FPL

August 30, 2013

L-2013-261
10 CFR 50.4
10 CFR 50.55a

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Re: St. Lucie Unit I
Docket No. 50-335
Inservice Inspection Plan
RAI Response to Fourth Ten-Year Interval Unit 1
Relief Request No. 7, Revision 0

References:

1. FPL Letter L-2013-240 dated August 5, 2013, "Inservice Inspection Plan Fourth Ten-Year Interval Unit I Relief Request No. 7, Revision 0," (ML Accession No. ML13220A029).

2. NRC e-mail from Siva Lingham to Ken Frehafer dated August 16, 2013," St Lucie Unit 1-- Relief Request 7 Regarding Alternate Repair of Intake Cooling Water Piping (TAC No. MF2529) - Request for Additional Information (RAI)."

In Reference 1, Florida Power & Light Company (FPL) requested relief from certain requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000 regarding the repair of intake cooling water piping at St Lucie Unit 1. FPL proposed an alternative repair for the intake cooling water piping as documented in Relief Request Number 7, Revision 0. In Reference 2, the Nuclear Regulatory Commission (NRC) submitted a request for additional information (RAI) to complete its review.

The three (3) attachments to this letter forward the subject RAI response. There are no new regulatory commitments contained in this letter. If there are any questions, or if additional information is required, please contact Eric S. Katzman, Licensing Manager, at (772) 467-7734.

Sincerely,

ES Katzman

Eric S. Katzman
Licensing Manager
St. Lucie Plant

A047
NRR

Attachments (3)

1. Request for Additional Information Relief Request Number 7 Alternate Repair of Intake Cooling Water Pipe St. Lucie Unit 1 Florida Power and Light Company Docket Number 50-335.

2. Typical Bolted Patch Plate Sketch (PSL CADD File ENG 08168-001 R1.DWG).

3. FPL Calculation PSL-1FSM-05-031, Rev. 1, "Evaluation of I-30" –CW-30 Patch Plate Repairs.

ESK/LRB

REQUEST FOR ADDITIONAL INFORMATION
RELIEF REQUEST NUMBER 7
ALTERNATE REPAIR OF INTAKE COOLING WATER PIPE
ST LUCIE UNIT 1
FLORIDA POWER & LIGHT COMPANY
DOCKET NUMBER 50-335

By letter dated August 5, 2013 (Agencywide Documents and Access Management System Accession No. ML13220A029), Florida Power & Light Company (the licensee) requested relief from certain requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000 regarding the repair of intake cooling water piping at St Lucie Unit 1. The licensee proposed an alternative repair for the intake cooling water piping as documented in Relief Request Number 7, Revision 0. To complete its review, the Nuclear Regulatory Commission (NRC) staff requests the following additional information.

1. The proposed repair includes the use of a gasket and epoxy.
(a) Discuss the gasket and epoxy material, how many years are the gasket and epoxy qualified for in the seawater environment, and the industry standards to which the gasket and epoxy are qualified.

Response:
The gasket is cut from a sheet of 1/16" red rubber, which is Styrene Butadiene Rubber (SBR). EPRI Report NP-6608, May 1994, "Shelf Life of Elastomer Components" [10] provides a shelf life of 32 years for SBR. Based on the design, the gasket is encapsulated between the carbon steel pipe, plate and epoxy material. The gasket is not exposed to the seawater, air, sunlight, high temperatures or the pipe external environment and has a long shelf life. Based on this, the gasket is not expected to degrade.

The epoxy coatings used on the carbon steel surfaces of the internal piping and repair plate in accordance with SPEC-M-023 are Carboline Splash Zone A-788 and Duromar SAR-UW. See "Typical Bolted Patch Plate Sketch" for depiction of epoxy coatings. These are solvent free repair compounds that are formulated for both wet and underwater applications and will cure in either environment. Carboline A-788 and Duromar SAR-UW were used to separate the plate from the salt water environment of the ICW piping and to fill the degraded pipe cavity. The coatings were smoothed by hand to provide an optimized surface for fluid flow resulting in a total coating thickness over the patch plate in excess of 3/8 inch. These barrier coatings have service histories of over 25 years installed as immersion repair compounds protecting steel surfaces from corrosion.

The Epoxy repair compounds that were specified for this repair are subject to the internal seawater environment of the ICW system which is with in normal operating conditions for both epoxies. No elevated temperatures above 140 F [14] or sunlight/UV radiation are present. Both repair compounds cure chemically by crosslinking and are inert or non-reactive when maintained in seawater at normal ICW operating conditions. Epoxy compounds when properly installed degrade locally and do not fail catastrophically. The most likely cause of coating failure for properly installed coatings in this application would be due to scissorization or the breaking of the cross linked bonds which cause embrittlement. This reaction is driven by elevated temperatures and time which are outside the operating conditions for the ICW system and the effects would be detected by visual inspection. The coating industry has established that the most effective way to detect coating degradation is through visual inspection. Visual inspection of localized coating defects caused by scissorization will reveal cracking at which time physical examinations for embrittlement can be performed. This is not considered a credible cause of coating failure in the operating seawater environment of the ICW system.

(b) Section 4 of the relief request states that the inside of the subject pipe is lined with 1/8-inch thick epoxy or cement. Provide the thickness of epoxy covering the bolted plate.

Response:
As stated in the response above, in accordance with SPEC-M-023 the epoxy coatings used for the bolted patch plate are Carboline Splash Zone A-788 and Duromar SAR-UW. The Product Data Sheet for Carboline Splash Zone A-788 [12] provides allowable thickness range of 125 mils to 2" (0.125" to 2"). Product Data Sheet for Duromar SAR-UW [13] provides allowable thickness range of 40 mils to 1000 mils (0.040" to 1"). See "Typical Bolted Patch Plate Sketch" for depiction of epoxy coatings. Based on the minimum epoxy thickness and the configuration, the epoxy coating would exceed the 1/8" thickness of the original epoxy or cement.

(c) Confirm that the epoxy applied on the bolted plate will cover the studs, nuts, plate edges and gasket.

Response:
The epoxy coating completely covers the bolted plate, studs, nuts, plate edges and gaskets and is blended with surrounding coatings to provide smooth transitions to minimize ICW flow turbulence. See attached "Typical Bolted Patch Plate Sketch" for depiction of epoxy coatings.

2. Discuss the design life of the bolted plate assembly and how the design life is derived. Discuss the criteria or conditions that would require the in-service bolted plate to be removed.

Response:
The design life of the bolted plate is the same as the pipe based on inspection. The inspection methodology consists of draining the pipe and removing a section to allow internal access, cleaning the pipe surface, and performing a visual examination of the cement or epoxy liner. The inspector observes for signs of corrosion deposits, staining, cracks, missing lining, area blisters, peeling/delamination, surface irregularities, or discoloration. UT inspection of degraded pipe metal or plate would be performed where there is degradation. The inspection of the pipe and bolted patch plates during internal inspections of the pipe are performed every other refueling outage. The inspection

frequency is a commitment per L-2013-005, dated January 10, 2013, "Clarification of NRC Commitment Regarding Generic Letter 89-13" [15] and is instituted by Model Work Orders as part of the Preventive Maintenance Program. The inspections determine the condition of the internal coatings on the pipe and patch plate.

3. On page 4 of the relief request, the licensee states that a typical corrosion rate for the carbon steel in the seawater environment is 30 mils per year. The licensee further states that should the epoxy coating and gasket be breached to allow access to the original defect area the maximum extent of corrosion would be 0.09 inches, assuming a 3-year inspection interval. Based on this discussion, it appears that the licensee did not apply any safety factor to the corrosion rate of 30 mils to cover uncertainties in the corrosion rate. ASME Code Cases (e.g., Code Case N-821) require a factor of 2 to 4 applying to the corrosion rate to consider uncertainties. (a) Discuss whether the corrosion rate of 30 mils is used in the design of the repair. If yes, discuss whether a factor is used on the corrosion rate in the bolted plate repair method. If a safety factor is not used, provide justification.

Response:
The 30 mils per year (mpy) was not used in the design of the repair, however, the repair is adequate for this corrosion rate without a safety factor as discussed herein.

A review of the literature has been performed illustrating that the limiting corrosion rate of carbon steel in oxygen saturated flowing seawater is approximately 30 mils per year. This rate decreases with increasing exposure time in the environment. The supporting data and discussion are presented below.

As demonstrated in Figure 1, the general corrosion rate of carbon steel exposed to flowing oxygen saturated seawater at approximately 7 ft/s is less than 30 mpy [1].

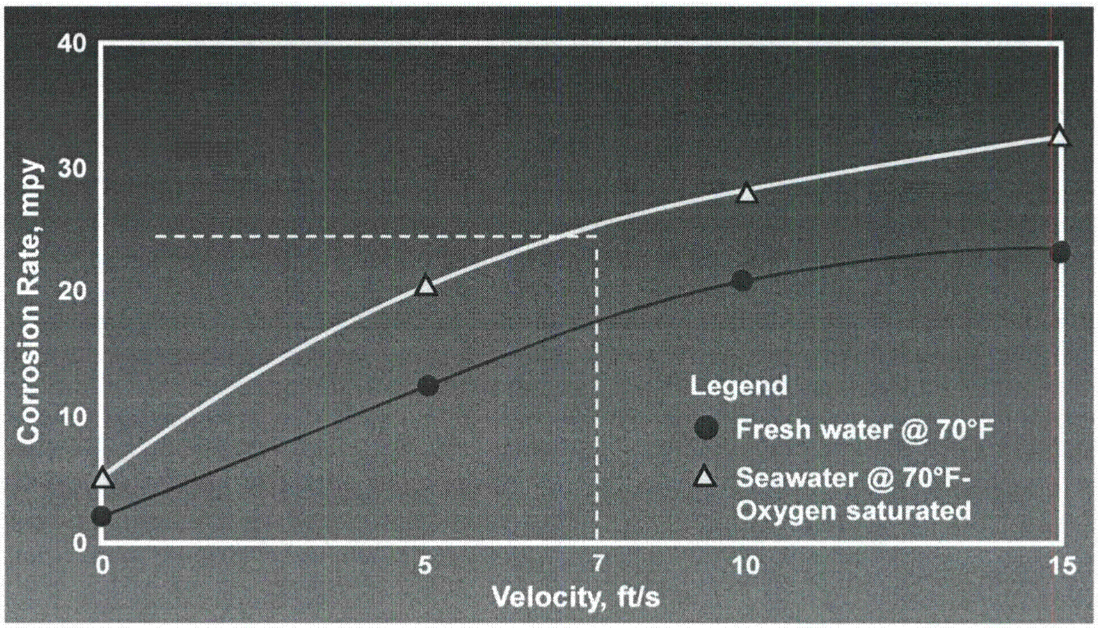


Figure 1. Effect of Flow Rate on General Corrosion of Carbon Steel
in Fresh Water and Seawater [1]

Since the general corrosion rate of carbon steel in aqueous solutions follows parabolic kinetics as shown in Figure 1 and as a sketched in Figure 2, i.e., the amount of corrosion is proportional to the square root of time ($\sqrt{t}$), the use of a linear general corrosion rate such as 30 mpy is conservative and there is no need for an additional "safety factor" for the corrosion rate, Figure 3 (theoretical calculated curve) [2].

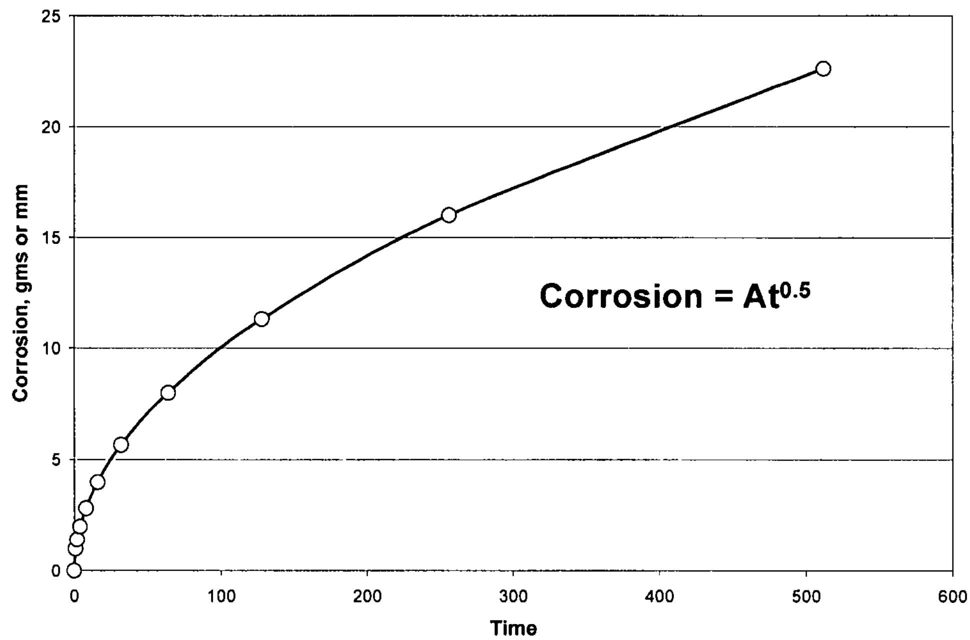


Figure 2. Theoretical Calculated Example of General Corrosion vs. Arbitrary Time for Carbon Steel

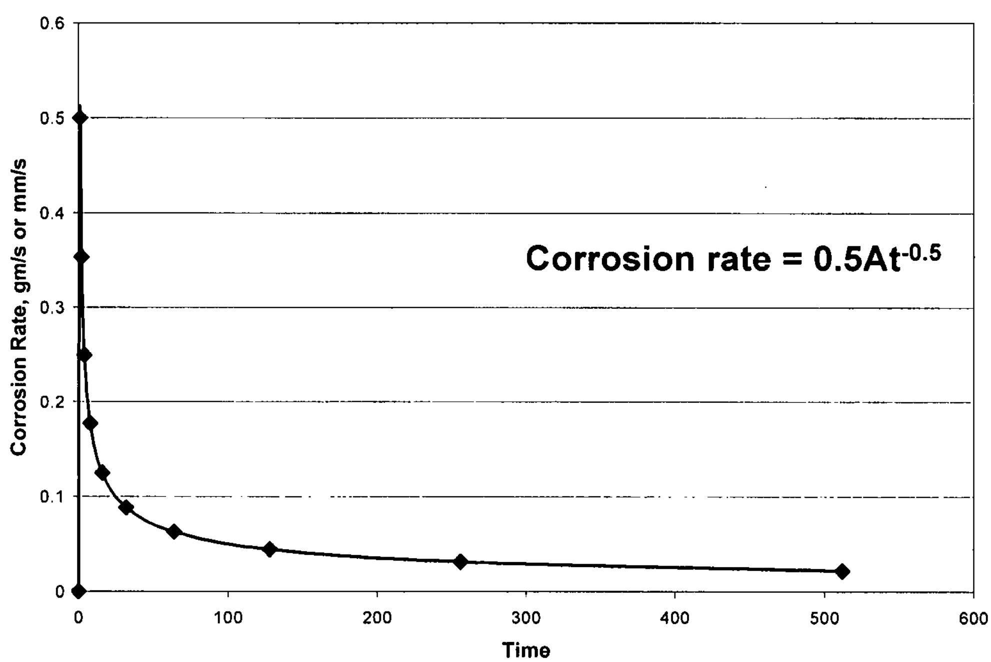


Figure 3. Theoretical Calculated Example of General Corrosion Rate vs. Arbitrary Time for Carbon Steel

Actual general corrosion rate data for carbon steel exposed to seawater is presented in Figure 4 [3], confirming the rate information presented in Figure 3. It can be seen that the corrosion rates decrease with exposure time and the long-term corrosion rates in this environment are very low.

