FPL

December 23, 2013

L-2013-342
10 CFR 50.4
10 CFR 50.55a

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

Re: St. Lucie Unit 2
Docket No. 50-389
Inservice Inspection Plan
Third Inspection Interval Relief Request Number 15, Revision 0
Fourth Inspection Interval Relief Request Number 1, Revision 0

Pursuant to 10 CFR50.55a(a)(3)(ii), Florida Power & Light, is requesting relief from the requirements of ASME Code, Section XI, Subsection IWA-4000 for defect removal prior to repair, since compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The details and justification for this request are provided in Attachments 1 through 4 to this letter.

FPL requests approval of this relief request to support the upcoming SL2-21 Spring 2014 refueling outage, which begins March 2, 2014.

This relief request is applicable to the St. Lucie Unit 2 Third Inservice Inspection Interval which began August 6, 2003 and ended August 7, 2013 and Fourth Inservice Inspection Interval which began August 8, 2012 and ends August 7, 2023.

Please contact Lyle Berry at (772) 467-7680 if there are any questions about this submittal.

Sincerely,

Eric S. Katzman
Licensing Manager
St. Lucie Plant

A047
NRR

Florida Power & Light Company

6501 S. Ocean Drive, Jensen Beach, FL 34957

Attachments

1. PSL Relief Request in Accordance with 10CFR50.55a(a)(3)(ii) St. Lucie Unit 2 Third Inservice Inspection Interval and Fourth Inservice Inspection Interval.

2. PSL Calculation PSL-2FSM -05-001, "Evaluation of CW-29 Patch Plate."

3. PSL Calculation PSL-2FSM-12-034, Rev. 1, "Minimum Wall Thickness and Bolted Plate Repairs - Line I-30"- CW-29 and I-30" - CW-30"- ICW Discharge to Canal."

4. Additional Details and Justification for St. Lucie Unit 2 Relief Request Nos. 15 and 1.

ESK/lrb

St. Lucie Unit 2
THIRD INSPECTION INTERVAL RELIEF REQUEST NUMBER 15, Revision 0
and
FOURTH INSPECTION INTERVAL RELIEF REQUEST NUMBER 1, Revision 0

PSL Relief Request

In Accordance with 10CFR50.55a(a)(3)(ii)

—Hardship or Unusual Difficulty without Compensating Increase in Level of Quality or Safety—

1. **ASME Code Component(s) Affected**

Class 3 Intake Cooling Water (ICW) System 30" diameter piping in Unit 2 as follows:

System 21, I-30"-CW-29 and I-30"-CW-30 (Discharge piping downstream of Component Cooling Water (CCW) Heat Exchangers only)

2. **Applicable Code Edition and Addenda**

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Rules for Inservice Inspection of Nuclear Power Plant Components, Section XI, 1998 Edition with Addenda through 2000[1] as amended by 10CFR50.55a, is the Code of Record for the St. Lucie Unit 2 3rd 10-year interval. The ASME Boiler and Pressure Vessel Code, Rules for Inservice Inspection of Nuclear Power Plant Components, Section XI, 2007 Edition with Addenda through 2008[2] as amended by 10CFR50.55a, is the Code of Record for the St. Lucie Unit 2 4th 10-year interval.

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Rules for Construction of Nuclear Power Plant Components, Section III, Class 3, 1971 Edition with Addenda through Summer 1973[3], is the Code of Record for St. Lucie Unit 2.

3. **Applicable Code Requirement**

ASME Code, Section XI, Paragraph IWA-4421(a) of the 1998 Edition with Addenda through 2000[1] states that "Welding, brazing, defect removal and installation activities shall be performed in accordance with the Owner's Requirements and the Construction Code of the component or system except as provided in (b) and (c) below." Subparagraph IWA-4422.1 states that "A defect is considered removed when it has been reduced to an acceptable size."

ASME Code, Section XI, Paragraph IWA-4421 of the 2007 Edition with Addenda through 2008[2] states that "Defects shall be removed or mitigated in accordance with the following requirements..." Subparagraph IWA-4422.1 states that "A defect is considered removed when it has been reduced to an acceptable size."

4. Reason for Request

The nuclear safety related ICW System for St. Lucie Unit 2 is comprised of two redundant trains (i.e., 'A' and 'B'). I-30"-CW-29 and I-30"-CW-30 are open ended discharge pipes to the ocean discharge canals. Due to the seawater content, the ICW piping constructed from Standard Wall 30" (0.375 inch wall), A-155 KC-65 (equivalent to SA 106 Grade B) Carbon Steel, has an internal liner to preclude the loss of internal pipe wall due to corrosion. The piping being addressed in this relief request is cement or epoxy lined 30 inch nominal diameter buried piping with a nominal liner thickness of 1/8-inch. The outer surface of the piping is coated with Coal-Tar Epoxy. The ICW piping is classified as a Class 3 component, qualified in accordance with ASME Code, Section III, Subsection ND criteria.

St. Lucie station performs single train internal pipe inspections each outage, resulting in 100% inspection every other outage. The inspections are performed in accordance with St. Lucie's commitment to the NRC Generic Letter GL 89-13[4]. The objective of this commitment is to perform routine inspection to ensure that corrosion, erosion, protective coating failure, silting, and biofouling does not degrade the performance of the ICW safety-related system. ICW pipe inspections at St. Lucie are performed by a qualified pipe inspector. 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 is performed where there is degradation.

The above described pipe inspections have from time to time identified localized areas of liner loss resulting from corrosion cells in the underlying piping. Should measurements detect a pipe wall loss resulting in a remaining pipe wall thickness less than the prescribed ASME Code required minimum pipe wall thickness or a through-wall leak is identified, a repair in compliance with ASME Code Section XI, Article IWA-4000 "Repair and Replacement" would be required. Full defect removal of discovered localized thinning per IWA-4000 may result in a through-wall defect. This case and in those instances where a through-wall defect is discovered, would result in the potential for leakage due to damage to the external coating. If the external coating was not damaged during the defect removal, a traditional repair of cutting a hole and installing a welded rolled plate to return the piping to its original design condition is not possible as the pipe is buried in the concrete wall of the CCW Building or potentially underground (as was the case for similar defects in the corresponding Unit 1 piping) and the outside of the pipe is not easily accessible. Welding would destroy the surrounding exterior coating and the location would prevent NDE of the exterior of the pipe. Consequently, Florida Power & Light, pursuant to 10 CFR 50.55a(a)(3)(ii), is requesting relief from the requirements of ASME Code, Section XI, Subsection IWA-4000 for defect removal prior to repair since compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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Florida Power and Light has installed two repairs without removing the defects, and is requesting relief to leave the existing repairs in place and to allow installation of additional repairs in the future to repair similarly damaged areas. The repairs are only applicable to wall loss defects resulting from general corrosion and flow erosion. The repairs are not applicable for any other types of defects (e.g., planar cracks) or any other degradation mechanisms (e.g., stress corrosion cracking). The existing repairs that are still in service were installed in 2005 and 2012 which is within the 3rd 10-year inspection interval stated in Section 2 and Section 3 above. Any future repairs would be installed during the 4th 10-year inspection interval stated in Section 2 and Section 3 above.

The existing repairs include two installed plates in I-30"-CW-29 (Train B) consisting of sizes of 5"x 5" and 8"x 8". One plate was installed in 2005 and the other was installed in 2012. Both plates are located in the same section of pipe. An isometric view showing the relative location of the bolted patch plate repairs in the ICW piping is provided in Figure 1.

5. Proposed Alternative and Basis for Use

Proposed Alternative

Install internal bolted patch plate repairs typical of that illustrated in Figure 2 and Figure 3 to cover the damaged areas of the inside surface of the pipe. The internal bolted patch plates are designed to meet the criteria of the applicable Code of Record[3], as required by ASME Code, Section XI[1 and 2], Paragraph IWA-4221.

