance with the requirements of NC-3100 and NC-3600 or ND-3100 and ND-3600, and Section III Appendices, Mandatory Appendix II.

(b) Material for reinforcing sleeves shall be ferritic, with welds of compatible weld filler metal.

(c) The minimum width of reinforcing sleeves shall be 4 in. (100 mm).

(d) The thickness of the reinforcing sleeve shall be sufficient to maintain required thickness for the predicted life of the repair.

(e) The following factors shall be considered, as applicable, in the design and application of the sleeves:

(1) all loading the sleeve is expected to encounter

(2) shrinkage effects, if any, on the piping

(3) stress concentrations caused by installation of the reinforcing sleeve or resulting from existing and predicted piping internal surface configuration

(4) effects of welding on any interior coating

(5) differential thermal expansion between reinforcing sleeve, the attachment welds, and the pipe

(6) potential for loose debris in the system from continued degradation of the reinforced area of the piping

(f) Longitudinal seam welds shall be full penetration. Backing may be applied to prevent burn-through of the pipe. If full contact between sleeve and pipe is required, any backing shall be recessed into the underside of the sleeve, or hardenable filler shall be used to fill the void, as indicated in Figure 3.

(g) Longitudinal seam joint efficiency of 0.8 shall be used, except that 100% joint efficiency is permitted if the longitudinal seam is volumetrically examined.

(h) Fatigue evaluation shall be performed if required for the original pipe, or if thermal gradients exceed 100°F (56°C), or if lesser thermal gradients will occur during more than 200 heatup and cool-down cycles over the life of the repair.

(i) If flexibility analysis was required by the original Construction Code, the effect of the reinforcement shall be reconciled with the original analysis.

(j) Final configuration of the attachment welds shall permit the examinations and evaluations required herein, including any required preservice or inservice examinations of attachment or adjacent welds.

(k) The predicted maximum degradation of the carrier base metal and reinforcing sleeve over the design life of the reinforcement shall be based on in-situ inspection and established data for similar base metals.

The initial degradation rate selected for design of the sleeve shall be at least 2 times the maximum rate observed at that location; or if unknown, 4 times the estimated maximum degradation rate for that system or a similar system at the same plant site for the same degradation mechanism. If the degradation rate for that location and the cause of the degradation are not determined, 4 times the maximum degradation rate observed for all degradation mechanisms for that system or a similar system at the same plant site shall be applied.

(l) Weld seams encompassed by the sleeve shall be ground flush. Alternatively, bulges may be rolled or formed in the sleeves to accommodate such obstructions. Refer to Figure 4.

(m) Sleeves shall closely match the outside surface of the carrier piping. If required by design, gaps shall be filled with hardenable filler.

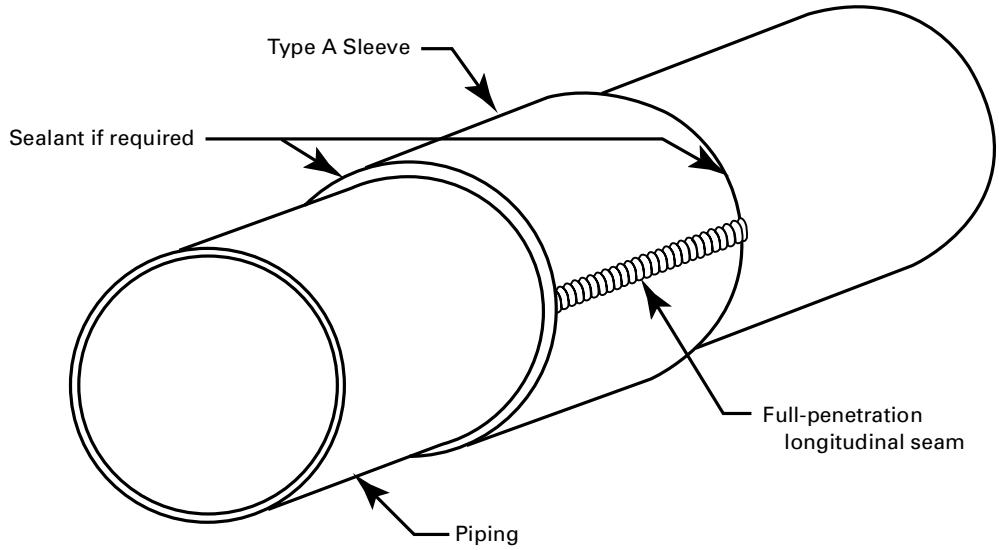
(n) Hardenable filler shall be suitable for the system operating conditions, and shall be compatible with the sleeve, weld metal, piping, and any exterior coating that is not removed from the piping.