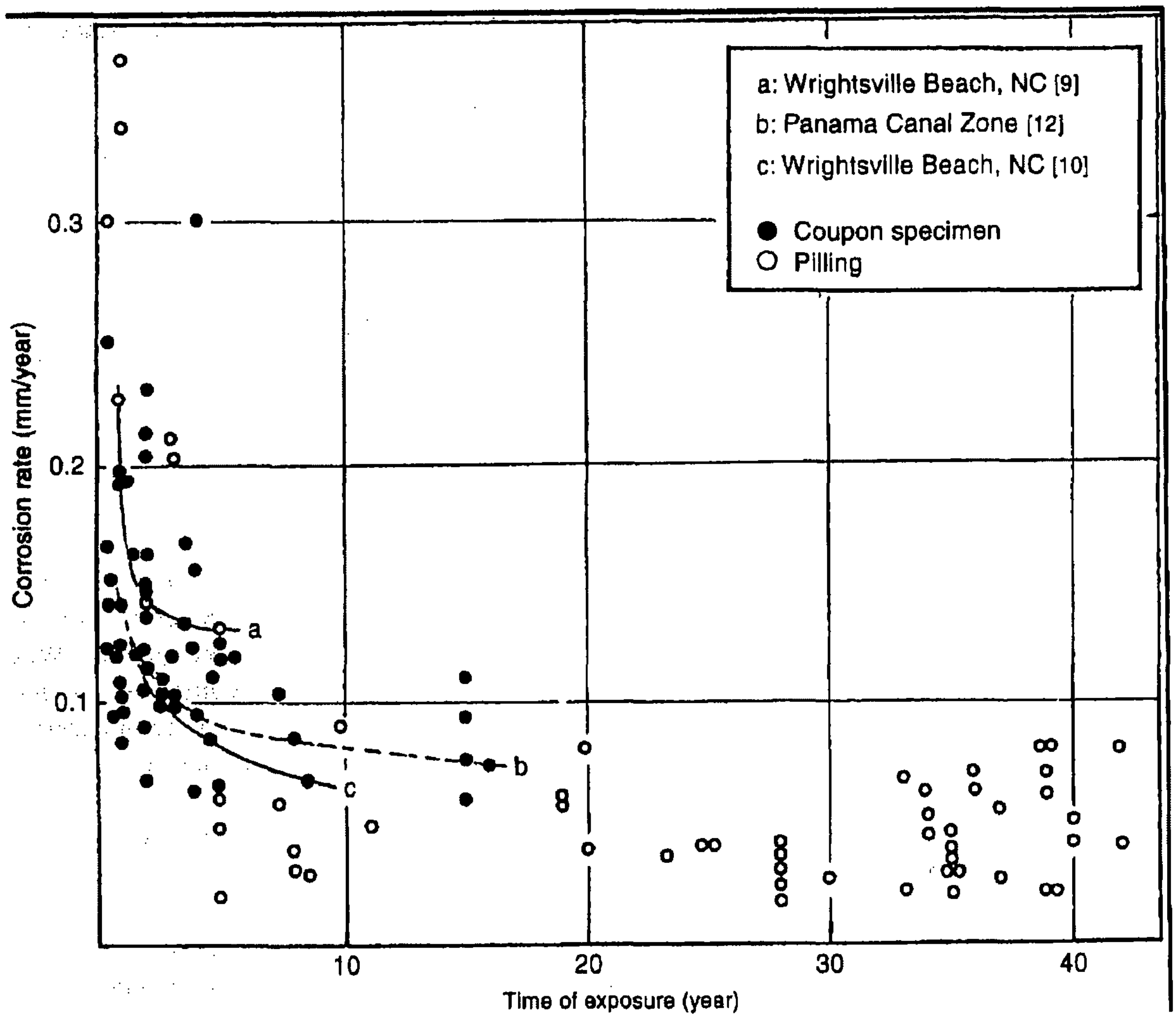


Figure 4. Average General Corrosion of Steel Continuously Immersed in Seawater [3]

Figure 4 reveals a long-term exposure general corrosion rate of less than approximately 0.1 mm/y or approximately 4 mpy, which provides significantly more than a safety factor of 4 conservatism in the suggested corrosion rate.

4. (a) Discuss whether the bolted plate provides structural support to the pipe wall underneath or it simply isolates the defect area from seawater without performing any structural support.

Response:
As shown in the calculations no reinforcement of the pipe is required due to the hole, the patch plate acts as a closure plate to isolate the defect area from seawater and provides a pressure boundary for the location. No structural support of the pipe from the patch plate is credited.

(b) On page 4 of the relief request, the licensee stated that the bolt hole drilled into the pipe wall will not exceed 1/4 inch deep to preserve the pipe minimum wall thickness requirement. Discuss the tolerance on the bolt hole depth.

Response:
The depth of the bolt holes is controlled in the Engineering Change Package implementation instructions as follows:

- Notify Engineering if any excess degradation is observed during cleaning, drilling or pipe thickness at bolt hole locations is <0.350".
- Drill and tap ¼"-20 UNC holes, ¼" deep on plate bolt pattern. Do NOT allow holes to exceed ¼" depth to maintain minimum wall thickness. (Note due to a field installation problem, 5/16"-18 UNC holes were used at one plate location and shown acceptable in calculation PSL-1FSM-05-031)

These instructions were transferred into the Work Order instructions. The wall thickness readings at the bolt hole locations were documented on inspection reports.

The calculated minimum wall thickness using the design pressure and temperature is 0.090". Using the above limitations provides 0.350"-0.250" = 0.100" which provides a margin of 0.01". However, based on review of the inspection reports, the wall thickness readings at the bolt hole locations range from 0.362" up to maximum of 0.435". Based on this, sufficient margin is provided to ensure that the minimum wall thickness is maintained.

(c) On page 2 of the relief request, the licensee stated that the repair performed in 2012 for intake cooling water pipe 1-30"-CW-29 (Train B) includes three plate sizes--3.5" x 3.5", 7.5" x 11.5" and 10" x 11". The licensee previously installed on intake cooling water pipe 1-30"-CW-30 (Train A) plate sizes of 3.5" x 3.5", 8" x 8", 10" x 11" and 11" x 11". The licensee presented stress analyses for plate sizes 3.5" x 3.5", 7.5" x 11.5", and 10" x 11", but not 8" x 8" and 11" x 11" as shown in Attachment 2 to the August 5, 2013 submittal. Discuss whether plate sizes, 8"x 8" and 11" x 11" were analyzed. If yes, submit the analysis. If not, provide justification.

Response:
The 8"x 8" and 11" x 11" plates were analyzed in an earlier calculation, PSL-1FSM-05-031 Rev. 1. A copy is attached.

(d) Discuss the maximum plate size that is qualified to be used in the repair. The NRC staff notes that the plate size should maintain a certain margin with respect to the defect area that it covers. See the following question.

Response:
At present, the largest qualified plate by area is the 11" X 11" plate on an approximately 9" corroded area. See discussion in response to question 5, below.

5. Attachment 2 (pages 5 to 8) to the August 5, 2013 submittal provides calculations to demonstrate that reinforcement is not needed if the repair is applied from a minimum assumed hole size of 0.25 inch to a maximum assumed hole size of 30 inches. The NRC staff would have reservations if the repair would apply to a 30-inch hole. The NRC staff notes that the plate size should exceed the hole size by some minimum margin with respect to the hole size to allow for potential corrosion growth.

(a) Discuss the maximum hole size and defect area that is allowed by the relief request.

Response:
The reinforcement calculation for holes of 0.25" to 30" inches was performed to provide a bounding calculation so as not to have to re-calculate for each individual hole. It is not the intent to cover a 30" hole with a patch plate. From review of the calculations, if the plate thickness is maintained the same as the pipe wall thickness of .375", then the size of the hole is limited. At present, the largest plate sizes included in the calculations are 7.5" x 11.5" and 11" x 11", with a required plate thickness of 0.360" and 0.341", respectively. Based on the plate thickness limitation, the maximum dimensions of the plate and hole would be limited to slightly larger than the current calculation allows.

(b) Discuss the minimum margin between the plate size and the defect area and/or holes size that is permitted by the relief request. The minimum margin would be the minimum plate size divided by the maximum allowable defect area or hole size (use the larger of the defect area or the hole size). The NRC staff notes that in general corrosion the defect area is usually larger than the hole size.

Response:
Calculations performed for hole size were conservative and not based on the through wall hole dimension (i.e., the 9" hole was actually approximately 5" by 7"). The existing analysis maximum allowable plate versus hole/degradation is based on an 11" X 11" plate (area 121 sq inches) on a 9" diameter hole (63.6 sq inches), 121/63.6 = 1.9 margin. Review of the Engineering Change Packages and Inspection Reports indicates than the margin is typically higher than this value due to the presence of localized pitting instead of wide scale degradation.

6. Section 5 of the relief request appears to state that the bolted plate design will be used to repair a 100 percent through wall defect. Pages 26 and 28 in Attachment 2 to the August 5, 2013 letter identify two holes at two locations on pipe 1-30"-CW-29 and they appear to be part of the repair performed in 2012. After a hole is filled with epoxy and the bolted plate is installed on the inside surface of the pipe, the corrosion could continue to grow laterally from the outside diameter surface if the pipe is in contact with ground water.

(a) Discuss how the bolted plate repair can eliminate corrosion from the outside diameter surface if the repair is performed on a 100 percent through wall defect.

Response:
The bolted patch plate by the use of studs and nuts instead of welding does not impact or destroy the external coatings on the pipe. The corrosion hole is cleaned and filled with epoxy material to the profile of the pipe ID. The application of epoxy to the through wall hole provides protection for the pipe and patch plate. The corrosion cell would need to extend a relative large distance past the gasket seating surface to be visible during internal inspection. Based on UT reading around repair areas, external corrosion has not been observed.

(b) Discuss the defects (e.g., planar cracks) and/or degradation mechanisms (e.g., stress corrosion cracking) for which the bolted plate repair will not be applicable.

Response:
The bolted plate repair is only applicable to wall loss defects resulting from general corrosion and flow erosion. The bolted plate repair is not applicable for any other types of defects (e.g., planar cracks) or any other local degradation mechanisms (e.g., stress corrosion cracking).

7. Discuss pressure and temperature during normal operation, considering seasonal changes.

Response:
Based on the location of this open ended discharge piping downstream of an orifice, during normal operation pressure varies down the pipe from being under a slight vacuum at the orifice [9] to the elevation difference in the piping, which is ~12 feet [5 & 6]. There is no instrumentation in this section of piping but an estimation of the pressure range would be slightly less than 0 psig to 5.2 psig. Temperatures in the subject piping during normal operation vary a few degrees above seawater temperatures [7] because there is little heat load on the Component Cooling Water Heat Exchangers during normal operation. DBD-ICW-1 [8] provides the recorded minimum and maximum ocean water temperatures as 52° to 87° F.

8. The relief request stated that the subject pipe is fabricated with A-155 KC-65 (equivalent to SA-106 Grade B carbon steel) and the plate is made of SA-106. The bolt is made of alloy steel, SA-193 Grade B7 and the nut is made of SA-194 Grade 2H. Confirm that galvanic corrosion is not a concern for the bolted plate assembly and it has not been observed in the repaired locations since 2005.

Response:
The most straight forward way to determine whether there is a potential galvanic couple between the SA-106 Grade B carbon steel plate, the SA-193 Grade B7 low alloy steel bolt and the SA-194 Grade 2H carbon steel nut is to evaluate the measured standard electrode potential of the two steel alloys in seawater. Figure 5 presents the galvanic or electromotive series for various metals and alloys exposed to seawater [4]. It is observed that since electrode potentials for carbon steel and low alloy steel in seawater are approximately the same, there would be minimal electrochemical driving force between them to facilitate measurable accelerated corrosion of the carbon steel.

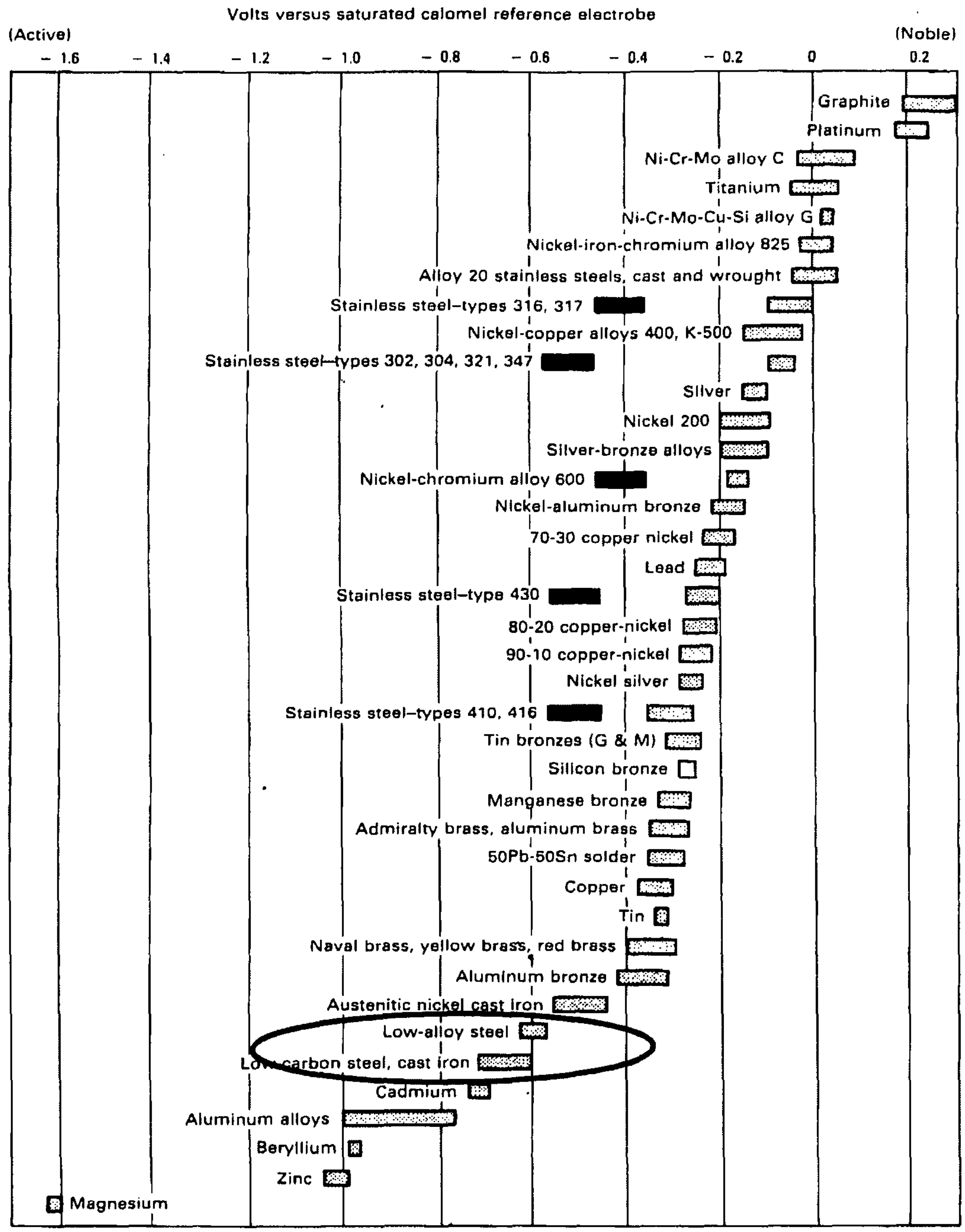


Figure 5. Galvanic Series in Seawater [4]

A second and equally important factor for galvanic corrosion is the relative areas of the two materials. In this St. Lucie case, a small area cathode (e.g., low alloy steel bolts) is coupled to a large area anode (e.g., carbon steel bolted plate repair), which is the most favorable condition when galvanic couples cannot be electrically isolated. The reverse combination, i.e., small anode/large cathode is the combination for utmost corrosion concern (e.g., steel nails attaching copper plates to a wooden ship hull or aluminum bolts secured to stainless steel in seawater). In addition the plate and bolting is encapsulated in epoxy. Therefore, galvanic corrosion is not a concern for the St. Lucie bolted plate assembly.