Basis

A description of the process used to qualify the design, a description of the installation process, and the inspection program to monitor the condition of the repairs is included in this section.

Design Qualification Process:

The design qualification process determines the minimum pipe wall thickness using design formulas of ASME Code, Section III and the criteria presented within FSAR Table 3.9-7 for reviewing interactions of pressure stress and longitudinal bending stresses. The calculations evaluate 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. Attachment 4 discusses additional design considerations and limitations which applied to the Unit 1 bolted patch plate repairs[5] and also apply to existing and future repairs for Unit 2.

The design qualification process includes the following steps:

1. Develop a minimum pipe wall thickness based on hoop stress and longitudinal bending stress per ASME Code, Section III, ND-3641.1 as required by Subsection ND.

2. Determine required and actual reinforcement areas and zones per ASME Code, Section III, Subsection ND.
3. Determine patch plate thickness requirements per ASME Code, Section III, Subsection ND. The installed plate nominal thickness is at least equal to the nominal thickness of the undamaged pipe.
4. Determine the gasket loading and bolt requirements per ASME Code, Section III, Appendix E.
5. Review thread engagement using machinery principles.
6. Address interaction or reinforcement zones per ASME Code, Section III, Subsection ND.
7. Perform stress intensification factor review.

Installation Process Summary:

1. Avoiding damage to any external coatings on the pipe outside surface (OD), prepare the surface of corrosion holes by blast cleaning and fill with epoxy material to the profile of the pipe ID.
2. Remove a section of the pipe lining centered on the affected area.
3. Clean and smooth interior of pipe to support closure plate fit-up.
4. Layout bolt hole locations on pipe and ultrasonically inspect for thickness. The degraded areas are ultrasonically inspected to determine surrounding wall thickness. All readings outside of the areas of degradation are within the manufacturer's tolerance of nominal wall thickness.
5. Drill and tap ¼" deep bolt holes. Do not allow holes to exceed ¼" depth to maintain minimum wall thickness.
6. Install the studs wrench tight without lubrication.
7. Apply epoxy to pipe beneath closure plate area including corrosion holes previously filled and the gasket area.
8. Before epoxy hardens, install gasket, closure plate, washers and nuts (lightly lubricated).
9. Trim studs flush with the tops of the nuts, degrease and surface prep the exposed area, and cover the entire repair area with epoxy coating. Ensure that the coating is blended to provide smooth transitions to minimize ICW flow turbulence.

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Post-installation Inspections:

The piping inspections described in Section 4 are continued after the internal bolted patch plate repairs are performed. In addition to the visual inspection, a hammer test is generally performed for all patches installed in the pipe. Partial disbondment of a patch will produce a hollow sound when tapped with a chipping hammer. A solid, non-hollow sound indicates that the patch remains in good condition. If a patch is suspect based on visual examination or hammer test results, the patch is removed from the pipe surface for further examination.

Since the bolted patch plate is installed on the inside surface of the piping and it completely covers the damaged area with a gasketed closure, the damaged area is isolated from the corrosive environment. Also, the damaged area is covered with an epoxy coating prior to the repair, including filling the damaged areas for a smooth repair surface, and after the repair, including the bolted plate, studs, nuts, plate edges and gaskets and is blended with surrounding coatings to provide smooth transitions to minimize ICW flow turbulence, and further isolate the damaged area from the corrosion surface. There is therefore minimal potential for the damaged area to expand over time during service such that the repair would no longer be effective. Additional details regarding the gasket and epoxy material are provided in Attachment 4, including the qualification lifetime in the seawater environment, and the industry standards to which the gasket and epoxy are qualified.

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.

While a corrosion rate was not included in the repair design, based on a typical corrosion rate of carbon steel exposed to seawater of 30 mils per year (mpy)[6], the maximum extent of corrosion should the epoxy coating and gasket be breached to allow access to the original defect area would be 0.09-inch, assuming a 3-year inspection interval. The extent of the bolted plate beyond the defect area is always much greater than 0.09 inch so any additional corrosion of the defected area would be identified and corrected during the next inspection.

The corrosion rate of 30 mpy is conservative in that the general corrosion rate of carbon steel exposed to flowing oxygen saturated seawater at approximately 7 feet per second (f/s) is less than 25 mpy[7] and the corrosion rate decreases with exposure time. The long-term corrosion rates in this environment are very low, less than approximately 0.1 millimeter per year (mm/y) or approximately 4 mpy [8], which provides significantly more

than a safety factor of 4 conservatism in the suggested corrosion rate. Note that the minimum nominal thickness of the bolted plate is at least as thick as the undamaged piping so the potential corrosion of the plate is no greater than that of the undamaged piping.

Since the electrode potentials for carbon steel and low alloy steel in seawater are approximately the same [9], there is minimal electrochemical driving force between the carbon steel piping and repair plate and the low alloy steel bolts to facilitate measureable accelerated corrosion of the carbon steel. 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.

Periodic inspections completed to date have not identified any degradation of the existing internal bolted patch plate repairs.

As discussed above, the bolted patch plate repair is installed on the inside surface of the piping which isolates the damaged area from the corrosive environment. Also, the damaged area is covered with an epoxy coating prior to the repair, including filling the damaged areas for a smooth repair surface, and subsequent to the repair, including all repair components, and is blended with surrounding coatings to provide smooth transitions to minimize ICW flow turbulence, further isolate the damaged area from the corrosion surface.

There is therefore minimal potential for the damaged area to expand over time during service such that the repair would no longer be effective. Limitation on the life of the repair based on the potential degradation to grow to an unacceptable size for the repair or additional subsequent inspections is not required.

The design qualification process, installation process, and the post-installation inspections for the bolted patch plate repairs provide reasonable assurance of the structural integrity of the repair. The location of the defects and the potential additional damage that could occur if the defects were removed prior to the repair as required by the ASME Code, Section XI support the request for an alternative to the ASME Code, Section XI requirement because complying with the requirement would represent a hardship or unusual difficulty without a compensating increase in the level of quality or safety.

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6. Duration of Request

This relief request is applicable to the St. Lucie Unit 2 Third Inservice Inspection Interval which began August 8, 2003 and ended August 7, 2013 and the Fourth Inservice Inspection Interval which began August 8, 2013 and ends August 7, 2023.

7. Precedents

St. Lucie Unit 1 Fourth Inspection Interval Relief Request No. 7 – Request for Relief from Requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Subsection IWA-4000 for defect removal prior to repair of Intake Cooling Water System using Bolted Plate Repair Methodology, Accession Number ML13220A29. This relief request was verbally approved on September 25, 2013.

8. References

1. ASME Code, Section XI, "Rules For Inservice Inspection of Nuclear Power Plant Components," 1998 Edition with Addenda through 2000.

2. ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2007 Edition with Addenda through 2008.

3. ASME Code, Section III, "Rules for Construction of Nuclear Power Plant Components," 1971 Edition with Addenda through Summer 1973.

4. 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," Accession No. ML13025A208.

5. St. Lucie Letter No. L-2013-261 10 CFR 50.4 10 CFR 50.55a, dated August 30, 2013 to the USNRC Re: St. Lucie Unit 1, Docket No. 50-335, "RAI Response to Fourth Ten-Year Interval Unit 1 Relief Request No. 7, Revision 0."

6. "Seabrook Station, Unit 1 – Request for Relief to Use an Alternative to the Requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI (TAC No. ME9187)," SER Dated January 14, 2013, Accession Number ML12185A069.

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

8. 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.