(o) Branch connections may be installed on reinforcing sleeves only for the purpose of filling or venting during installation, or for leak testing of the sleeve, and shall be limited to NPS 1 (DN 25) or smaller.

3.3 Specific Requirements — Type A Sleeves. Type A sleeves in moist environments shall have edges sealed, but not seal welded, to prevent moisture intrusion and corrosion.

[2] If a Type A or partial-structural Type B reinforcing sleeve is installed during a refueling outage, the maximum permitted service life is one fuel cycle, until the next refueling outage.

Figure 1
Type A Reinforcing Sleeve



3.4 Specific Requirements — Type B Sleeves.

(a) If permitted by the design, suitable gasket material may be applied inside the sleeve to prevent moisture during welding (see Figure 2).

(b) Hardenable filler and gasket material shall be compatible with the system fluid.

(c) Partial-structural sleeves shall be designed to withstand the design pressure.

(d) Partial-structural sleeves may be attached by fillet welds in accordance with the requirements of 3.2(a).

(e) Full-structural sleeves shall be attached by partial-penetration welds (see Figure 5) that, unless otherwise established by analysis in accordance with the requirements of 3.2(a), extend for a distance of at least s in each axial direction beyond the area predicted, over the design life of the repair, to fall below the required thickness,[3] where

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

and

$$s \geq 1 \text{ in. } (25 \text{ mm})$$

where

$R = D/2$ = outer radius of the piping
t_{nom} = nominal wall thickness of the piping

The thickness of the partial-penetration attachment welds shall equal the thickness of the sleeve, and the outer edges of the welds shall be tapered to the piping surface at a maximum angle ("α" in Figure 5) of 45 deg.

(f) If flexibility analysis was required by the original Construction Code, and unless a lower stress intensification factor (SIF or i) is established, an SIF (i) of 2.1 shall be applied for attachment fillet welds and tapered edges of partial-penetration attachment welds on straight pipe and at adjacent welds. Also, a stress multiplier of 1.7 shall be applied to the SIF (i) for sleeves enclosing standard elbows, and an SIF (i) of 2.1 shall be applied for sleeve attachments on tees and branch connections provided the toe of the fillet or tapered edge is not less than $2.5\sqrt{Rt_{\text{nom}}}$ from any branch reinforcement. (See Figure 5.)

4 WATER-BACKED APPLICATIONS

(a) Manual welding of reinforcing sleeves on water-backed piping shall use the SMAW process and low-hydrogen electrodes.[4]