References

1. R. Moss, "Effect of Flow Rate on Carbon Steel Corrosion," paper presented at the NACE Western Region Meeting, 1966.

2. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Third Edition, J. Wiley & Sons, Inc., New York, NY, 1985.

3. I. Matsushima, "Carbon Steel – Corrosion by Seawater," Chapter 32, Uhlig's Corrosion Handbook, Second Edition, R. W. Revie, Editor, J. Wiley & Sons, Inc., New York, NY, 2000, p. 545.

4. H. P. Hack, "Evaluation of Galvanic Corrosion," Metals Handbook Ninth Edition Volume 13 Corrosion, ASM International, Metals Park, OH, 1987, p. 234.

5. Drawing 8770-G-125 Sh. CW-F-3 Rev. 23

6. Drawing 8770-G-125 Sh. CW-F-10 Rev. 5

7. PI – Process Book EWIS – St. Lucie Unit 1 TCW/CCW Temps Trend 8/28/13

8. DBD-ICW-1 Rev. 4, Intake Cooling Water System

9. Calculation 129154-M-0014 Rev. 2, Hydraulic Analysis of Plant St. Lucie ICW System

10. EPRI Report NP-6608 dated May 1994, Shelf Life of Elastomeric Components

11. SPEC-M-023 Rev. 7, St. Lucie Units 1 and 2 ICW & CW System Inspection and Repair

12. Splash Zone A-788 Carboline Product Data dated March 2013

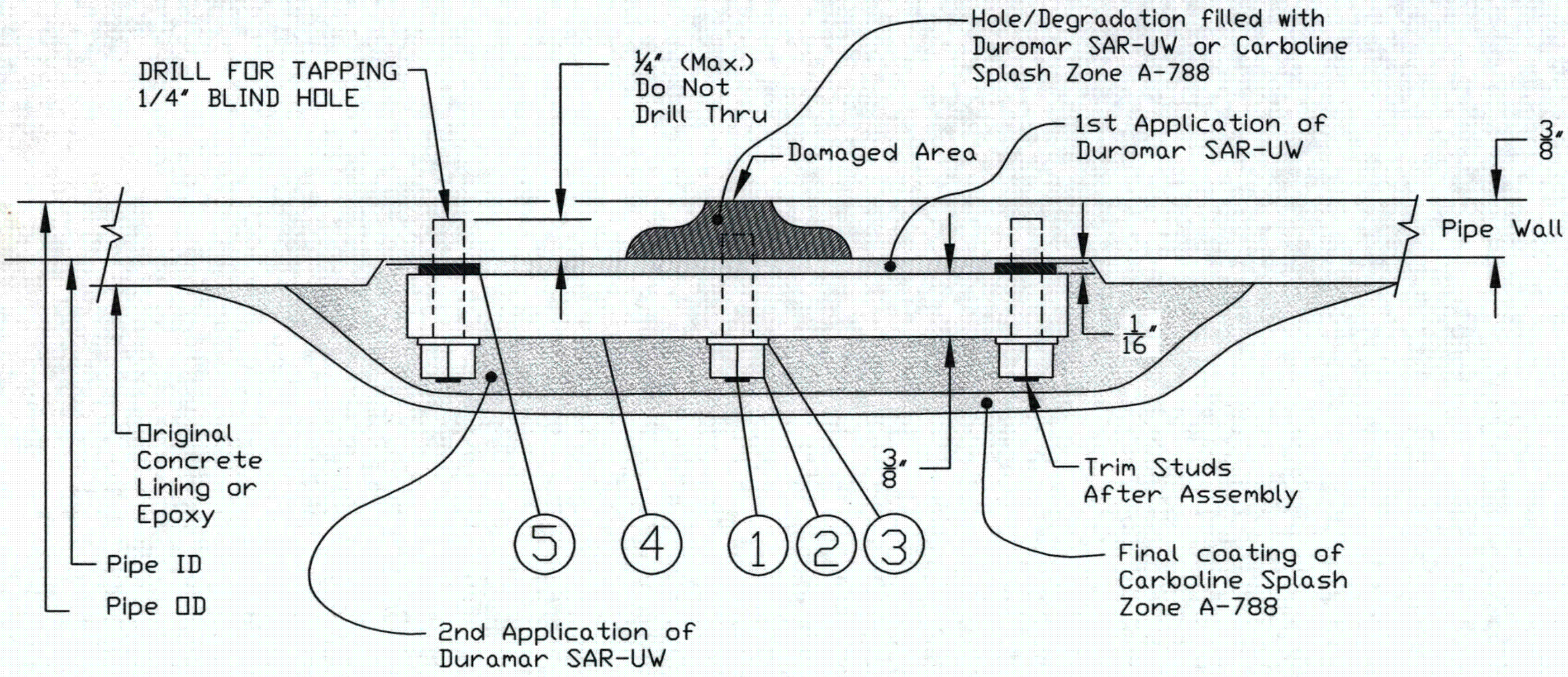
13. Duromar SAR-UW Product Data Sheet Rev. 05/13

14. Letter from Jerry Arnold of Carboline to Garth Dolderer of FPL dated August 28, 2013

15. St. Lucie Letter No. L-2013-005 10 CFR 50.4, dated January 10, 2013 to the USNRC Re: St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, "Clarification of NRC Commitment Regarding Generic Letter 89-13"

16. SIA Report No. 1300894.403.R0, St. Lucie Unit 1 Relief Request No. 7, Alternate Repair of Intake Cooling Water Pipe – SI Responses to Request for Additional Information Nos. 3, 6.(b), and 8

L-2013-261



TYPICAL BOLTED PATCH PLATE SKETCH

BILL OF MATERIALS

1 STUDS 1/4"-20-UNC x 1 1/8" LONG, SA-193 GRB7, QL-1 (QTY=8)

2 NUTS 1/4" x 20, SA-194-2H, QL-1 (QTY=8)

3 FLAT WASHER 1/4" STD, STEEL, ZINC PLATED, QL-3 (QTY=8)

4 CLOSURE PLATE 8"x8"X3/8" THICK, CUT FROM 30" SA-672 GR C65/70 PIPE OR CUT FROM SA-155 GR 65/70 PLATE AND ROLL TO SUIT, QL-1.

5 GASKET, RED RUBBER, 1/16" THICK, QL-3

CADD FILE ENG 08168-001 R1.DWG

CALCULATION COVER SHEET

Calculation No: **PSL-1FSM-05-031**

Title: **Evaluation of I-30"-CW-30 Patch Plate Repairs**

This calculation addresses application of bolted repair plates on line I-30"-CW-30. The subject line has no isolation valves to the discharge canal and operates at near atmospheric pressure. The calculation reviews a repair methodology that blanks off the corrosion holes with bolted plates on the ID of the pipe. Bounding hole sizes are assumed for the analysis.

		By			
		Check			
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		Apr			
1	Add plates for PCM 08168, EC 274859	By	Gordon McKenzie	Gordon McKenzie	12-15-11
		Check	Carl M. Wallace	Carl M. Wallace	12-15-11
		Apr	S. Ramani	[signature]	12-15-11
0	Issued For Use	By	Gordon McKenzie	On File	10/30/05
		Check	W.B. Neff	On File	10/30/05
		Apr	P.G. Barnes	On File	11/03/05
No.	Description	By	Printed Name	Signature	Date
REVISIONS					

Equivalent of Form 82A, rev. 1

Calculation No: **PSL-1FSM-05-031**

Title: **Evaluation of I-30"-CW-30 Patch Plate Repairs**

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5	Section 4.0	Data Input	1
6	Section 5.0	Part 1 - Minimum Wall Calculation (ASME NC-3641.1)	1
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8	Section 5.0	Part 2A - Reinforcement for 5.5" Hole	1
9	Section 5.0	Part 3A - Plate Thickness for 5.5" Hole	1
10	Section 5.0	Part 4A - Bolt/Gasket Loading for 5.5" Hole	1
11	Section 5.0	Part 5A - Bolting for 5.5" Hole	1
12	Section 5.0	Part 2B - Reinforcement for 9" Hole	1
13	Section 5.0	Part 2B - Reinforcement for 9" Hole	1
14	Section 5.0	Part 3B - Plate Thickness for 9" Hole	1
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ATTACHMENTS

No.	Attachment Title	Pages	Rev
1	Stress Intensification Review for Unreinforced Tee	1	1
2	Drawing Plate 1: ENG-05192-001, Sheets 1-3	3	1
3	Drawing Plate 1: CRN 05192-12929	6	1
4	Drawing Plate 2: ENG-08168-001, Sheets 1-3	3	1
5	Drawing Plate 3: EC274859-M-001, Sheets 1-3	3	1

St. Lucie Unit 1
Evaluation of I-30"-CW-30 Patch Plate Repairs

1.0 Purpose / Scope

Calculation addresses application of bolted repair plates on line I-30"-CW-30. The subject line has no isolation valves to the discharge canal and operates at near atmospheric pressure. The calculation reviews a repair methodology that blanks off the corrosion holes with bolted plates.

Calculation determines the minimum pipe wall thickness using design formulas of ASME Section III and the criteria presented within FSAR Table 3.9-3 for reviewing interactions of pressure stress and longitudinal bending stresses. Calculation evaluates the required reinforcement versus the actual reinforcement available around the corrosion holes and reviews bolting requirements for the patch plate which is analyzed as a blind flange. Reinforcement interaction is reviewed for the multiple holes to ensure additional reinforcement is not required.

Design concept was used on Unit 1 per NCR 1-380, PSL-1-S-M-90-0002 and JPN-PSL-SEMS-90-012.
Design concept was used on Unit 2 per CR 2005-710, MSP 05010, PSL-2FSM-05-001.

Revision 0 was developed to support EC 235503 (MSP 05192). Revision 0 was subsequently used to support EC 235964 (08168).

Revision 1 provides a general update to address multiple openings and formally encompasses EC 235503 (MSP 05192), EC 235964 (08168), EC 206588 (CRN-08168-12929), and EC 274859. Due to the general revision, revision bars are not utilized.

2.0 Methodology

Part

1 Develop a minimum pipe wall thickness based on hoop stress and longitudinal bending stress.

2 Determine required and actual reinforcement areas and zones per ASME Section III, Subsection ND.

3 Determine patch plate thickness requirements per ASME Section III, Subsection ND.

4 Determine gasket loading and bolt requirements per ASME Section III Appendix E.

5 Review thread engagement using machinery principles.

6 Address interaction of reinforcement zones per ASME Section III, Subsection ND.

3.0 References

1 St. Lucie Unit 1 FSAR Amendment 24
2 St. Lucie NAMS DataBase
3 Navco Piping Catalog, Edition 11, 1984
4 Code of Record (COR): ASME Section III, Class 3, 1971 Edition With Addenda through Summer 1973
5 COR NC-3641.1(a)
6 Roark's Formulas for Stress & Strain, 6 Edition, page 67
7 EBASCO Backfit Stress Analysis Design Criteria, Rev 3, 12/7/87
8 Piping Isometric 8770-G-125 Sh CW-F-3 Rev 22
9 St. Lucie Unit 1 Stress Calculation 1001 Rev 5, DP 19 & 181
10 St. Lucie Unit 1 Stress Isometric: CW-172-12 Rev 5
11 Spool Detail I-30-CW-30-1
12 EPRI Good Bolting Practices Volume 1, NP-5067
13 Machinery's Handbook, 26 Edition, Industrial Press, Inc., Pages 1490, 1491
14 Fastener Standards, 6th Edition, Industrial Fasteners Institute
15 Drawing ENG-05192-001, Sheets 1-3, Rev 0
16 Drawing ENG-08168-001, Sheets 1-3, Rev 0
17 Drawing EC274859-M-001, Sheets 1-3, Rev 0

4.0 Assumptions

1 Plate material will be a low carbon steel, such as SA/A-106 Grade B (Allowable 15,000 psi) Equivalent materials are acceptable. For specific materials used, see EC.

2 Fastener material will be SA/A-193 Grade B7 and SA/A-194-2H. Equivalent materials are acceptable. For specific materials used, see EC.

3 Plate is on ID of Pipe. An arbitrary external pressure of 15 psig will be used to calculate gasket loading assuming zero pressure within the piping.

5.0 Data Input

Piping System Inputs:				REF
Pipe Size:		30		2
Schedule:	*	0.375		2
Material:	*	A-155 KC65 Class 1		11
t-nominal: tnom	*	0.375	in	3
Outside Diameter : Do		30	in	3
Corrosion Allowance : *(generally 0 for this analysis)*		0	in	-
Design P:		90	psig	2
Design T:	*	125	deg F	2

Stress Analysis Inputs:	ASME Section III, Class 3			REF
Piping Isometric 8770-G-125 Sh CW-F-3 Rev 22				8
Stress Calculation 1001 Rev 5, DP 19 & 181				9
Stress Isometric: CW-172-12 Rev 5				10
Code of Record:	ASME Section III, Class 3, 1971 Ed. With Add. through Summer 1973			9
Piping designed and fabricated per USAS B31.7 Class 3, 1969 Edition				1, 7, 8
		Max Stress		
Long Press. Stress (tnom) (Do NOT include in below Eq's)		1733	psi	9
Eq 8 (P)+(Dead Weight)**		600	psi**	9
Eq 9 Upset Conditions (P)+(DWt+OBE Inertia)**		846	psi**	9
Eq 9 Emergency (P)+(DWt+DBE Inertia)**		1092	psi**	9
Eq 11 (P)+(DWt +Thermal + Seismic Anchor Moments OBE)**		2142	psi**	9
Stress Allowable Hot: Sh		15000	psi	9
Allowable Stress Range for Expansion Stresses: Sa		22500	psi	9
y coefficient	*(0.4 if less than 900F)*	0.4		5

Stress Analysis Data Input Verification:

Prepared: [signature] 12/14/11 Verified: S. [signature] 12/15/11

* For information only. Data not used by the analysis.
**Equations Show General Form with Pressure Stress Included
The 4 Boxed Max Stress Values Provide the Moment Stress Only (Pressure Stress subtracted out)

6.0 Calculation

Part 1 - Minimum Wall Calculation (ASME NC-3641.1)

Develop tmin based on Hoop Stress:

					REF
tmin based on Hoop Stress	(P Do)/(2 (Sh + P y)) + A		0.090	in	5
Original Section Modulus:	Z = 3.14/32 (Do^4 - Di^4)/Do		255.167	cu in	6
Nominal Wall	tnom		0.375	in	2
Mill Tolerance (tnom +/- 12.5%)		0.328 to	0.422	in	3

Determine if tmin based on Hoop Stress bounds Longitudinal Stress:

					REF
tmin based on Hoop Stress	*From above calculation*		**0.090**	in	5
Diameter Inside Di'	Di'=Do-2tmin		**29.820**	in	-
New Section Modulus	Z' = 3.14/32 (Do^4 - Di'^4)/Do		**62.866**	cu in	6
Section Modulus Ratio	SM Ratio = Z / Z'		**4.06**	-	-
Longitudinal Pressure Stress	(P Do)/(4 tmin)		**7518**	psi	6
	May Not Exceed		L Stress	**IR≤1.0**	
Eq 8 = P + SM Ratio (DWt)	Sh	15000	**9953**	**0.66**	1
Eq 9 = P + SM Ratio (Dwt + OBE Inertia)	1.2 Sh	18000	**10952**	**0.61**	1
Eq 9 = P + SM Ratio (Dwt + DBE Inertia)	1.8 Sh	27000	**11950**	**0.44**	1
Eq 11 = P + SM Ratio (Th + Dwt + SAM OBE)	Sa + Sh	37500	**16212**	**0.43**	1

Minimum Wall Based On Hoop Stress is Sufficient for Longitudinal Stresses.
The Analysis Table Above Controls. Ignore the Analysis Table Below

Determine tmin Based on Longitudinal Stresses:

					REF
tmin based on Longitudinal Stress (Guess & Iterate)			**0.060**	in	
Diameter Inside Di'	Di'=Do-2tmin		**29.881**	in	-
New Section Modulus	Z' = 3.14/32 (Do^4 - Di'^4)/Do		**41.787**	cu in	6
Section Modulus Ratio	SM Ratio = Z / Z'		**6.106**	-	-
Longitudinal Pressure Stress	(P Do)/(4 tmin)		**11345**	psi	6
	May Not Exceed		L Stress	**IR≤1.0**	
Eq 8 = P + SM Ratio (DWt)	Sh	15000	**15008**	**1.00**	1
Eq 9 = P + SM Ratio (Dwt + OBE Inertia)	1.2 Sh	18000	**16510**	**0.92**	1
Eq 9 = P + SM Ratio (Dwt + DBE Inertia)	1.8 Sh	27000	**18013**	**0.67**	1
Eq 11 = P + SM Ratio (Th + Dwt + SAM OBE)	Sa + Sh	37500	**24424**	**0.65**	1

The Minimum Wall Criteria is 0.090 Inches.
The minimum wall criteria is controlled by the hoop stresses.

Part 2A - Reinforcement for 5.5" Hole

Branch Connection Reinforcement Calculation per ASME Section III, NC-3643.3

Symbol	Units	Description
Dob	in	outside diameter of branch connection
Doh	in	outside diameter of header
d1	in	inside diameter of branch connection
d2	in	half width of reinforcing zone, greater of d1 orTb+Th+(d1/2) but not > Dob
L	in	height of reinforcement zone outside of run or reinforcement = 2.5Tb
te	in	thickness of attached reinforcing pad
Tb	in	thickness of the branch, use minimum
Th	in	thickness of the run, use minimum
tmb	in	required minimum wall thickness branch
tmh	in	required minimum wall thickness header / run
P	psi	internal Design Pressure
T	deg F	internal Design Temperature
S	psi	maximum allowable stress for the material at design temperature
y		coefficient
A	in	additional thickness
a	deg	angle between axes of branch and run
tc	in	weld throat, smaller of 1/4" or 0.7Tb(ave) Fig NB-3352.4-2
w	in	weld leg, =1.41 tc

5.5" Branch Connection (assumed size bounds the two throughwall holes)
Leave 5.5" hole in main line I-30"-CW-30, std. wall
Pipe Code CS-1, Material ASME SA-155, KC65 Class 1

						Ref
Dob	5.5				Assumed, Bounding	15, 16
Doh	30				Design	2
d1	5.5				Assumed, Bounding	15, 16
		d1	Tb+Th+(d1/2)	Dob	NC-3643.3	4
d2	5.5	5.5	3.125	5.5	NC-3643.3	4
L	0.000				NC-3643.3	4
te	0				Assume no reinforcing pad	-
Tb (ave)	0				Assume no wall thickness	-
Tb (min)	0.000				87.50%	3
Th (ave)	0.375				NAMS	2
Th (min)	0.328				87.50%	3
tmb	N/A	tmb=(P*Dob)/ 2 (S+Py) + A			NC-3641.1(a)	5
tmh	0.090				See Part 1	-
P	90				NAMS	2
T	125				NAMS	2
S	15,000				See Part 1	9
y	0.4				See Part 1	5
A	0				See Part 1	5
a	90				Design	15, 16
a radians	1.571				360 degrees = 2 π radians	-
		1/4"	0.7Tb		NC-3643.3	4
tc	0	0	0		Not Used	-
w	0				Not Used	-

Calculate area required:

Area required = 1.07(tmh)(d1)
0.528 sq. in.

Calculate area available (see ASME Section III, ND-3643.3 for clarification):

Area A1 = (2*d2-d1)*(Th min-tmh)
1.311 sq. in.

Area A2 = 2L*(Tb min-tmb)/sina
0 sq. in.

Area A3= area provided by deposited weld metal beyond OD of run & branch
2 (0.5 * w*w)
0 sq. in.

Area A4= area provided by a reinforcing ring, pad or integral reinforcement
0 sq. in.

Area A5= area provided by a saddle on right angle connections
0 sq. in.

Aavail= A1 + A2 + A3 + A4 + A5
1.311 sq. in.

Compare area available to required area:

Avail		Required area
1.311 sq. in.	>	0.528 sq. in.

No additional reinforcement of the assumed 5.5" hole is required.

Part 3A - Plate Thickness for 5.5" Hole

Data used in the 5.5" hole plate and bolting analysis is summarized in this section.

Patch Plate Inputs:			Value	Units	REF
Design Temperature			125	F	2
Design Pressure			90	psig	2
Base Metal Information					
Pipe Nominal Wall			0.375	in	2
Material			SA/A-155 KC65 CL1		11
Allowable Stress	Table I-7.1	Assume SA/A-106 Gr. B	15000	psi	4, 9
Patch Information					
Height			8	in	15, 16
Width			8	in	15, 16
Material			SA/A-106 Gr B		15, 16
Allowable Stress	Table I-7.1	SA/A-106 Gr. B or equiv	15000	psi	4
Opening Dimensions					
Gasket Width			0.75	in	15, 16
Height		8" - 2(1/8" + 3/4")	6.25	in	15, 16
Width		8" - 2(1/8" + 3/4")	6.25	in	15, 16
Bolting Information					
Diameter			0.25	in	15, 16
Material			SA/A193 Gr. B7		15, 16
Allowable Stress	Table I-7.3		25000	psi	4
Yield Stress	Table I-1.3		105000	psi	4
Number of Bolts			8		15, 16
Area of Bolt			0.0318	in^2	14
k for Thread Lubricant N-5000			0.15	-	12

Minimum Required Patch Plate Thickness (ASME Section III, NB-3647.2)

tm	minimum thickness = t + A	
t	calculated thickness = d6*(3*P/16*S)^.5	
d6	Gasket ID	Assume width, increase by 10%, conservative.
P	Design Pressure	Use of design pressure is extremely conservative.
S	Stress Allowable	
A	Mechanical Allowances (NB-3613) = 0	

tm =	(110% *6.25*((3*90)/(16*15000))^0.5+0 =	0.231	in
	Required plate thickness is	**0.375**	**in**

Part 4A - Bolt/Gasket Loading for 5.5" Hole

See Att. 3 for evaluation of alternate bolting.

FLANGE JOINT LOADING/GASKET SEATING CALCULATIONS

ASME Section III Appendix E methodology, modified for square patch plate

GASKET AREA			Value	Units	REF
W	Pressure Width	Gasket Centerline	7	in	15, 16
H	Pressure Height	Gasket Centerline	7	in	15, 16
Land	Gasket Width		0.75	in	15, 16
b	1/2 Gasket Width	Land/2	0.375	in	
A	Short Dimension Cover	8 - 2 (0.125)	7.75	in	15, 16
B	Long Dimension Cover	8 - 2 (0.125)	7.75	in	15, 16
C	Short Dimension Gasket ID	8 - 2 (0.125 + .75)	6.25	in	15, 16
D	LongDimension Gasket ID	8 - 2 (0.125 + .75)	6.25	in	15, 16
d	Bolt Diameter		0.25	in	15, 16
N	Number of Bolts		8		15, 16
PRESSURE AREA					
P Area	W*H		49	in^2	-
REQUIRED SEATING LOAD (Wm2)					
y			200	lb/in^2	4
G Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		20.1	in^2	4
Wm2	y* G Area		4023	lb	4
OPERATING SEATING LOAD (Wm1)					
P ext	Patch is on ID, Assume 15 psi external		15	psig	Ass. 3
P Area	W*H		49	in^2	
m	Gasket Factor		1		4
Wm1	(P ext*P Area)+(G Area*m*P ext)		1037	lb	4
REQUIRED BOLT STRESS/TORQUE					
Load	Greater of Wm1 or Wm2		4023	lb	4
Bolt Diameter			0.25	in	15, 16
Load/Bolt	Load / N		503	lb	-
Bolt Stress	Load/Bolt/(3.14/4*Bolt Dia^2)		10245	psi	-
Bolt Torque	K*d* (Load/Bolt)/12		1.57	ft-lbs	12
			2 ft-lbs specified		

Part 5A - Bolting for 5.5" Hole

See Att. 3 for evaluation of alternate bolting.

The critical areas of stress of mating screw threads are:
1. Effective cross sectional area, or tensile stress area, of the external thread (the bolt)
2. External thread shear area which depends principally on minor diameter of tapped hole
3. Internal thread shear area which depends principally on major diameter of external thread

In general, the design goal is for the bolt to break before either internal or external threads strip.

ICW Pipe - SA/A-155 KC65 Class 1 (Lower properties of SA/A-106 Grade B Used)
Bolts: SA/A-193 Grade B7, 1/4"-20 UNC-2A

				REF
D	Bolt Basic Major Diameter (nominal diameter)	0.250	in	15
n	Threads per inch	20	-	15
	Thread Class (External)	2A	-	15
Le'	Actual Thread Engagement	0.250	in	15
Esmin	External Thread Minimum pitch diameter	0.2127	in	14
Dsmin	External Thread Minimum major diameter	0.2408	in	14
Yieldbolt	External Thread Yield Strength	105,000	psi	4
UTSbolt	External Thread Thread Ultimate Tensile Strength	125,000	psi	4
Enmax	Internal Thread Maximum pitch diameter	0.2223	in	14
Knmax	Internal Thread Maximum minor diameter	0.207	in	14
Yieldhole	Internal Thread Yield Strength	35,000	psi	4
UTShole	Internal Thread Ultimate Tensile Strength	60,000	psi	4

1. Review for Potential Stripping of External Threads (Before Bolt Breaks)

At	Tensile Area of Screw Thread UTSbolt < 100 ksi: At = .7854 (D- .9743/n)^2 UTSbolt ≥ 100 ksi: At = 3.1416 (Esmin/2 - .16238/n)^2	0.030	sq in	13
Le	Required Length of Engagement for External Threads to Develop Full Bolt Load Le = (2*At) / [3.14 Knmax (.5 + .57735 n (Esmin- Knmax)]	0.165	in	13

2. Review for Potential Stripping of Internal Threads (Before Bolt Breaks)

As	As = 3.1416 n Le Knmax (1/(2n) + .57735(Esmin - Knmax))	0.061	sq in	13
An	An = 3.1416 n Le Dsmin (1/(2n) + .57735 (Dsmin - Enmax))	0.089	sq in	13
J	J factor = (As UTSbolt) / (An UTShole)	1.42	-	13
Q	Required Length of Internal Threads to Develop Full Bolt Load Q = J * Le	0.234	in	13

3. Load Required to Break Bolt/Screw

Pbolt	Pbolt = At * UTSbolt	3789	lbs	13

Governing Bolt/Thread Failure Load

Threaded Joint Failure Load	Component Failure Review based on minimum load for bolt breakage, external thread strippage or internal thread strippage Failure Load = Minimum (1 , Le'/Le, Le'/Q) x (Pbolt)	3789	lbs	-
Bolt Torque	Torque which will yield undamaged joint with actual engagement Bolt Torque = (Failure Load/Pbolt) D*Yield bolt*At*K/12	10	ft-lbs	-

2 ft-lbs max torque specified.

Developed Percent of Bolt Yield Strength = M	20%	%	-
Nut Factor (Fel-Pro N-5000)	0.15	-	12
Bolt Torque = M D Yieldbolt At K / 12	**2.00**	ft-lbs	12

Specified Field torque is 2 ft-lbs	%Yield	%Ultimate
Bolt Stress compared to bolt material strength	20%	17%
External Thread Stress compared to bolt material strength	13%	11%
Internal Thread Stress compared to hole material strength	27%	16%

Part 2B - Reinforcement for 9" Hole

Branch Connection Reinforcement Calculation per ASME Section III, NC-3643.3

Symbol	Units	Description
Dob	in	outside diameter of branch connection
Doh	in	outside diameter of header
d1	in	inside diameter of branch connection
d2	in	half width of reinforcing zone, greater of d1 orTb+Th+(d1/2) but not > Dob
L	in	height of reinforcement zone outside of run or reinforcement = 2.5Tb
te	in	thickness of attached reinforcing pad
Tb	in	thickness of the branch, use minimum
Th	in	thickness of the run, use minimum
tmb	in	required minimum wall thickness branch
tmh	in	required minimum wall thickness header / run
P	psi	internal Design Pressure
T	deg F	internal Design Temperature
S	psi	maximum allowable stress for the material at design temperature
y		coefficient
A	in	additional thickness
a	deg	angle between axes of branch and run
tc	in	weld throat, smaller of 1/4" or 0.7Tb(ave) Fig NB-3352.4-2
w	in	weld leg, =1.41 tc

9" Branch Connection (assumed size bounds the throughwall hole)
Leave 9" hole in main line I-30"-CW-30, std. wall
Pipe Code CS-1, Material ASME SA-155, KC65 Class 1

						Ref
Dob	9				Assumed, Bounding	17
Doh	30				Design	2, 17
d1	9				Assumed, Bounding	17
		d1	Tb+Th+(d1/2)	Dob	NC-3643.3	4
d2	9	9	4.875	9	NC-3643.3	4
L	0.000				NC-3643.3	4
te	0				Assume no reinforcing pad	-
Tb (ave)	0				Assume no wall thickness	-
Tb (min)	0.000				87.50%	3
Th (ave)	0.375				NAMS	2
Th (min)	0.328				87.50%	3
tmb	N/A	tmb=(P*Dob)/ 2 (S+Py) + A			NC-3641.1(a)	5
tmh	0.090				See Part 1	-
P	90				NAMS	2
T	125				NAMS	2
S	15,000				See Part 1	9
y	0.4				See Part 1	5
A	0				See Part 1	5
a	90				Design	17
a radians	1.571				360 degrees = 2 π radians	-
		1/4"	0.7Tb		NC-3643.3	4
tc	0	0	0		Not Used	-
w	0				Not Used	-

Calculate area required:

Area required = 1.07(tmh)(d1)
0.865 sq. in.

Calculate area available (see ASME Section III, ND-3643.3 for clarification):

Area A1 = (2*d2-d1)*(Th min-tmh)
2.145 sq. in.

Area A2 = 2L*(Tb min-tmb)/sina
0.000 sq. in.