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

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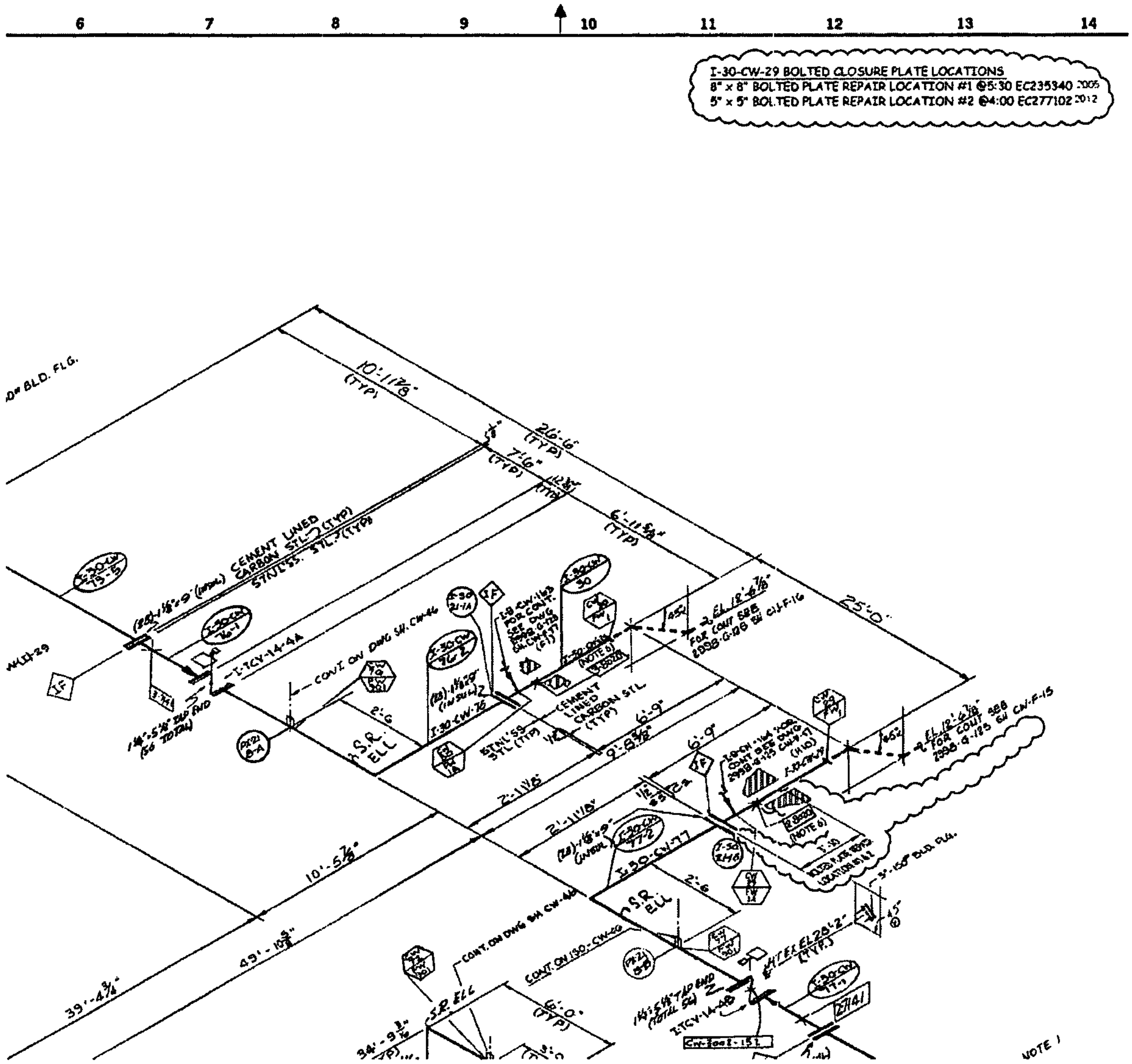

Figure 1: Bolted Patch Plate Repair Locations
I-30”-CW-29 (Train B) (Two Locations)

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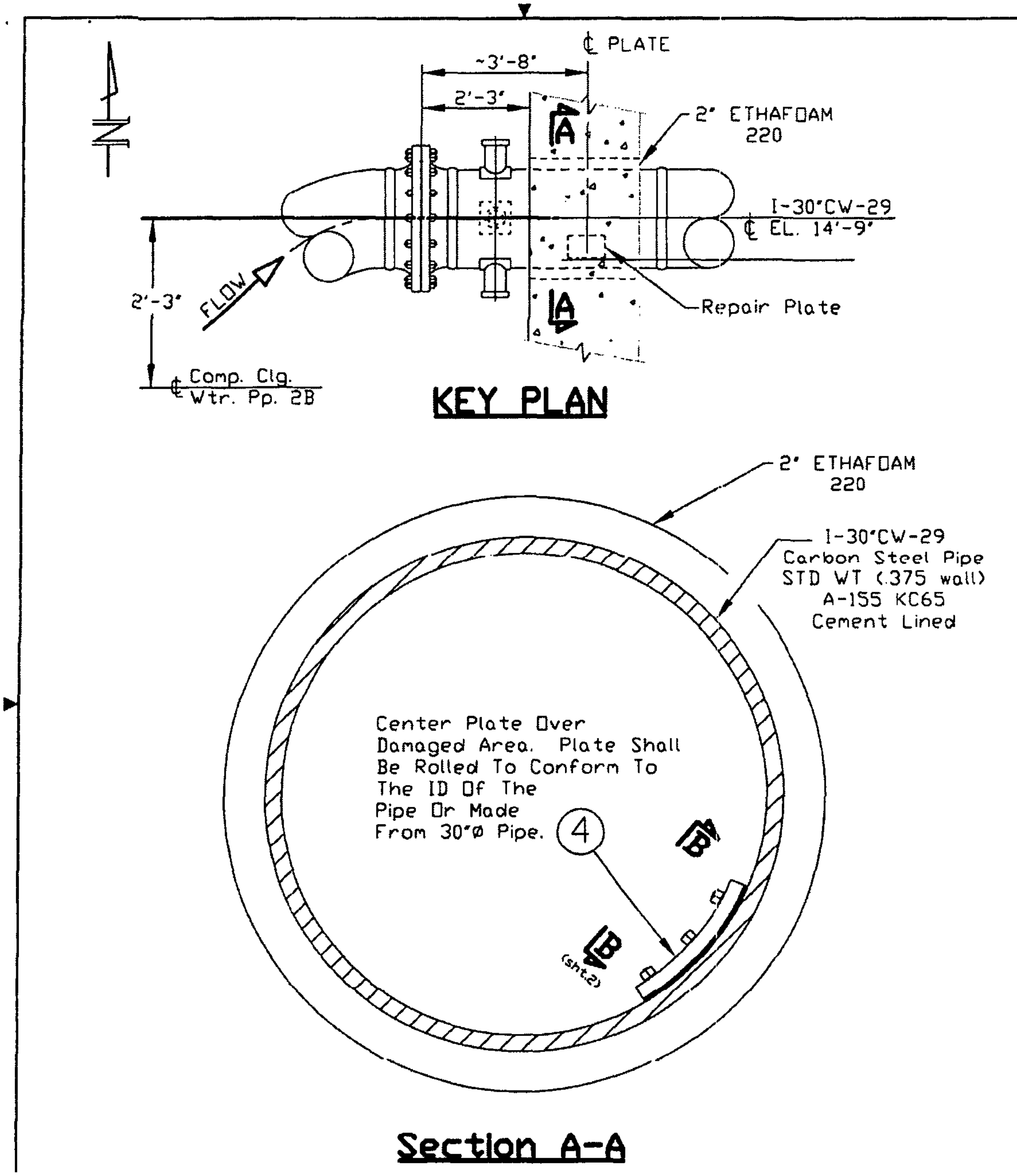