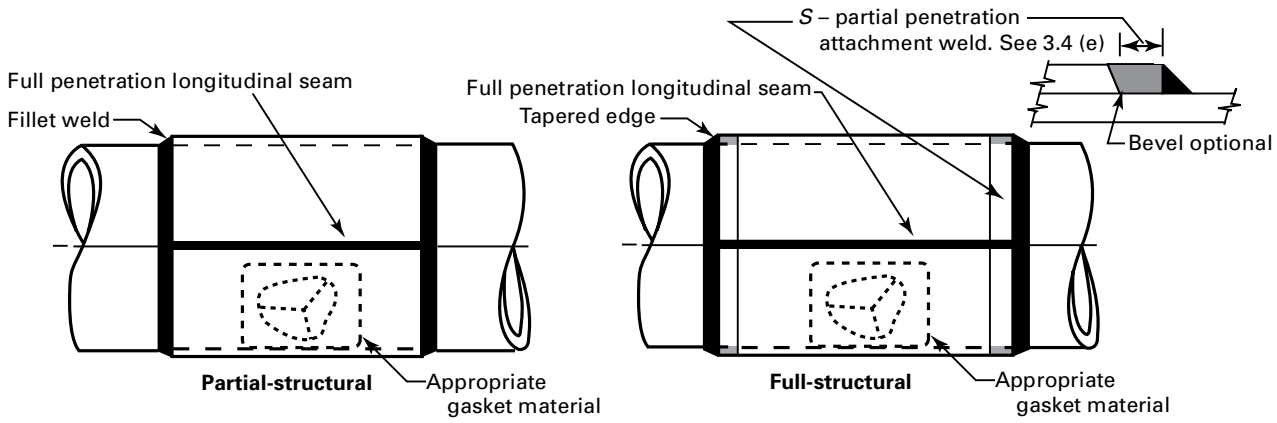
(b) When welding a reinforcing sleeve to a leaking area, precautions, such as installation of a gasket or sealant beneath the sleeve, shall be taken to prevent welding on wet surfaces.

(c) For piping materials other than P-No. 1 Group 1, the surface examination of welds required in 6 shall be performed no sooner than 48 hr after completion of welding.

[3] Design thickness as prescribed by the Construction Code.

[4] Testing has shown that piping with areas of wall thickness less than the diameter of the electrode may burn through during welding on water-backed piping.

Figure 2
Type B Reinforcing Sleeves



5 INSTALLATION

(a) The circumference of the base material in the area to be welded or to provide backing for welding shall be cleaned to bare metal. The entire area shall be cleaned, if required for application of hardenable filler.

(b) The sleeve shall be fitted tightly around the pipe. Preheating the sleeve to achieve a shrink fit, or use of mechanical or hydraulic clamping, draw bolts, or other devices may be used to ensure fit.

(c) If hardenable filler is used, it may be applied prior to sleeve installation or pumped into the annulus between the sleeve and base metal after the sleeve is in place. If pumped into the annulus, provisions shall be made to prevent over-pressurization and intrusion of the hardenable filler into the system.

(d) Means shall be provided to isolate or divert leakage to eliminate moisture during welding. If welding is performed on a wet surface, the maximum permitted life of the reinforcing sleeve shall be the time until the next refueling outage.

(e) Weld metal shall be deposited using a groove-welding procedure qualified in accordance with Section IX and the Construction Code.

(f) Fillet weld leg length shall be increased by the amount of fit-up gap. Care shall be exercised to avoid sharp discontinuities that could cause stress risers at the toes of fillet welds or tapered edges of partial-penetration attachment welds.

(g) Provision for venting during the final closure weld or pressure testing shall be made if necessary.

(h) The surfaces of all welds shall be prepared, if necessary, by machining or grinding, 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) All welds 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 Section III (NC-5300 or ND-5300).

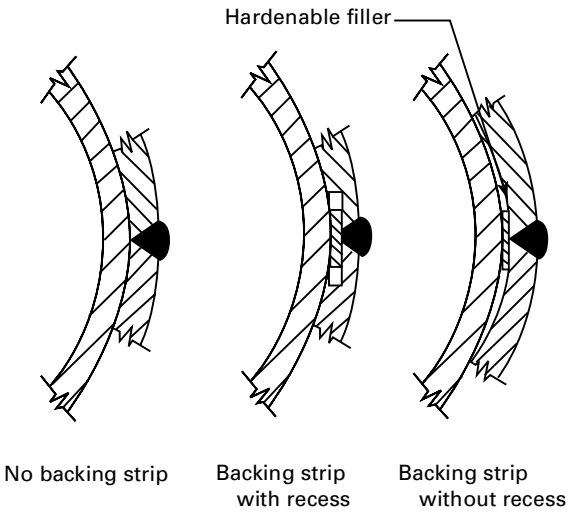
(b) Except for the tapered edges, partial-penetration attachment welds, including the piping base metal upon which they are applied, shall be examined ultrasonically to verify and record baseline wall thickness.