Area A3= area provided by deposited weld metal beyond OD of run & branch
2 (0.5 * w*w)
0.000 sq. in.

Area A4= area provided by a reinforcing ring, pad or integral reinforcement
0.000 sq. in.

Area A5= area provided by a saddle on right angle connections
0.000 sq. in.

Aavail= A1 + A2 + A3 + A4 + A5
2.145 sq. in.

Compare area available to required area:

Avail		Required area
2.145 sq. in.	>	0.865 sq. in.

No additional reinforcement of the assumed 9" hole is required.

Part 3B - Plate Thickness for 9" Hole

Data used in the 9" hole plate and bolting analysis is summarized in this section.

Patch Plate Inputs:			Value	Units	REF
Design Temperature			125	F	2
Design Pressure			90	psig	2
Base Metal Information					
Pipe Nominal Wall			0.375	in	2, 17
Material			SA/A-155 KC65 CL1		11
Allowable Stress	Table I-7.1	Assume SA/A-106 Gr. B	15000	psi	4, 9
Patch Information					
Height			11	in	17
Width			11	in	17
Material			SA/A-106 Gr B		17
Allowable Stress	Table I-7.1	SA/A-106 Gr. B or equiv	15000	psi	4
Opening Dimensions					
Gasket Width			0.75	in	17
Height		11" - 2(1/8" + 3/4")	9.25	in	17
Width		11" - 2(1/8" + 3/4")	9.25	in	17
Bolting Information					
Diameter			0.25	in	17
Material			SA/A193 Gr. B7		17
Allowable Stress	Table I-7.3		25000	psi	4
Yield Stress	Table I-1.3		105000	psi	4
Number of Bolts			8		17
Area of Bolt			0.0318	in^2	14
k for Thread Lubricant N-5000			0.15	-	12

Minimum Required Patch Plate Thickness (ASME Section III, NB-3647.2)

tm	minimum thickness = t + A	
t	calculated thickness = d6*(3*P/16*S)^.5	
d6	Gasket ID	Assume width, increase by 10%, conservative.
P	Design Pressure	Use of design pressure is extremely conservative.
S	Stress Allowable	
A	Mechanical Allowances (NB-3613) = 0	

tm =	(110% * 9.25*((3*90)/(16*15000))^0.5+0 =	0.341	in
	Required plate thickness is	**0.375**	**in**

Part 4B - Bolt/Gasket Loading for 9" Hole

FLANGE JOINT LOADING/GASKET SEATING CALCULATIONS

ASME Section III Appendix E methodology, modified for square patch plate

GASKET AREA			Value	Units	REF
W	Pressure Width	Gasket Centerline	10	in	17
H	Pressure Height	Gasket Centerline	10	in	17
Land	Gasket Width		0.75	in	17
b	1/2 Gasket Width	Land/2	0.375	in	
A	Short Dimension Cover	11 - 2 (0.125)	10.75	in	17
B	Long Dimension Cover	11 - 2 (0.125)	10.75	in	17
C	Short Dimension Gasket ID	11 - 2 (0.125 + .75)	9.25	in	17
D	LongDimension Gasket ID	11 - 2 (0.125 + .75)	9.25	in	17
d	Bolt Diameter		0.25	in	17
N	Number of Bolts		8		17
PRESSURE AREA					
P Area	W*H		100	in^2	-
REQUIRED SEATING LOAD (Wm2)					
y			200	lb/in^2	4
G Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		29.1	in^2	4
Wm2	y* G Area		5823	lb	4
OPERATING SEATING LOAD (Wm1)					
P ext	Patch is on ID, Assume 15 psi external		15	psig	Ass. 3
P Area	W*H		100	in^2	
m	Gasket Factor		1		4
Wm1	(P ext*P Area)+(G Area*m*P ext)		1937	lb	4
REQUIRED BOLT STRESS/TORQUE					
Load	Greater of Wm1 or Wm2		5823	lb	4
Bolt Diameter			0.25	in	17
Load/Bolt	Load / N		728	lb	-
Bolt Stress	Load/Bolt/(3.14/4*Bolt Dia^2)		14829	psi	-
Bolt Torque	K*d*(Load/Bolt)/12		2.27	ft-lbs	12
			3 ft-lbs specified		

Part 5B - Bolting for 9" Hole

The critical areas of stress of mating screw threads are:
1. Effective cross sectional area, or tensile stress area, of the external thread (the bolt)
2. External thread shear area which depends principally on minor diameter of tapped hole
3. Internal thread shear area which depends principally on major diameter of external thread

In general, the design goal is for the bolt to break before either internal or external threads strip.

ICW Pipe - SA/A-155 KC65 Class 1 (Lower properties of SA/A-106 Grade B Used)
Bolts: SA/A-193 Grade B7, 1/4"-20 UNC-2A

				Ref
D	Bolt Basic Major Diameter (nominal diameter)	0.250	in	17
n	Threads per inch	20	-	17
	Thread Class (External)	2A	-	17
Le'	Actual Thread Engagement	0.250	in	17
Esmin	External Thread Minimum pitch diameter	0.2127	in	14
Dsmin	External Thread Minimum major diameter	0.2408	in	14
Yieldbolt	External Thread Yield Strength	105,000	psi	4
UTSbolt	External Thread Thread Ultimate Tensile Strength	125,000	psi	4
Enmax	Internal Thread Maximum pitch diameter	0.2223	in	14
Knmax	Internal Thread Maximum minor diameter	0.207	in	14
Yieldhole	Internal Thread Yield Strength	35,000	psi	4
UTShole	Internal Thread Ultimate Tensile Strength	60,000	psi	4

1. Review for Potential Stripping of External Threads (Before Bolt Breaks)

At	Tensile Area of Screw Thread UTSbolt < 100 ksi: At = .7854 (D- .9743/n)^2 UTSbolt ≥ 100 ksi: At = 3.1416 (Esmin/2 - .16238/n)^2	0.030	sq in	13
Le	Required Length of Engagement for External Threads to Develop Full Bolt Load Le = (2*At) / [3.14 Knmax (.5 + .57735 n (Esmin- Knmax)]	0.165	in	13

2. Review for Potential Stripping of Internal Threads (Before Bolt Breaks)

As	As = 3.1416 n Le Knmax (1/(2n) + .57735 (Esmin - Knmax))	0.061	sq in	13
An	An = 3.1416 n Le Dsmin (1/(2n) + .57735 (Dsmin - Enmax))	0.089	sq in	13
J	J factor = (As UTSbolt) / (An UTShole)	1.42	-	13
Q	Required Length of Internal Threads Q = J * Le to Develop Full Bolt Load	0.234	in	13

3. Load Required to Break Bolt/Screw

Pbolt	Pbolt = At * UTSbolt	3789	lbs	13

Governing Bolt/Thread Failure Load

Threaded Joint Failure Load	Component Failure Review based on minimum load for bolt breakage, external thread strippage or internal thread strippage Failure Load = Minimum (1 , Le'/Le, Le'/Q) x (Pbolt)	3789	lbs	-
Bolt Torque	Torque which will yield undamaged joint with actual engagement Bolt Torque = (Failure Load/Pbolt) D*Yield bolt*At*K/12	10	ft-lbs	-

3 ft-lbs max torque specified.

Developed Percent of Bolt Yield Strength =M	30%	%	-
Nut Factor (Fel-Pro N-5000)	0.15	-	12
Bolt Torque = M D Yieldbolt At K / 12	**3.00**	**ft-lbs**	12

Specified Field torque is 3 ft-lbs	%Yield	%Ultimate
Bolt Stress compared to bolt material strength	30%	25%
External Thread Stress compared to bolt material strength	20%	17%
Internal Thread Stress compared to hole material strength	41%	24%

Part 6 - Reinforcement Zone Interaction Review

Based on the size of the individual openings, determine whether additional reinforcement is required per ASME Section NC-3643.3(f) criteria. Additional reinforcement is required if the individual reinforcement zones overlap.

Individual openings are as follows:

	EC	CR/AR	Location	Orientation	d2	
Plate 1	EC 235503	CR 2005-29217	36" east of flange	5:30	5.5	in
Plate 2	EC 235964	CR 2008-33008	42" east of flange	11, 12:00	5.5	in
Plate 3	EC 274859	AR 1712438	41" east of flange*	3:30	9	in

* Per picture 38" to edge + 3" to CL

Plate 1 Orientation per CR 2005-29217

Section ND-3643.3(e). Reinforcement Zones extend from centerline (CL) of opening
d2 = reinforcement zone length, extends from centerline (CL) of opening.

Internal Diameter	30" Pipe	29.25	in
Circumference	30" Pipe	91.89	in

Two closest plates are Plate 1 and Plate 3.
Minimum distance between CL of openings for EC 274859 and EC 235503 (PCM 05192) without imposing Multiple Opening Reinforcement critera:

Minimum CL distance	Plate d2 + Plate 3 d2	14.5	in
Actual distance between CLs of Plate 1 and Plate 3		15.3	in
Angle between CLs of Plate 1 and Plate 3		60	degrees

Conclusion:
The openings for closest holes are spaced sufficiently apart that additional reinforcement criteria per ASME III, Section ND-3643.3(f) is not required.

7.0 Results

Pipe

The Minimum Wall Criteria is	**0.090**	**Inches**

The minimum wall criteria is controlled by the hoop stresses.

5.5" Diameter Opening

No additional reinforcement of a 5.5" hole is required.

Required closure plate thickness Is	**0.375**	**Inches**
Minimum Bolt Torque (1/4" -20UNC) is	**1.57**	**Ft-lbs**

Note that the thread engagement in the ICW piping does not meet standard design to assure the bolt breaks before stripping the threads. However, field torque limitations will prevent stripping of the hole.

Alternate Bolting (Attachment 3)

Minimum Bolt Torque (5/16"-18UNC) is	**2.02**	**Ft-lbs**

Note that the thread engagement in the ICW piping does not meet standard design to assure the bolt breaks before stripping the threads. However, field torque limitations will prevent stripping of the hole.

9" Diameter Opening

No additional reinforcement of an 9" hole is required.

Required closure plate thickness is	**0.375**	**Inches**
Minimum Bolt Torque (1/4" -20UNC) is	**2.27**	**Ft-lbs**

Note that the thread engagement in the ICW piping does not meet standard design to assure the bolt breaks before stripping the threads. However, field torque limitations will prevent stripping of the hole.

Interaction Between Multiple Openings

The openings for closest holes are spaced sufficiently apart that :
additional reinforcement criteria per ASME III, Section ND-3643.3(f) is not required.

Stress Intensifiction Factor Review

The bolted patch plate repair methodology provides a branch connection but does not impose any moment inducing loads from branch piping. ASME Section III Edition 1971 through Summer 1973 Addenda provides stress intensification factors (SIFs) for various configurations which impose moment loading of piping components but does not address a branch hole with or without a bolted covering.

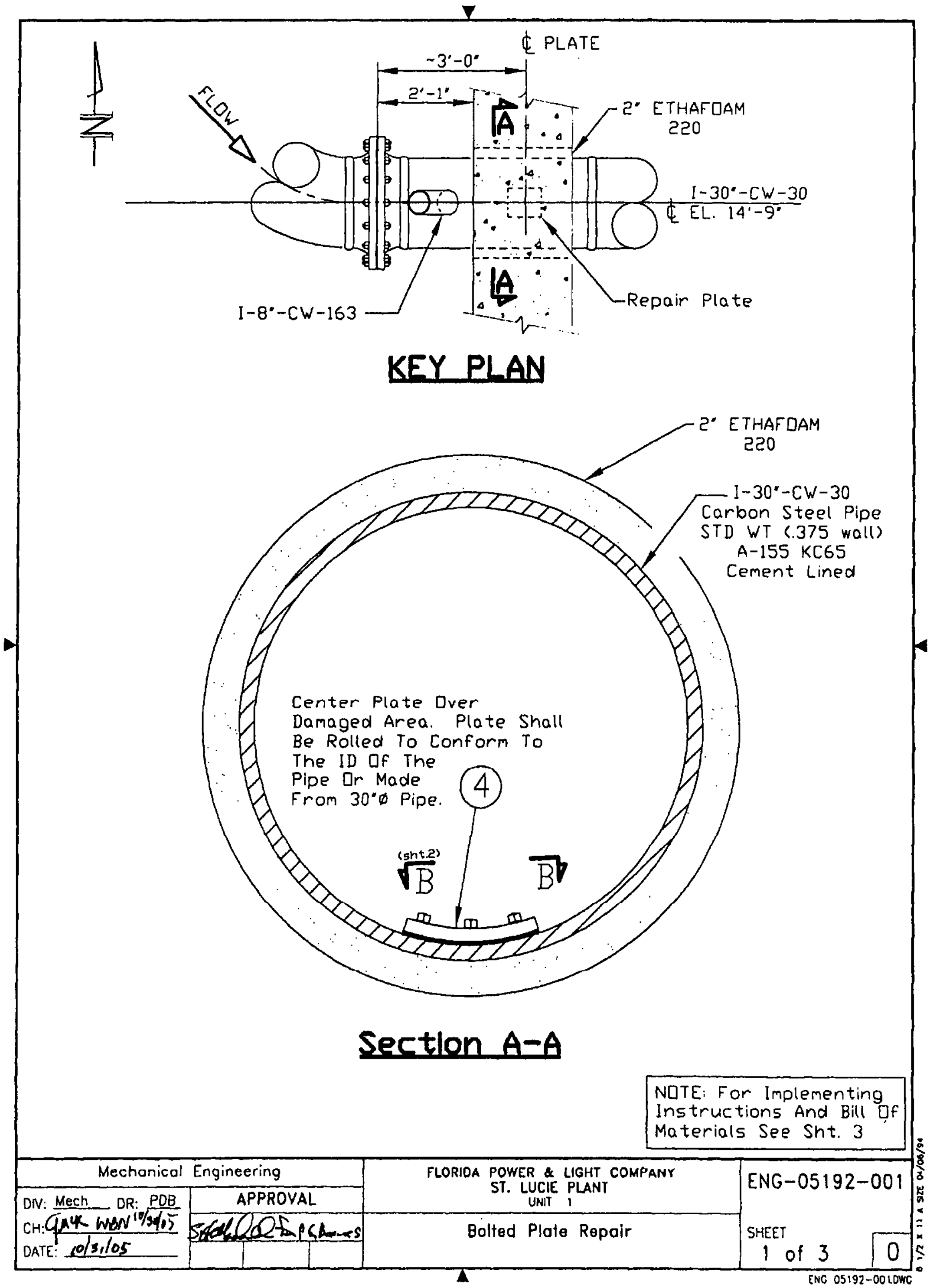
Stress indices and stress intensification factors (SIFs) are used in the design of piping systems that must meet Code requirements. SIFs are fatigue correlation factors that compare the fatigue life of piping components (for example, tees and branch connections) to that of girth butt welds in straight pipe subjected to bending moments.

As the subject opening with a bolted cover is not subjected to increased bending moments or externally applied loads, a SIF does not need to be applied to the configuration. Code criteria regarding reinforcement zones for a branch penetration apply.