Figure 2: Typical Bolted Patch Plate Drawing Key Plan and Section A-A View

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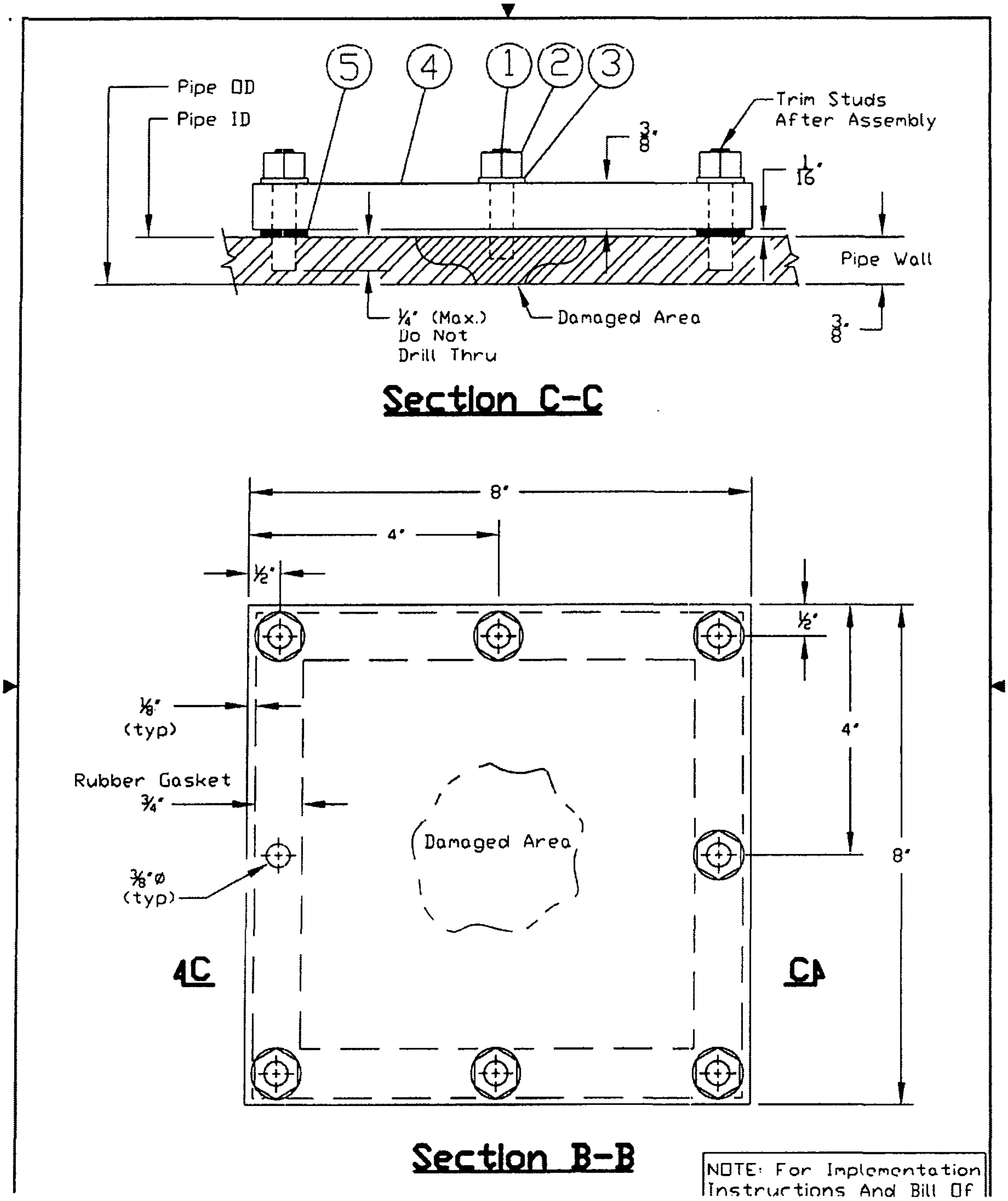

Figure 3: Typical Bolted Patch Plate Drawing Section B-B View

CALCULATION COVER SHEET

Calculation No: **PSL-2FSM-05-001**

Title: Evaluation of CW-29 Patch Plate

This calculation determines the minimum pipe wall thickness using design formulas of ASME Section III and the criteria presented within FSAR Table 3.9-7 for reviewing interactions of pressure stress and longitudinal bending stresses.
This calculation evaluates the required reinforcement versus the available reinforcement for the holes in the piping, and reviews the bolting requirements for the patch plate.

LIST OF EFFECTIVE PAGES

Page	Section	Rev
1	Cover Sheet	1
1	List of Effective Pages and Table of Contents	1
2	Sections 1.0, 2.0, 3.0	1
3	Section 4.0	0
4	Section 5.0	0
5	Section 5.0	0
6	Section 5.0	0
7	Section 5.0	0
8	Section 6.0	0

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ATTACHMENTS

No.	Attachment Title	Pages	Rev
1	Stress Intensification Review	1	1
2	Drawing ENG-05010-001 Sheets 1-3	3	0

1	Revised Att. 1	[signature]	9/19/13	[signature]	9/19/13	[signature]	9/19/13
0	Issued For Use	S. Cornell	1/13/2005	W. B. Neff	1/13/2005	S. Marshall for P. Barnes	1/13/2005
No.	Description	By	Date	Chk/Ver	Date	Appr	Date
REVISIONS							

St. Lucie Unit 2
Evaluation of CW-29 Patch Plate

1.0 Purpose / Scope

This calculation determines the minimum pipe wall thickness using design formulas of ASME Section III and the criteria presented within FSAR Table 3.9-7 for reviewing interactions of pressure stress and longitudinal bending stresses.

This Calculation evaluates the required reinforcement versus the actual reinforcement available for the holes remaining in the Unit 2 ICW Header (line 30"-CW-29), and reviews the bolting for the patch plate.

Calculation developed to support MSP 05010

The same design concept was used on Unit 1 per NCR 1-380, PSL-1-S-M-90-0002 and JPN-PSL-SEMS-90-012.

Revision 1: Replace Attachment 1 with latest position concerning stress intensification factors.

2.0 Methodology

Part 1:

The methodology used in the analysis is to:

1. Develop a minimum pipe wall thickness based on hoop stress.
2. Review the longitudinal stress interactions using wall thickness calculated from the hoop stress. If Interaction Ratios are less than 1.0, hoop stress governs and no further analysis is required.
3. If any of the four Interaction Ratios are greater than 1.0, longitudinal stresses govern. The minimum wall thickness must be increased to carry the longitudinal bending stress. This latter step is an iterative calculation.

This analysis extrapolates the original pipe stress analysis to determine new longitudinal stress interaction ratios. A new pressure stress is calculated for the assumed wall thickness and the bending stresses within the interaction equations are extrapolated by multipling them by the ratio of the nominal wall section modulus to the reduced wall section modulus.

Part 2:
Use ASME Section III, Subsection ND to determine required and actual reinforcement areas, and reinforcement zones.

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

Part 4:
Determine gasket loading requirements per ASME Section III Appendix E.

Part 5:
Verify proper bolt sizing per ANSI B1.1.

3.0 References

1. St. Lucie Passport DataBase
2. Navco Piping Catalog, Edition 11, 1984
3. Section III, 1971 Edition, Summer 1973 Addenda, NC-3641.1
4. Section III, 1971 Edition, Summer 1973 Addenda, Appendix I
5. Section III, 1971 Edition, Summer 1973 Addenda, NC-3611.1
6. Section III, 1971 Edition, Summer 1973 Addenda, NB-3652
7. Roark's Formulas for Stress & Strain, 6 Edition, page 67
8. ASME Section III, Subsection ND, 1986 Edition
9. EBASCO Backfit Stress Analysis Design Criteria, Rev 3, 12/7/87
10. St. Lucie Unit 2 FSAR Amendment 15
11. St. Lucie Unit 2 Stress Isometric: CW-172-11, Stress Calculation 3002 dated 7/9/86
12. CR 2005-710
13. Crane Technical Paper No. 410, 1981
14. Drawing ENG-05010-001 Sheet 2 Revision 0
15. EPRI Good Bolting Practices Volume 1, NP-5067
16. Machinery's Handbook, 24 Edition, Industrial Press, Inc., Page 1324
17. Fastener Standards, 6th Edition, Industrial Fasteners Institute
18. ANSI B 1.1, 1989 Edition

4.0 Assumptions/Data Input

All data used in the analysis is summarized in this section. As stress analysis input data was obtained from the Civil discipline, signatures indicating the verification of that data are provided below.