(c) Longitudinal seam welds in the sleeve shall be ultrasonically or radiographically examined in accordance with the Construction Code or Section III if longitudinal seam welds in the piping require volumetric examination. If the design does not permit a joint efficiency of 0.8, Class 3 longitudinal seam welds may be examined in accordance with (d), in lieu of volumetric examination.

(d) Partial-penetration attachment welds (Figure 2) shall be volumetrically examined when full-penetration girth welds in the carrier piping are required by the Construction Code to be volumetrically examined. Where configuration does not permit meaningful volumetric examination, and for Class 3 longitudinal seam welds requiring volumetric examination [see (c)], the first layer, each $\frac{1}{2}$ in. thickness of weld deposit, and final surface shall be examined in accordance with (a), in lieu of volumetric examination.

(e) When volumetric examination is required, the full volume of the attachment weld, excluding the tapered edges but including the volume of base metal required for the service life of the reinforcing sleeve, 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 piping, satisfy the acceptance criteria for weldments of the Construction Code or Section III (NC-5300 or ND-5300). Any volume of the piping beneath the reinforcing sleeve that is credited

Figure 3
Type A and Type B Sleeve Longitudinal Seams



in the design shall satisfy the volumetric acceptance criteria of NC-5320 and NC-5330, or ND-5320 and ND-5330, as applicable.

7 PRESSURE TESTING

In lieu of IWA-4540, a system leakage test of the repair/replacement activity shall be performed in accordance with IWA-5000 prior to, or as part of, returning to service. Type B reinforcing sleeves attached to piping that has not been breached shall be equipped with pressure taps for performance of pressure testing.

8 INSERVICE EXAMINATION

(a) Preservice and inservice examination of Type B full-structural reinforcing sleeve welds shall be performed in accordance with IWC-2000 or IWD-2000, if required. [See 1(e).]

(b) The Owner shall perform a base-line inspection of full-structural reinforcing sleeves, their attachment welds, adjacent base metal for a length of at least $0.75\sqrt{Rt_{\text{nom}}}$, and the surrounding areas showing signs of degradation [see 2(b)], using ultrasonic or direct thickness measurement.

(c) The Owner shall prepare a plan to repeat the thickness monitoring inspections at least every refueling outage, to verify that minimum design thicknesses required by the Construction Code or Section III are not violated in the sleeve or at the attachment welds, including the underlying base metal.

(1) More frequent thickness monitoring inspections shall be scheduled when warranted by the degradation rates observed during these inspections, such that the required design thicknesses will be maintained at least until the subsequently scheduled thickness monitoring inspection.

(2) Provisions shall be made for access to full-structural reinforcing sleeves on buried piping in order to accomplish these inspections.

(d) Type A and partial-structural Type B reinforcing sleeves shall be visually monitored for evidence of leakage at least monthly. If the areas containing these sleeves are not accessible for direct observation, monitoring shall be accomplished by visual assessment of surrounding areas or ground surface areas above pressure pads on buried piping, or by monitoring of leakage collection systems, if available.

(e) For Type A and partial-structural Type B reinforcing sleeves, regardless of when during a cycle or inspection interval they are installed, the repair shall be considered to have a maximum service life of the time until the end of the next refueling outage.

(f) If the cause of the degradation is not determined, the maximum permitted service life of any reinforcing sleeve shall be the time until the end of the next refueling outage.