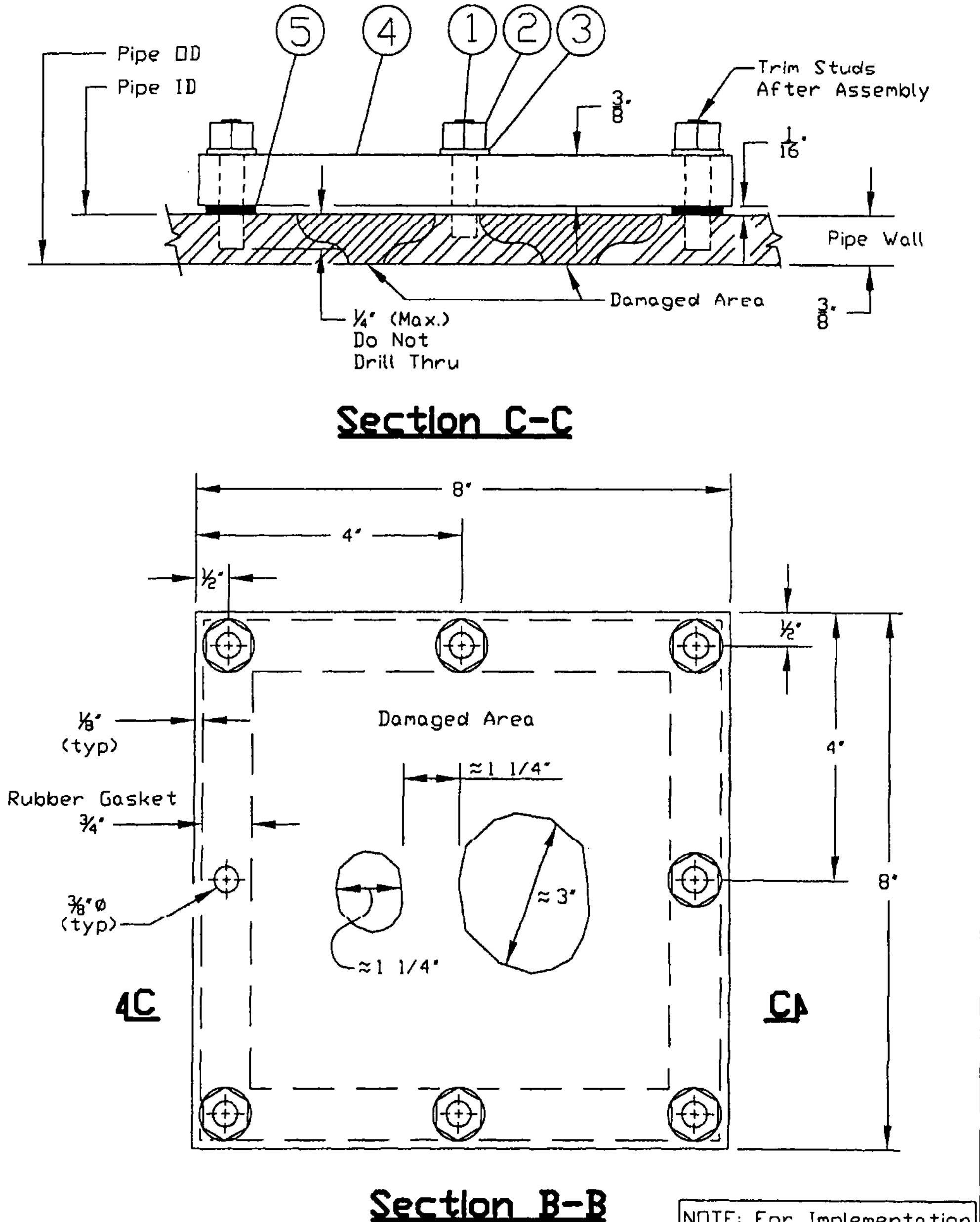
Similarly, a SIF is not required for multiple openings. Code criteria regarding overlap of reinforcement zones for adjacent penetrations apply.

Prepared By:	Gordon McKenzie	Date:	12-15-11
Verified By:		Date:	12-15-11
Approved By:		Date:	12.15.11

PSL-1FSM-05-031, Rev. 1, Att. 2, Page 1 of 3



PSL-1FSM-05-031, Rev. 1, Att. 2, Page 2 of 3



NOTE: For Implementation Instructions And Bill Of Materials See Sht. 3

Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	ENG-05192-001
DIV: Mech DR: PDB	APPROVAL		
CH: QMK WAN 10/30/05		Bolted Plate Repair Sections / Details	SHEET 2 of 3 — 0
DATE: 10/31/05			

ENG 05192-001.DWG

PSL-1FSM-05-031, Rev. 1, Att. 2, Page 3 of 3

Implementation Instructions

1. Perform all epoxy and coating applications in accordance with SPEC-C-004 and the instructions of the Coating Specialist.
2. Fabricate closure plate in accordance with drawing and apply protective coating.
3. Fabricate gasket in accordance with drawing. Cut out of gasket center is required.
4. Avoiding damage to any coatings or Ethafoam on the pipe OD, prep surface of corrosion holes and fill with epoxy material to the profile of the pipe ID. Underfill is acceptable, do NOT overfill.
5. Remove an 8" x 8" section of the pipe lining centered on the affected area.
6. Clean and smooth interior of pipe to support closure plate fit-up.
7. Layout bolt hole locations on pipe wall and UT for thickness
8. Notify Engineering if any excess degradation is observed during cleaning, drilling or pipe thickness at bolt hole locations is <0.350"
9. Drill and tap ¼"-20-UNC holes, ¼" deep on plate bolt pattern. Do NOT allow holes to exceed ¼" depth to maintain minimum wall thickness.
10. Install the studs wrench tight without lubrication.
11. Trial fit plate and enlarge bolt holes as required for fit-up. Grind off any cavity overfill that would prevent gasket crush.
12. Apply epoxy to pipe beneath closure plate area including gasket area. Caution: Excessive epoxy may prevent proper gasket crush or push out on tightening.
13. Before epoxy hardens, install gasket, closure plate, washers and nuts (lightly lubricated).
14. Before epoxy hardens, torque nuts to 2 ft-lbs (24 inch-lbs) in a crisscross pattern. Retighten if epoxy creep relaxes fastener torque.
15. Trim studs flush with the tops of the nuts using suitable means. Avoid excessive heating.
16. Degrease and surface prep the exposed area.
17. Cover entire repair area with epoxy coating. Ensure coating is blended to provide smooth transitions to minimize ICW flow turbulence.

<u>BILL OF MATERIALS</u>

1 STUDS 1/4"-20-UNC x 1 1/8" LONG, SA-193 GRB7, PC-1 (QTY=8)

2 NUTS 1/4" x 20, SA-194-2H, PC-1 (QTY=8)

3 FLAT WASHER 1/4" STD, STEEL, ZINC PLATED, PC-3 (QTY=8)

4 CLOSURE PLATE 8"x8"X3/8" THICK, CUT FROM 30" SA-672 GR C65/70 PIPE OR CUT FROM SA-155 GR 65/70 PLATE AND ROLL TO SUIT, PC-1.

5 GASKET, RED RUBBER, 1/16" THICK, PC-3

Mechanical Engineering DIV: Mech DR: PDB CH: [illegible] WBN 10/31/05 DATE: 10/31/05	APPROVAL [illegible signatures]	FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1 Bolted Plate Repair Bill Of Materials And Notes	ENG-05192-001 SHEET 3 of 3	0

8 1/2 x 11 A SIZE 04/06/94

ENG 05192-001.DWG

PSL-1FSM-05-031, Rev. 1, Att. 3, Page 1 of 6

REVISION NO. 14A	PROCEDURE TITLE: DESIGN CONTROL	PAGE:
PROCEDURE NO. QI-3-PSL-1	ST. LUCIE PLANT	29 of 33

APPENDIX E
CHANGE REQUEST NOTICE (CRN)
(Page 1 of 1)

THIS DOCUMENT SUPERSEDES CRN-05192-12926

ORIGINATOR

PC/M or MSP NO. 05192 SUPPLEMENT 0 UNIT 1
CRN No. 12929 Page 1 of 2 WBN 11/8/05
☒ SR ☐ QR ☐ NNS

Reason for Change: Wrong sized drill bit used to drill for ¼"-20 tap. Drill bit used was ¼"
THIS CRN SUPERCEDES CRN-05192-12926

Provide Change Description / Before and After (as required): Drill out existing holes with an "F" sized drill bit and tap all the holes (8) for 5/16 – 18 bolting. Change Bill Of Materials to reflect 5/16- 18 studs 1-1/8" long A354 GR BD, 5/16" 2H nuts, 5/16" flat washer. 3/8" diameter holes in item 4 may be enlarged to 7/16" if required.

Affected Documents:
ENG-05192-001 SH 3 Rev. 0
~~SH 2~~ Rev. ~~0~~ WBN 11/8/05
Rev.
Rev.
Rev.
Rev.
Rev.

This CRN Affects Work Order(s):
WO(s): 35026597-02 Steps(s):
WO(s): Steps(s):
Prepared By: BOB GIBBENS Date: 11/7/05
Department: PROJECTS Tel. No.: 3443
WO(s) scheduled completion date SL1-20
IMPLEMENTING DEPARTMENT SUPV. APPROVAL:
(Approval signifies the CRN will be processed in accordance with QI-3-PSL-1, Design Control, as applicable.)
Roger R. Barlow Date: 11/08/05

Source of Change:
☐ Doc. Update Only (Prelim. Eng. Disp. Not Required)
☐ Material Substitution
☐ Implementor Convenience
☐ Existing Condition
☒ Implementor Error
☐ Other

ENGINEERING PRELIMINARY DISPOSITION:
☐ HOLD ☒ PROCEED AT RISK

This CRN has been discussed (☒ by phone ☐ in person) with:
Gordon Mckenzie Dept. ENG Date 11/7/05
(N/A if prepared by Engineering or for Doc. Update Only)

ENGINEERING

☐ Design Evolution
☐ Design / Drafting Error
☐ Planned
☒ Physical Field Discrepancy
☐ Other

Scope of Work:
☐ Increase ☐ Decrease ☒ Unchanged

IMPACT OF CHANGE	YES	NO
1. Design Basis / Analysis Affected *	☐	☒
2. 50.59 Applic / Scrn / Eval Affected *	☐	☒
3. PODs Functionally Affected	☐	☒
4. PMT, OPS or Maint Reqm'ts Affected	☐	☒
5. Document Update Required	☐	☒
6. TEDB Affected	☐	☒

* If Yes Do Not Use CRN

FINAL DISPOSITION:
☒ Approved ☐ Not Approved
FPL ENG
Cognizant Design Organization (CDO)

PCM / MSP Expiration Date 12/31/06
Prepared: G McKenzie Date: 11-8-05
Verified: W.B. Null Date: 11/8/05
Approved: [signature] Date: 11-8-05
Engineering (if not CDO): Date:

Additional Affected Documents: ☒ Listed Below ☐ Listed on Page:
ENG-05192-001 SH Rev. 0 Rev. Rev.
Rev. Rev. Rev.
Rev. Rev. Rev.

Remarks/Basis for Disposition:
See Page 2

END OF APPENDIX E

BASIS FOR DISPOSITION

CRN 05192-12929 concerns substitution of 5/16" bolting material due to a field drilling error. Per discussion with Planning, some of the subject holes were drilled with a ¼" drill bit which is oversize for tapping the design ¼" -20 stud hole. Engineering's direction was to substitute 5/16" fasteners in lieu of the design fasteners at all holes. Substitute materials for WO 35026597 are addressed below.

Material	Design	CRN Substitution
Stud	1/4"-20UNC-2A , SA- 193 Gr B7	5/16"-18UNC-2A , A-354, Gr BD SC 237879-1
Nut	1/4"-20UNC-2B , SA- 194 Gr 2H	5/16"-18UNC-2B, Heavy Hex, SA-194, Gr 2H SC 27945-1
Washer	1/4", Std Steel, zinc plated	5/16", Std Steel, zinc plated, SC 27698-3

Fastener materials remain in accordance with SPEC-M-004. Material strength remains in accordance with design assumptions and material type is standard pressure boundary material in ASME Section III design. The use of ASTM stud material in place of ASME stud material (due to availability) is acceptable for use within Unit 1.

The 5/16" size and number of fasteners is adequate to develop the required gasket seating load and the ¼" depth of stud engagement of the studs is adequate to achieve the required fastener load. Fastener Torque remains unchanged at 2 ft/lbs per attached calculation reviewing fastener substitution.

The slightly coarser thread for the 5/16" bolt will provide marginally fewer number of engaged threads. This reduction is acceptable given the low loads, conservative design (pressure stress provides additional clamping force) and the offsetting increase in stud diameter.

Based on the above, this CRN change is acceptable for use.

Review of Fastener Substitution CRN 05192-12929, Page 3 of 6
Reference: Calc PSL-1FSM-05-031 Rev 0

Part 4: Bolt/Gasket Loading Review

Note that although the patch plate is on the inside of the piping, the bolted connection is designed as if it were on the OD.
Water pressure actually decreases bolt load requirements.

FLANGE JOINT LOADING/GASKET SEATING CALCULATIONS
Per ASME Section III Appendix E, modified for square patch plate

			1/4" stud	5/16" stud		
GASKET AREA			Value	Value	Units	REF
H		Bolt Centerline	7	7	in	(14)
W		Bolt Centerline	7	7	in	(14)
Land			0.75	0.75	in	(14)
b	1/2 Gasket Width	Land/2	0.375	0.375	in	
A	Short Dimension Cover		7.75	7.75	in	(14)
B	Long Dimension Cover		7.75	7.75	in	(14)
C	Short Dimension Hole		6.25	6.25	in	(14)
D	Long Dimension Hole		6.25	6.25	in	(14)
d	Bolt Diameter		0.25	0.3125	in	(14)
N	Number of Bolts		8	8		(14)
Gasket Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		20.1164278	19.79736	in^2	
PRESSURE AREA						
AREA' (of Opening)		W*H	49	49	in^2	
REQUIRED SEATING LOAD (Wm2)						
y			200	200	lb/in^2	(8)
Gasket Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		20.12	19.80	in^2	
Wm2	y* Gasket Area		4023.29	3959.47	lb	
OPERATING SEATING LOAD (Wm1)						
PRESS	Use of operating is conservative as patch is on ID		60	60	psig	(1)
AREA'		W*H	49	49	in^2	
m gasket factor			1	1		(8)
Wm1	(PRESS*AREA')+(AREA*m*PRESS)		4146.99	4127.84	lb	
REQUIRED BOLT STRESS/TORQUE						
LOAD	Greater of Wm1 or Wm2		4146.99	4127.84	lb	
BOLT DIA			0.25	0.3125	in	(14)
LOAD/BOLT	Fp= LOAD/N		518.37	515.98	lb	
BOLT STRESS	LOAD/BOLT/(3.14159*BOLT DIA^2/4)		10560.22	6727.34	psi	
BOLT TORQUE	K*d*Fp/12		1.62	2.02	ft-lbs	(15)

Part 5: Bolt Strength and Thread Engagement Review

The critical areas of stress of mating screw threads are.
1. Effective cross sectional area, or tensile stress area, of the external thread (the bolt)
2. External thread shear area which depends principally on minor diameter of tapped hole
3. Internal thread shear area which depends principally on major diameter of external thread

In general, the design goal is for the bolt to break before either internal or external threads strip.