Piping System Inputs:				REF
Pipe Size:		30		(1)
Schedule:	*	0.375		(1)
Material:	*	SA-155 KC65		(1)
t-nominal: tnom	*	0.375	in	(2)
Outside Diameter : Do		30	in	(2)
Corrosion Allowance : A	*(generally 0 for this analysis)*	0	in	(3)
Design P:		90	psig	(1)
Design T:	*	150	deg F	(1)

Stress Analysis Inputs:	ASME Section III, Class 3			REF
Stress Prob:				
Stress Isometric: CW-172-11, Stress Calculation 3002 dated 7/9/86				
Piping Isometric 2998-G-125 Sh CW-F-14 Rev 25				
Stresses were taken on Pipe at Data Points 8020				
Code of Record:				(9)
ASME Section III, Class 3				
		Max Stress		
Long Press. Stress (tnom) (Do NOT include in below Eq's)		1733	psi	(11)
Eq 8 (P)+(Dead Weight)**		97	psi**	(11)
Eq 9 Upset/Emergency (P)+(DWt+OBE Inertia)**		890	psi**	(11)
Eq 9 Faulted (P)+(DWt+DBE Inertia)**		1173	psi**	(11)
Eq 11 (P)+(DWt +Thermal + Seismic Anchor Moments OBE)**		807	psi**	(11)
Stress Allowable Hot: Sh		15000	psi	(4)
Allowable Stress Range for Expansion Stresses: Sa		22500	psi	(5)
y coefficient	*(0.4 if less than 900F)*	0.4		(3)

Stress Analysis Data Input Verification:

Prepared: [signature] Verified: [signature]

* 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)

5.0 **Calculation**

PART 1 - MINIMUM WALL CALCULATION

Develop tmin based on Hoop Stress:

						REF
tmin based on Hoop Stress	(P Do)/(2 (Sh + P y)) + A			0.090	in	(3)
Original Section Modulus:	Z = 3.14/32 (Do^4 - Di^4)/Do			255.167	cu in	(7)
Nominal Wall	tnom			0.375	in	-
Mill Tolerance (tnom +/- 12.5%)		0.328	to	0.422	in	(2)

Determine if tmin based on Hoop Stress bounds Longitudinal Stress:

tmin based on Hoop Stress	*From above calculation*			0.090	in		(3)
Diameter Inside Di'	Di'=D0-2tmin			29.820	in		-
New Section Modulus	Z' = 3.14/32 (Do^4 - Di'^4)/Do			62.866	cu in		(7)
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	7912	**0.53**		(10)
Eq 9 = P + SM Ratio (Dwt + OBE Inertia)		1.2 Sh	18000	11130	**0.62**		(10)
Eq 9 = P + SM Ratio (Dwt + DBE Inertia)		2.4 Sh	36000	12279	**0.34**		(10)
Eq 11 = P + SM Ratio (Th + Dwt + SAM OBE)		Sa + Sh	37500	10794	**0.29**		(10)

Minimum Wall Based On Hoop Stress is Sufficient for Longitudinal Stresses
[illegible]

Determine tmin Based on Longitudinal Stresses:

tmin based on Longitudinal Stress (Guess & Iterate)				0.090	in		
Diameter Inside Di'	Di'=D0-2tmin			29.820	in		-
New Section Modulus	Z' = 3.14/32 (Do^4 - Di'^4)/Do			63.015	cu in		(7)
Section Modulus Ratio	SM Ratio = Z / Z'			4.049	-		-
Longitudinal Pressure Stress	(P Do)/(4 tmin)			7500	psi		(6)
		May Not Exceed		L Stress	**IR≤1.0**		
Eq 8 = P + SM Ratio (DWt)		Sh	15000	7893	**0.53**		(10)
Eq 9 = P + SM Ratio (Dwt + OBE Inertia)		1.2 Sh	18000	11104	**0.62**		(10)
Eq 9 = P + SM Ratio (Dwt + DBE Inertia)		2.4 Sh	36000	12250	**0.34**		(10)
Eq 11 = P + SM Ratio (Th + Dwt + SAM OBE)		Sa + Sh	37500	10768	**0.29**		(10)

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

The minimum wall criteria is controlled by the hoop stresses.

PART 2 - REINFORCEMENT CALCULATION

Code of Record ASME Section III
Branch Connection Reinforcement Calculation per ASME Section III, ND-3643.3

	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 in no case > 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)
w	in	weld leg, =1.41 tc

5" Branch Connection (assumed size bounds the two throughwall holes)
Leave 5" hole in main line 30"-CW-29, std. wall
Pipe Code CS-4, Material ASME SA-155, KC65

					References
Dob	5				Assumed, Bounding
Doh	30				Given
d1	5				Assumed, Bounding
		d1	Tb+Th+(d1/2)	Dob	
d2	5	5	2.875	5	
L	0.000				
te	0				Assume no reinforcing pad
Tb (ave)	0				Assume no wall thickness
Tb (min)	0.000				87.50%
Th (ave)	0.375				TEDB
Th (min)	0.328				87.50%
tmb	N/A	tmb=(P*Dob)/ 2 (S+Py) + A			ASME Section III, ND-3641
tmh	0.090				from Part 1
P	90				TEDB
T	150				TEDB
S	15,000				ASME Section III, App I-7.1
y	0.4				ASME Section III, ND-3641
A	0				ASME Section III, ND-3641
a	90				Given
a radians	1.571				
		1/4"	0.7Tb		
tc	0	0	0		Not Used
w	0				Not Used

Calculate area required:

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

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

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

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

Area A3= area provided by deposited weld metal beyond the outside diam of run and 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
1.192 sq. in.

Compare area available to required area:

Avail		Required area
1.192 sq. in.	>	0.480 sq. in.

No additional reinforcement of the assumed 5"hole is required.

In addition, the pipe stresses were reviewed in Attachment 1 for intensification due to the resulting configuration being equivalent to an unreinforced tee. The piping continues to meet Code allowables.

PART 3 - Plate Thickness Review

All data used in the analysis is summarized in this section.

Patch Plate Inputs:			Value	Units	REF
Design Temperature			150	F	(1)
Design Pressure			90	psig	(1)
Operating Pressure			60	psig	(1)
Opening Dimensions					
Height			6.875	in	(14)
Width			6.875	in	(14)
Base Metal Information					
Height			0.375	in	(14)
Width			0.75	in	(14)
Material			SA-155 KC65		(14)
Allowable Stress	Table I-7.1	Assume SA-106 Gr. B	15000	psi	(8)
Patch Information					
Height			8	in	(14)
Width			8	in	(14)
Material		SA-106 Gr. B or	SA-515 Gr 70		(14)
Allowable Stress	Table I-7.1	Assume SA-106 Gr. B	15000	psi	(8)
Bolting Information					
Diameter			0.25	in	(14)
Material			ASTM A193 Gr. B7		(14)
Allowable Stress	Table I-7.3		25000	psi	(8)
Yield Stress			105000	psi	(8)
Number of Bolts			8		(14)
Area of Bolt			0.0318	in^2	(17)
Bolt Spacing			3.5	in	(14)
k for Thread Lubricant N-5000			0.15		(15)

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

tm minimum thickness = t + A
t calculated thickness = d6*(3*P/16*S)^.5
d6 Gasket ID (Assume diagonal distance to corner bolting, conservative)
P Design Pressure
S Stress Allowable
A Mechanical Allowances (ND-3613) = 0

tm = (2^0.5)*7*((3*90)/(16*15000))^0.5+0 = 0.332 in
Minimum required plate thickness is 0.332 in