Figure 4
Bulge to Accommodate Girth Weld

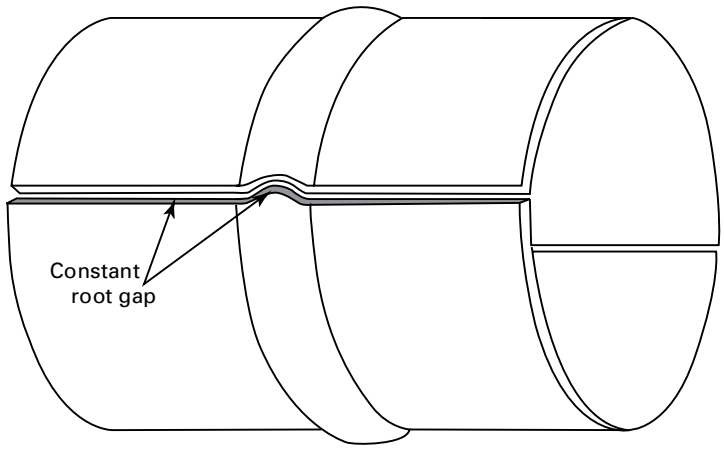
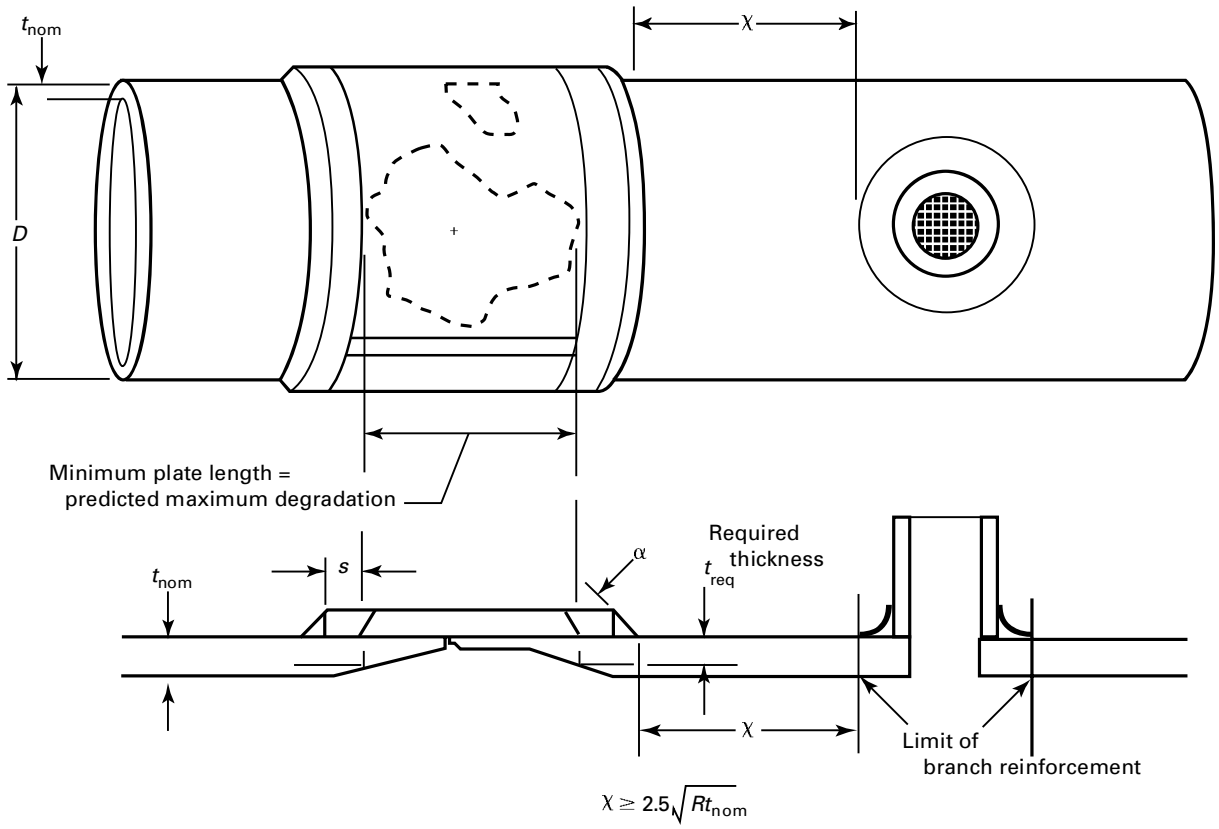


Figure 5
Design Details — Type B Full-Structural Sleeves



INTENTIONALLY LEFT BLANK