ICW Pipe - A-155 KC65
Bolts: SA-193 Gr B7, 1/4"-20 UNC vs.. A-354 Gr BD, 5/16"-18-2A UNC

		1/4" stud Value	5/16" stud Value		REF
D	Bolt Basic Major Diameter (nominal diameter)	0.250	0.3125	in	(14)
n	Threads per inch	20	18	#/in	(14)
	Thread Class (External)	2A	2A	-	(14)
Le'	Actual Thread Engagement	0.250	0.250	in	(14)
Esmin	External Thread Minimum pitch diameter	0.2127	0.2712	in	(17)
Dsmin	External Thread Minimum major diameter	0.2408	0.3026	in	(17)
Yieldbolt	External Thread Yield Strength	105,000	130,000	psi	(8)
UTSbolt	External Thread Thread Ultimate Tensile Strength	125,000	150,000	psi	(8)
Enmax	Internal Thread Maximum pitch diameter	0.2224	0.2817	in	(17)
Knmax	Internal Thread Maximum minor diameter	0.207	0.265	in	(17)
Yieldhole	Internal Thread Yield Strength	30,000	30,000	psi	(8)
UTShole	Internal Thread Ultimate Tensile Strength	55,000	55,000	psi	(8)
	Calc #	PSL-1FSM-05-031 Page 10 of 10 Rev 0			

1. Review for Potential Stripping of External Threads (Before Bolt Breaks)

At	Tensile Area of Screw Thread UTSbolt < 180 ksi: At = .7854 (D- .9743/n)^2 UTSbolt ≥ 180 ksi: At = 3.1416 (Esmin/2 - .16238/n)^2	0.032	0.052	sq in	(17,18)
Le	Required Length of Engagement for External Threads to Develop Full Bolt Load Le = (2*At) / [3.14 Knmax (.5 + .57735 n (Esmin- Knmax)]	0.173	0.223	in	

2. Review for Potential Stripping of Internal Threads (Before Bolt Breaks)

As	As = 3.1416 n Le Knmax (1/(2n) + .57735(Esmin - Knmax))	0.064	0.105	sq in	(18)
An	An = 3.1416 n Le Dsmin (1/(2n) + .57735 (Dsmin - Enmax))	0.093	0.152	sq in	
J	J factor = (As UTSbolt) / (An UTShole)	1.55	1.88	-	
Q	Required Length of Internal Threads to Develop Full Bolt Load Q = J * Le	0.268	0.420	in	

CAUTION: Full thread engagement is not provided by internal threads

3. Load Required to Break Bolt/Screw

Pbolt	Pbolt = At * UTSbolt	3978	7865	lbs

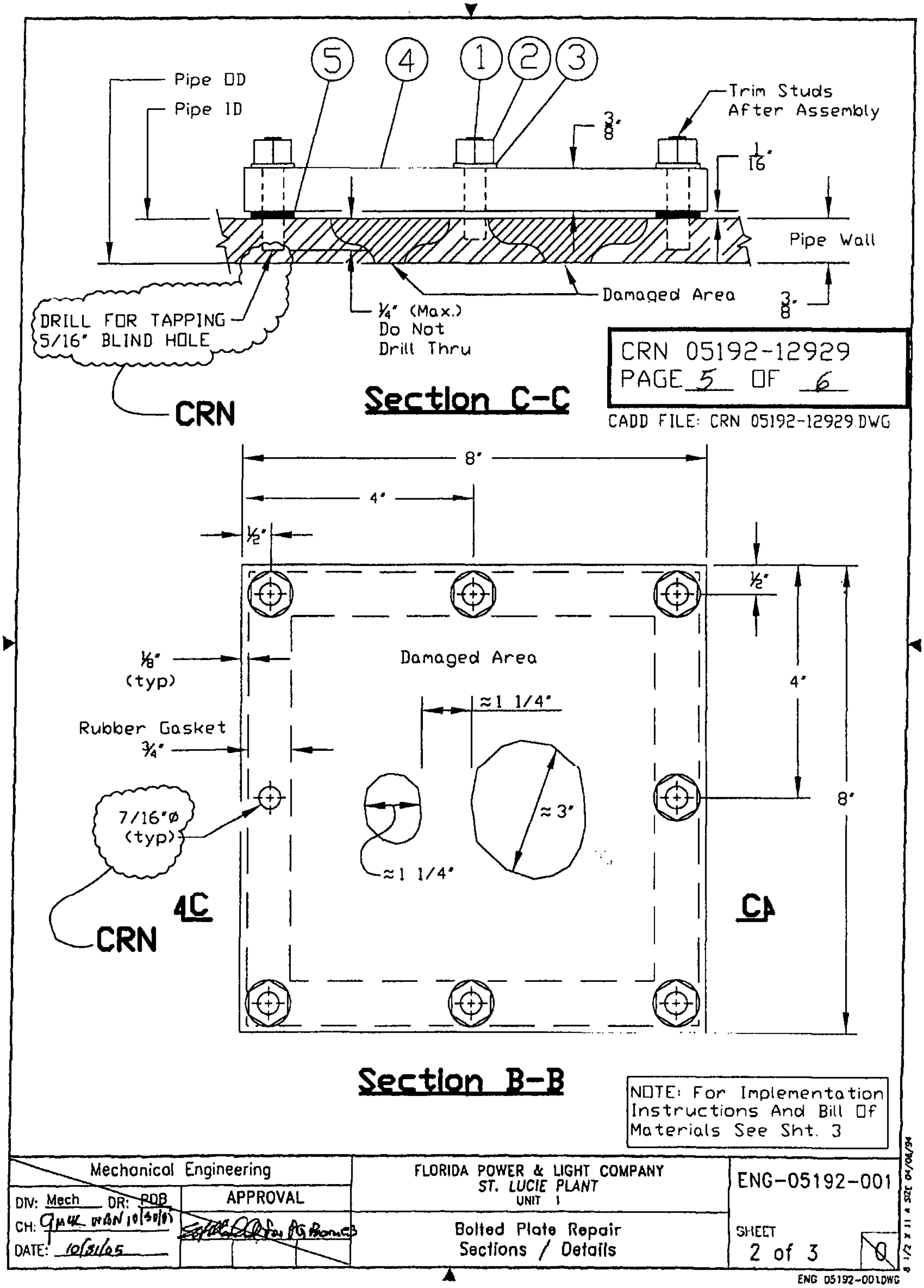
Governing Bolt/Thread Failure Load

Threaded Joint Failure Load	Component Failure Review based on minimum load for bolt breakage, external thread strippage or internal thread strippage	3704	4685	lbs
Bolt Torque	Torque which will fail undamaged joint with actual engagement (D*Yield bolt*At*K/12)	10	16	ft-lbs

The Minimum Bolt Torque is	**1.62**	**2.02**	**Ft-lbs**

Note that the thread engagement in the ICW piping does not meet standard design to assure the bolt breaks before stripping the threads. However, the torque is limited to 2 ft-lbs which will prevent stripping of the hole.

PSL-1FSM-05-031, Rev. 1, Att. 3, Page 5 of 6



PSL-1FSM-05-031, Rev. 1, Att. 3, Page 6 of 6

CRN 05192-12929
PAGE 6 OF 6

CADD FILE: CRN 05192-12929.DWG

Implementation Instructions

1. Perform all epoxy and coating applications in accordance with SPEC-C-004 and the instructions of the Coating Specialist.
2. Fabricate closure plate in accordance with drawing and apply protective coating.
3. Fabricate gasket in accordance with drawing. Cut out of gasket center is required.
4. Avoiding damage to any coatings or Ethafoam on the pipe OD, prep surface of corrosion holes and fill with epoxy material to the profile of the pipe ID. Underfill is acceptable, do NOT overfill.
5. Remove an 8" x 8" section of the pipe lining centered on the affected area.
6. Clean and smooth interior of pipe to support closure plate fit-up.
7. Layout bolt hole locations on pipe wall and UT for thickness
8. Notify Engineering if any excess degradation is observed during cleaning, drilling or pipe thickness at bolt hole locations is <0.350"
9. Drill and tap 5/16"-18-UNC holes, ¼" deep on plate bolt pattern. Do NOT allow holes to exceed ¼" depth to maintain minimum wall thickness. CRN
10. Install the studs wrench tight without lubrication.
11. Trial fit plate and enlarge bolt holes as required for fit-up. Grind off any cavity overfill that would prevent gasket crush.
12. Apply epoxy to pipe beneath closure plate area including gasket area. Caution: Excessive epoxy may prevent proper gasket crush or push out on tightening.
13. Before epoxy hardens, install gasket, closure plate, washers and nuts (lightly lubricated).
14. Before epoxy hardens, torque nuts to 2 ft-lbs (24 inch-lbs) in a crisscross pattern. Retighten if epoxy creep relaxes fastener torque
15. Trim studs flush with the tops of the nuts using suitable means. Avoid excessive heating.
16. Degrease and surface prep the exposed area.
17. Cover entire repair area with epoxy coating. Ensure coating is blended to provide smooth transitions to minimize ICW flow turbulence.

BILL OF MATERIALS

CRN

1 STUDS 5/16"-18-UNC x 1 1/8" LONG, A-354 GRBD, PC-1 (QTY=8)

2 NUTS 5/16" x 18, SA-194-2H, PC-1 (QTY=8)

3 FLAT WASHER 5/16" STD, STEEL, ZINC PLATED, PC-3 (QTY=8)

4 CLOSURE PLATE 8"x8"X3/8" THICK, CUT FROM 30" SA-672 GR C65/70 PIPE OR CUT FROM SA-155 GR 65/70 PLATE AND ROLL TO SUIT, PC-1.

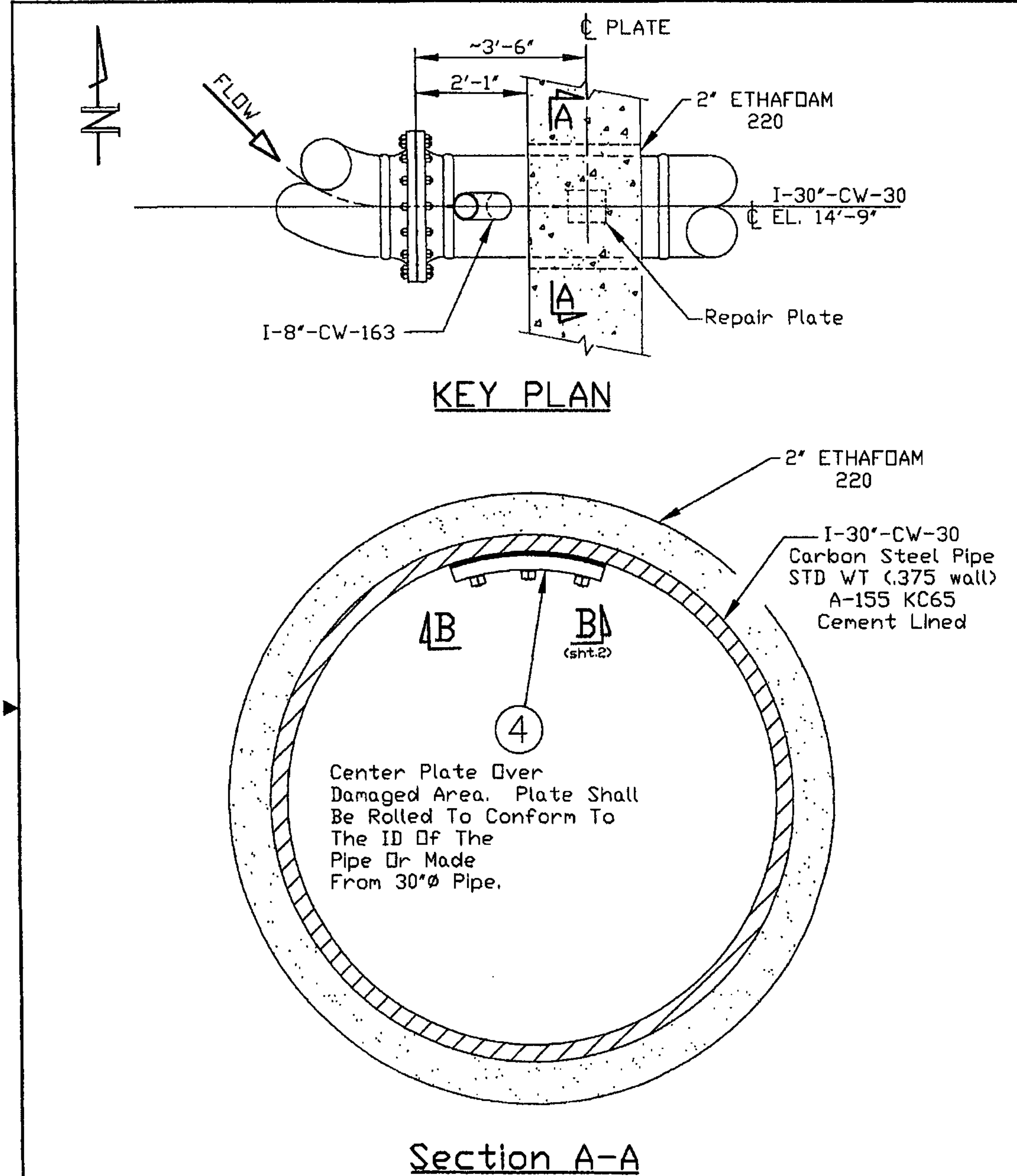
5 GASKET, RED RUBBER, 1/16" THICK, PC-3

ical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	ENG-05192-001
DIV: Mech DR: PDB	APPROVAL		
CH: GMK WBN 10/31/05	[signatures]	Bolted Plate Repair Bill Of Materials And Notes	SHEET 3 of 3 REV 0
DATE: 10/31/05			

ENG 05192-001.DWG

8 1/2 x 11 A SIZE 04/06/94

PSL-1FSM-05-031, Rev. 1, Att. 4, Page 1 of 3



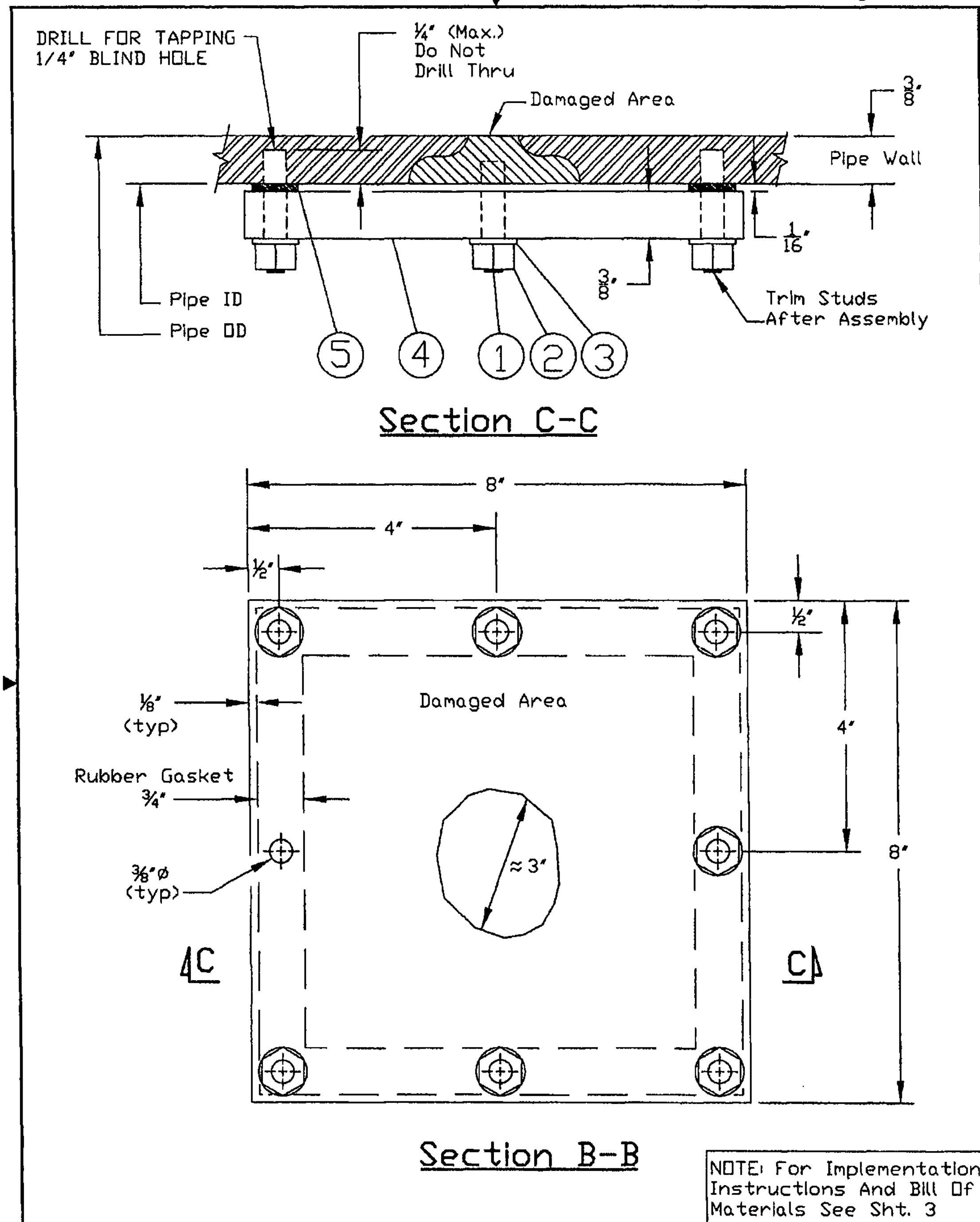
NOTE: For Implementing Instructions And Bill Of Materials See Sht. 3

Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	ENG-08168-001
DIV: Mech DR: PDB CH: [signature] 10/29/08 DATE: 10-28-08	APPROVAL [signature]	Bolted Plate Repair	SHEET 1 of 3 | 0

8 1/2 X 11 A SIZE 04/08/94

ENG 08168-001.DWG

PSL-1FSM-05-031, Rev. 1, Att. 4, Page 2 of 3



Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	ENG-08168-001
DIV: Mech DR: PDB	APPROVAL		
CH: N.B.H. 10/28/08		Bolted Plate Repair Sections / Details	SHEET 2 of 3	0
DATE: 10-28-08			

8 1/2 X 11 A SIZE 04/08/94

ENG 08168-001DWG

Implementation Instructions

1. Perform all epoxy and coating applications in accordance with SPEC-C-004 and the instructions of the Coating Specialist.
2. Fabricate closure plate in accordance with drawing and apply protective coating.
3. Fabricate gasket in accordance with drawing. Cut out of gasket center is required.
4. Avoiding damage to any coatings or Ethafoam on the pipe OD, prep surface of corrosion holes and fill with epoxy material to the profile of the pipe ID. Underfill is acceptable, do NOT overfill.
5. Remove an 8" x 8" section of the pipe lining centered on the affected area.
6. Clean and smooth interior of pipe to support closure plate fit-up.
7. Layout bolt hole locations on pipe wall and UT for thickness
8. Notify Engineering if any excess degradation is observed during cleaning, drilling or pipe thickness at bolt hole locations is <0.350"
9. Drill and tap ¼"-20-UNC holes, ¼" deep on plate bolt pattern. Do NOT allow holes to exceed ¼" depth to maintain minimum wall thickness.
10. Install the studs wrench tight without lubrication.
11. Trial fit plate and enlarge bolt holes as required for fit-up. Grind off any cavity overfill that would prevent gasket crush.
12. Apply epoxy to pipe beneath closure plate area including gasket area. Caution: Excessive epoxy may prevent proper gasket crush or push out on tightening.
13. Before epoxy hardens, install gasket, closure plate, washers and nuts (lightly lubricated).
14. Before epoxy hardens, torque nuts to 2 ft-lbs (24 inch-lbs) in a crisscross pattern. Retighten if epoxy creep relaxes fastener torque.
15. Trim studs flush with the tops of the nuts using suitable means. Avoid excessive heating.
16. Degrease and surface prep the exposed area.
17. Cover entire repair area with epoxy coating. Ensure coating is blended to provide smooth transitions to minimize ICW flow turbulence.

<u>BILL OF MATERIALS</u>

1 STUDS 1/4"-20-UNC x 1 1/8" LONG, SA-193 GRB7, PC-1 (QTY=8)

2 NUTS 1/4" x 20, SA-194-2H, PC-1 (QTY=8)

3 FLAT WASHER 1/4" STD, STEEL, ZINC PLATED, PC-3 (QTY=8)

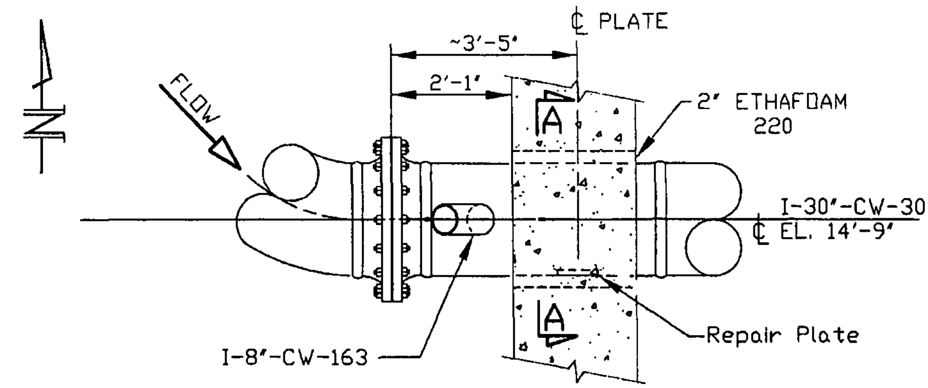
4 CLOSURE PLATE 8"x8"X3/8" THICK, CUT FROM 30" SA-672 GR C65/70 PIPE OR CUT FROM SA-155 GR 65/70 PLATE AND ROLL TO SUIT, PC-1.

5 GASKET, RED RUBBER, 1/16" THICK, PC-3

Mechanical Engineering DIV: Mech DR: PDB CH: W.B.M. 10/28/08 DATE: 10-28-08 APPROVAL: PGB	FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1 Bolted Plate Repair Bill Of Materials And Notes	ENG-08168-001 SHEET 3 of 3 0

8 1/2 X 11 A SIZE 04/08/94

ENG 08168-001.DWG



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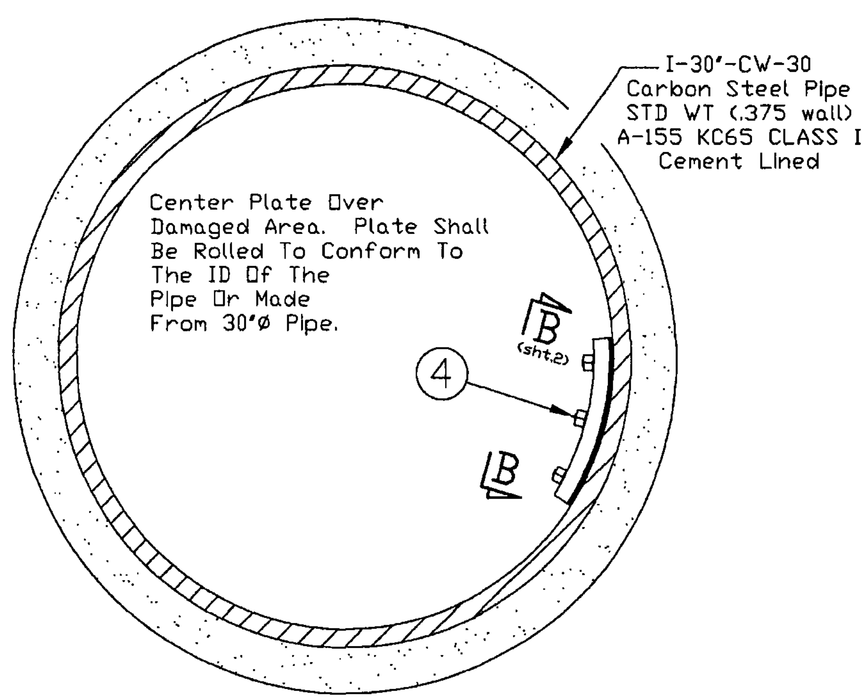


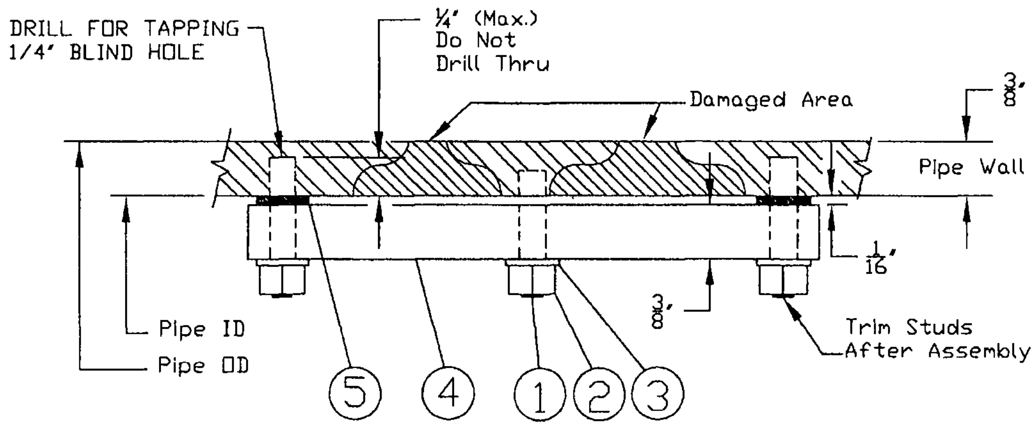
Section A-A

NOTE: For Implementing Instructions And Bill Of Materials See Sht. 3

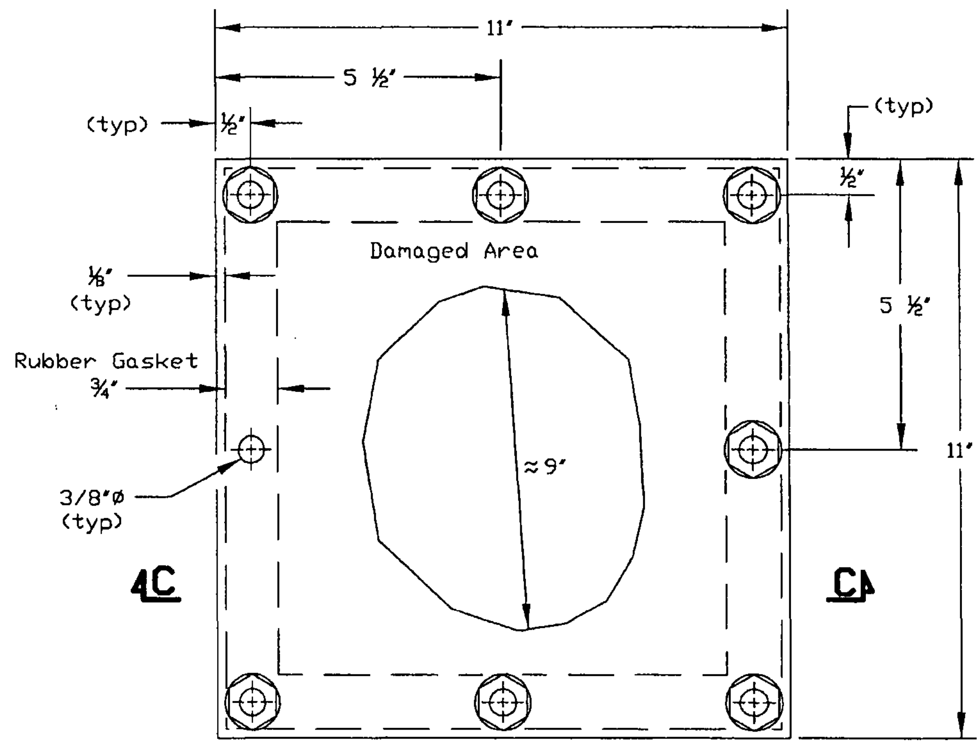
Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	EC274859-M-001
DIV: Mech DR: PDB	APPROVAL		
CH:	W.B.M. for S. Ramnan	Bolted Plate Repair	SHEET 1 of 3
DATE: 12-15-11	12/15/11		0

EC274859.DWG

8 1/2 X 11 A SIZE 04/08/94



Section C-C



Section B-B

NOTE: For Implementation Instructions And Bill Of Materials See Sht. 3

Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1	EC274859-M-001
DIV: Mech DR: PDB W.A. Wolfe	APPROVAL		
CH: Carol M. Wallace	W. B. [illegible] for S. Roman	Bolted Plate Repair Sections / Details	SHEET 2 of 3 — 0
DATE: 12-15-11	12/15/11		

8 1/2 X 11 A SIZE 04/05/94

EC274859-M-001.DWG

Implementation Instructions

1. Perform all epoxy and coating applications in accordance with SPEC-C-004 and the instructions of the Coating Specialist.
2. Fabricate closure plate in accordance with drawing and apply protective coating.
3. Fabricate gasket in accordance with drawing. Cut out of gasket center is required.
4. Avoiding damage to any coatings or Ethafoam on the pipe OD, prep surface of corrosion holes and fill with epoxy material to the profile of the pipe ID. Underfill is acceptable, do NOT overfill.
5. Remove a 12" x 12" section of the pipe lining centered on the affected area.
6. Clean and smooth interior of pipe to support closure plate fit-up.
7. Layout bolt hole locations on pipe wall and UT for thickness
8. Notify Engineering if any excess degradation is observed during cleaning, drilling or pipe thickness at bolt hole locations is <0.350"
9. Drill and tap ¼"-20-UNC holes, ¼" deep on plate bolt pattern. Do NOT allow holes to exceed ¼" depth.
10. Install the studs wrench tight without lubrication.
11. Trial fit plate and enlarge bolt holes as required for fit-up. Grind off any cavity overfill that would prevent gasket crush.
12. Apply epoxy to pipe beneath closure plate area including gasket area. Caution: Excessive epoxy may prevent proper gasket crush or push out on tightening.
13. Before epoxy hardens, install gasket, closure plate, washers and nuts (lightly lubricated).
14. Before epoxy hardens, torque nuts to 3 ft-lbs (36 inch-lbs) in a crisscross pattern. Retighten if epoxy creep relaxes fastener torque.
15. Trim studs flush with the tops of the nuts using suitable means. Avoid excessive heating.
16. Degrease and surface prep the exposed area.
17. Cover entire repair area with epoxy coating. Ensure coating is blended to provide smooth transitions to minimize ICW flow turbulence.

BILL OF MATERIALS

1 STUDS 1/4"-20-UNC-2A x 1 1/8" LONG, SA-193 GRB7, QL-1 (QTY=8)

2 NUTS 1/4" x 20-UNC-2B, SA-194-2H, QL-1 (QTY=8)

3 FLAT WASHER 1/4" STD, STEEL, ZINC PLATED, QL-4 (QTY=8)

4 CLOSURE PLATE 11" x 11" x 3/8" THICK, CUT FROM 30" SA-672 GR C65/70 CLASS 22 OR 42 PIPE OR CUT FROM SA-155 GR 65/70 PLATE AND ROLL TO SUIT, QL-1.

5 GASKET, RED RUBBER, 1/16" THICK, QL-3

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DATE: 12-15-11	12/15-11			

8 1/2 X 11 A SIZE 04/08/94

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