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					REF
Per ASME Section III Appendix E, modified for square patch plate					
GASKET AREA			Value	Units	
H		Bolt Centerline	7	in	(14)
W		Bolt Centerline	7	in	(14)
Land			0.75	in	(14)
b	1/2 Gasket Width	Land/2	0.375	in	
A	Short Dimension Cover		7.75	in	(14)
B	Long Dimension Cover		7.75	in	(14)
C	Short Dimension Hole		6.25	in	(14)
D	Long Dimension Hole		6.25	in	(14)
d	Bolt Diameter		0.25	in	(14)
N	Number of Bolts		8		(14)
Gasket Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		20.11642781	in^2	
PRESSURE AREA					
AREA' (of Opening)		W*H	49	in^2	
REQUIRED SEATING LOAD (Wm2)					
y			200	lb/in^2	(8)
Gasket Area	(A*B)-(C*D)-(N*3.14159/4*(d+0.125)^2)		20.12	in^2	
Wm2	y* Gasket Area		4023.29	lb	
OPERATING SEATING LOAD (Wm1)					
PRESS	Use of operating is conservative as patch is on ID		60	psig	(1)
AREA'		W*H	49	in^2	
m	gasket factor		1		(8)
Wm1	(PRESS*AREA')+(AREA*m*PRESS)		4146.99	lb	
REQUIRED BOLT STRESS/TORQUE					
LOAD	Greater of Wm1 or Wm2		4146.99	lb	
BOLT DIA			0.25	in	(14)
LOAD/BOLT	Fp= LOAD/N		518.37	lb	
BOLT STRESS	LOAD/BOLT/(3.14159*BOLT DIA^2/4)		10560.22	psi	
BOLT TORQUE	K*d*Fp/12		1.62	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 - SA-155 KC65
Bolts: A-193 Grade B7, 1/4"-20 UNC

D	Bolt Basic Major Diameter (nominal diameter)	0.250	in	(14)
n	Threads per inch	20	#/in	(14)
	Thread Class (External)	2A	-	(14)
Le'	Actual Thread Engagement	0.250	in	(14)
Esmin	External Thread Minimum pitch diameter	0.2127	in	(17)
Dsmin	External Thread Minimum major diameter	0.2408	in	(17)
Yieldbolt	External Thread Yield Strength	105,000	psi	(8)
UTSbolt	External Thread Thread Ultimate Tensile Strength	125,000	psi	(8)
Enmax	Internal Thread Maximum pitch diameter	0.2223	in	(17)
Knmax	Internal Thread Maximum minor diameter	0.207	in	(17)
Yieldhole	Internal Thread Yield Strength	30,000	psi	(8)
UTShole	Internal Thread Ultimate Tensile Strength	55,000	psi	(8)

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

CAUTION: Full thread engagement is not provided by internal threads

3. Load Required to Break Bolt/Screw

Pbolt	Pbolt = At * UTSbolt	3978	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	3710	lbs	
Bolt Torque	Torque which will fail undamaged joint with actual engagement (D*Yield bolt*At*K/12)	10	ft-lbs	

Actual Field torque is 2 ft-lbs max for 15,000 psi

		%Yield	%Ultimate
@ 2 ft-lbs:	Bolt Stress compared to bolt material strength	19%	16%
	External Thread Stress compared to bolt material strength	13%	11%
	Internal Thread Stress compared to hole material strength	32%	17%

6.0 Results

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

No additional reinforcement of the assumed 5" hole is required.

Minimum required closure plate thickness is 0.332 Inches.

The Minimum Bolt Torque is 1.62 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-2FSM-05-001, Attachment 1, Rev. 1, Page 1 of 1
Excerpt from Calc # PSL-1FSM-05-031, Attachment 1, Rev 1 Page 1 of 1

Stress Intensifiction Factor Review

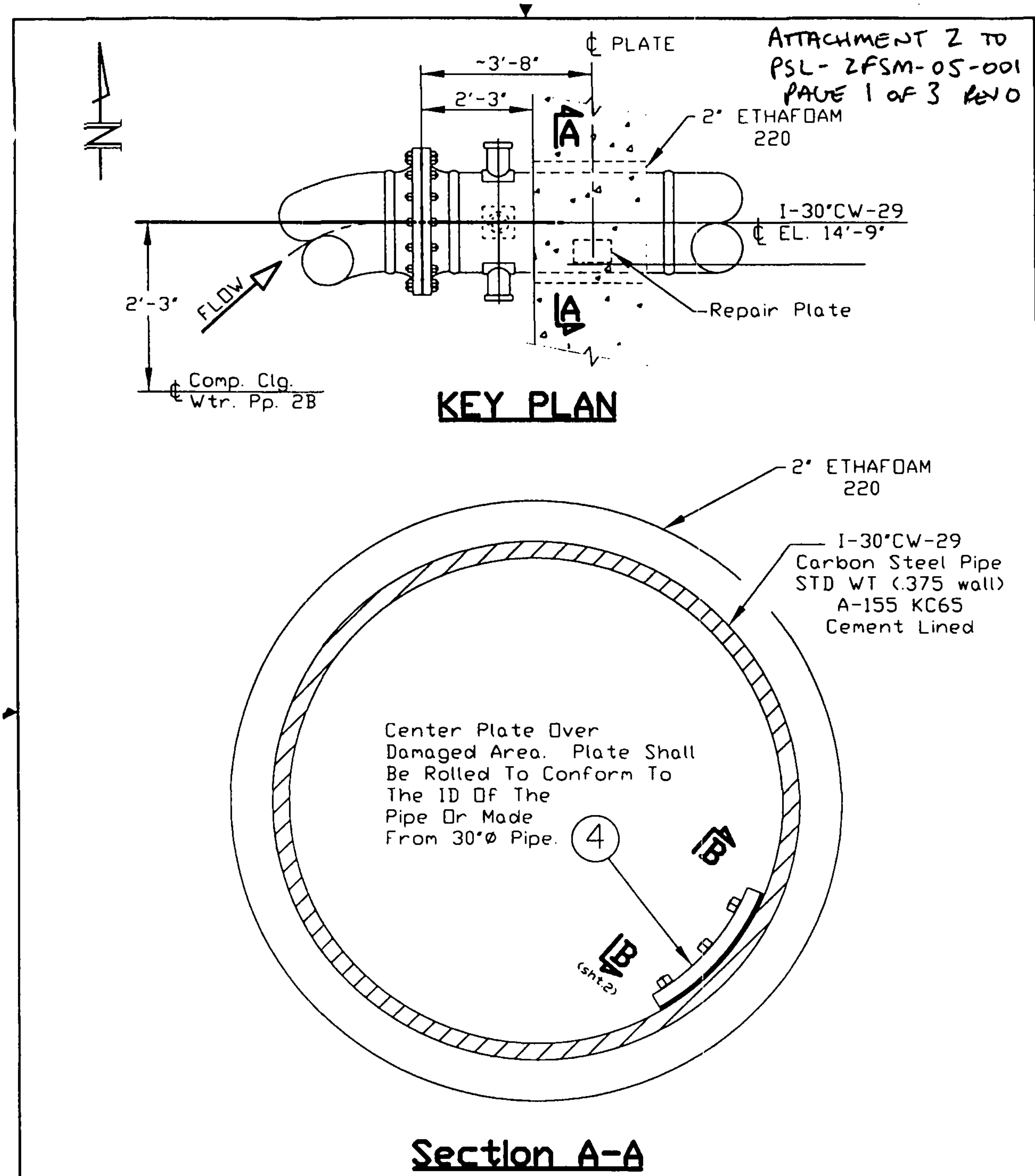
The bolted patch plate repair methodology provides a branch connection but does not impose any moment inducing loads from branch piping. ASME Section III Edition 1971 through Summer 1973 Addenda provides stress intensification factors (SIFs) for various configurations which impose moment loading of piping 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:	[signature]	Date:	12-15-11
Approved By:	[signature]	Date:	12.15.11

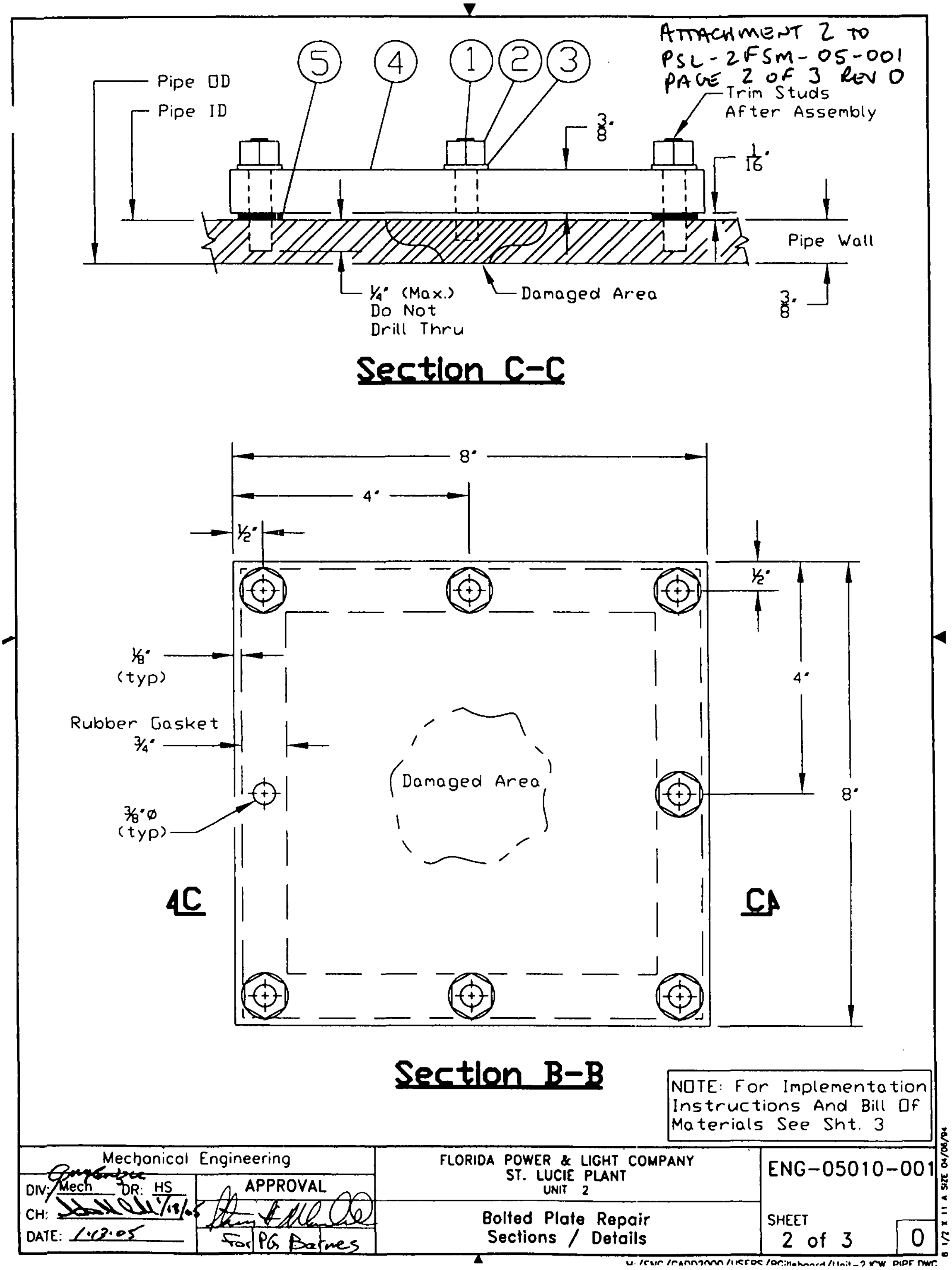


NOTE: For Implementing Instructions And Bill Of Materials See Sht. 3

Mechanical Engineering DIV: Mech DR: HS CH: SHC 1/13/05 DATE: 1/13/05	APPROVAL PG Barnes	FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 2 Bolted Plate Repair	ENG-05010-001 SHEET 1 of 3 0

H:/ENG/CADD2000/USERS/BGilleboard/Unit-2.ICW PIPE.DWG

B 1/2 X 11 A SIZE 04/06/94



ATTACHMENT 2 TO PSL-2FSM-05-001 PAGE 2 OF 3 REV 0
5
4
1
2
3
Pipe OD
Pipe ID
3/8"
Trim Studs After Assembly
1/16"
Pipe Wall
1/4" (Max.) Do Not Drill Thru
Damaged Area
3/8"
Section C-C
8"
4"
1/2"
1/2"
1/8" (typ)
Rubber Gasket 3/4"
Damaged Area
3/8"ø (typ)
4"
8"
C
C
Section B-B
NOTE: For Implementation Instructions And Bill Of Materials See Sht. 3
Mechanical Engineering
DIV: Mech
DR: HS
CH:
DATE: 1-13-05
APPROVAL
For PG Barnes
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT
UNIT 2
Bolted Plate Repair
Sections / Details
ENG-05010-001
SHEET
2 of 3
0

ATTACHMENT 2 TO
PSL - 2FSM - 05 - 001
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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 1/4"-20-UNC holes, 1/4" deep on plate bolt pattern. Do NOT allow holes to exceed 1/4" 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.

BILL OF MATERIALS

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", SA-515 GRADE 70 OR
FROM 30"Ø PIPE, SA-106 GRADE B, STD WEIGHT, .375 WALL, PC-1

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

Mechanical Engineering		FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 2	ENG-05010-001
DIV: Mech DR: HS	APPROVAL		
CH: [signature] 1/13/05	[signature]	Bolted Plate Repair Bill Of Materials And Notes	SHEET 3 of 3
DATE: 1-13-05	for PG Barnes		0

H:/ENG/CAD02000/USERS/RGillehoard/Unit-2 ICW PIPE DWG

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

CALCULATION COVER SHEET

Calculation No: **PSL-2FSM-12-034** Revision No: **1**

Title: **Min Wall Thickness and Bolted Plate Repairs- Line I-30"-CW-29 and CW-30 - ICW Discharge to Canal**

This calculation determines the pipe minimum wall thickness for Internal Corrosion per ASME Section III and the criteria presented within UFSAR Table 3.9-7 for reviewing interactions of pressure stress and longitudinal bending stresses.
This calculation addresses application of bolted plate repairs at a specific location on line I-30"-CW-29.
A review of the pipe stress input is required to determine applicable to I-30"-CW-30.

LIST OF EFFECTIVE PAGES

TABLE OF CONTENTS

No.	Description		Printed Name	Signature	Date
1	Revised stress input and expanded justification	By	W. B. Neff	W. B. Neff	9/19/13
		Check	David Russer	[signature]	9/19/13
		Apr	S. Cornell	[signature]	9/19/13
0	Issued For Use	By	David Russer	Signature on File	8/16/12
		Check	W. B. Neff	Signature on File	8/16/12
		Apr	S. Cornell	Signature on File	8/16/12
REVISIONS					

Form 82A (4/11), 82B (6/94), 82C (6/94) Equivalent

St. Lucie Unit 2
Min Wall Thickness and Bolted Plate Repairs-
Line I-30"-CW-29 and CW-30 - ICW Discharge to Canal

1.0 Purpose / Scope

This calculation determines the pipe minimum wall thickness for Internal Corrosion per design formulas of ASME Section III and the criteria presented within UFSAR Table 3.9-7 for reviewing interactions of pressure stress and longitudinal bending stresses.

This calculation addresses application of bolted plate repairs on line I-30"-CW-29. A review of the pipe stress input is required to determine applicable to I-30"-CW-30. The subject lines have no isolation valves to the discharge canal and operate at near atmospheric pressure. The calculation reviews a repair methodology that blanks off the corrosion holes or deep pitting with bolted plates on the ID of the pipe.

Calculation evaluates the required reinforcement versus the actual reinforcement available around the corrosion holes and reviews bolting requirements for the bolted plate which is analyzed as a blind flange. Reinforcement interaction is reviewed for the multiple holes to ensure additional reinforcement is not required.

Revision 1 provides the stress analysis inputs for the plate location and addresses the weight of the plates on the pipe, the shear of the bolting, the seismic properties of the plates and the pipe.

Calculation developed in support of AR 1793151.

2.0 Methodology

Part

1 The methodology used in the analysis is to:

1. Develop a minimum pipe wall thickness based on hoop stress.
2. Develop a minimum pipe wall thickness based on longitudinal stress calculated using the maximum allowed stress for each code equation.
3. The larger calculated minimum wall is used as the minimum wall criteria.

This analysis extrapolates the original pipe stress analysis to determine new longitudinal stress interaction ratios. A new pressure stress is calculated for the assumed wall thickness and the bending stresses within the interaction equations are extrapolated by the ratic of the nominal wall section modulus to the reduced wall section modulus.

Analysis assumes uniform wall reduction from the ID within the area of interest of the pipe run. Additional local wall thinning may be acceptable with further analysis and information on actual wall thickness of surrounding areas.

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

3 Determine repair plate thickness requirements per ASME Section III, Subsection NC.

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 NC.

3.0 References

1. St. Lucie Unit 2 FSAR Amendment 20
2. St. Lucie NAMS DataBase
3. Navco Piping Catalog, Edition 11, 1984
4. Section III, 1971 Edition, Summer 1973 Addenda, NC-3641.1
5. Section III, 1971 Edition, Summer 1973 Addenda, Appendix I
6. Section III, 1971 Edition, Summer 1973 Addenda, NC-3611.1
7. Section III, 1971 Edition, Summer 1973 Addenda, NB-3652
8. EBASCO Backfit Stress Analysis Design Criteria, Rev 2, 12/7/87
9. Roark's Formulas for Stress & Strain, 6 Edition, pages 67, 518
10. Not Used
11. Stress Calc 3002, Rev 5 (Orig Code of Record ASME Section III Class 3)
12. Stress Iso CW-172-11 R5
13. Piping Isometric 2998-G-125 Sh CW-F-14 R29
14 EPRI Good Bolting Practices Volume 1, NP-5067
15 Machinery's Handbook, 26 Edition, Industrial Press, Inc., Pages 1490, 1491
16 Fastener Standards, 6th Edition, Industrial Fasteners Institute
17 EC 277102
18 ASME Section III, 1971 Edition, Summer 1973 Addenda
19 Specification FLO-2998.099, Rev. 5, General Power Piping

4.0 Assumptions/Data Input

1 Plate material will be a low carbon steel, such as SA/A-106 Grade B (Allowable 15,000 psi, lowest allowable of materials allowed by Ref. 19 for Pipe Code CS-1). Equivalent materials are acceptable. For specific materials used, see EC.

2 Fastener material will be SA-193 Grade B7 and SA-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.

4 The addition of the stud holes and the required reinforcement area does not have a negative effect on the required reinforcement area of the branch connections as defined in the ASME Code Section NC-3643.3(c). Furthermore, the stud holes were not drilled beyond the minimum wall thickness.

5 The Stress Intensity Factor (SIF) was reviewed for the studs of each plate and was found to have a negligible effect on the result of Attachment 2. No additional evaluation was required however the conditions of Attachment 2 still apply.

Piping System Inputs:		30" 0.375 (STD) A-155 KC-65				
t-nominal: tnom	0.375 in	Outside Diameter : Do		30	in	(3)
		Inside Diameter : Di		29.25	in	(3)
Corrosion Allowance : A	*(generally 0 for this analysis)*			0	in	(4)
Design P:	90 psig	Design T:		150	deg F*	(2)

REF for header row: (2)

Stress Analysis Inputs:	PSL 2 Section III		REF
Prepared: **See Att. 1**	Verified: **See Att. 1**		
Code of Record: ASME B&PV Code Section III, 1971 Edition through Summer 1973 Addenda			(11)
Stress Calc 3002, Rev 5 (Orig Code of Record ASME Section III Class 3)			(11)
Stress Iso CW-172-11 R5			(12)
Piping Isometric 2998-G-125 Sh CW-F-14 R29			(13)

	Max Stress		REF
Long Press. Stress (tnom) (Do NOT include in below Eq's)	1733	psi	(11)
Eq 8 (P)+(Dead Weight)**	97	psi**	(11)
Eq 9 Upset/Emergency (P)+(DWt+OBE Inertia)**	890	psi**	(11)
Eq 9 Faulted (P)+(DWt+DBE Inertia)**	1173	psi**	(11)
Eq 10 Thermal**	615	psi**	(11)
Stress Allowable Hot: Sh	15000	psi	(11)
Allowable Stress Range for Expansion Stresses: Sa	22500	psi	(11)
y coefficient *(0.4 if less than 900F)*	0.4	-	(4)

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

5.0 Calculation

Part 1 - Minimum Wall Calculation

Develop tmin based on Hoop Stress:

					REF
tmin based on Hoop Stress	(P Do)/(2 (Sh + P y)) + A		**0.090**	in	(4)
Original Section Modulus:	$Z = 3.14/32\ (Do^4 - Di^4)/Do$		255.167	cu in	(9)
Mill Tolerance (tnom +/- 12.5%):	0.328 to 0.422 in	tnom	0.375	in	(3)

Develop tmin Based on Longitudinal Stresses:

tmin based on Longitudinal Stress (Guess & Iterate)			**0.055**	in	-
Diameter Inside Di'	Di'=Do-2tmin		29.889	in	-
New Section Modulus	$Z' = (3.14/32)\ (Do^4 - Di'^4)/Do$		38.933	cu in	(9)
Section Modulus Ratio	SM Ratio = Z / Z'		6.554	-	-
Longitudinal Pressure Stress	(P Do)/(4 tmin)		12181	psi	(9)
Code Equations & Acceptance Criteria:	*May Not Exceed*		L Stress	IR≤1.0	
Eq 8 = P + SM Ratio (DWt)	Sh	15000	12817	0.85	(11)
Eq 9 = P + SM Ratio (Dwt + OBE Inertia)	1.2 Sh	18000	18014	1.00	(11)
Eq 9 = P + SM Ratio (Dwt + DBE Inertia)	2.4 Sh	36000	19869	0.55	(11)
Eq 10 = SM Ratio (Th)	Sa	22500	4031	0.18	(11)

Calculation assumes general wall reduction due to Internal Corrosion
The Minimum Wall Criteria is 0.090 inches.

Calculation assumes general wall reduction due to Internal Corrosion
Additional local wall thinning may be acceptable with further analysis, provided the wall thickness of the surrounding area is greater than the above minimum wall criteria.

Part 2 (Case 1) - Reinforcement for Minimum Assumed Hole Size (0.25")

Branch Connection Reinforcement Calculation per ASME Section III, NC-3643.3
Pipe Code CS-4

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 or (Tb+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

						Ref
Dob	0.25				Assumed, Bounding	-
Doh	30				Design	2
d1	0.25				Assumed, Bounding	-
		d1	Tb+Th+(d1/2)	Dob	NC-3643.3	18
d2	0.25	0.25	0.45	0.25	NC-3643.3	18
L	0.000				NC-3643.3	18
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)	4
tmh	0.090				See Part 1	-
P	90				NAMS	2
T	150				NAMS	2
S	15,000				See Part 1	11
y	0.4				See Part 1	18
A	0				See Part 1	18
a	90				Design	2
a radians	1.571				360 degrees = 2 p radians	-
		1/4"	0.7Tb	Lesser of	Fig NB-3352.4-2	18
tc	0	0	0		Not Used	-
w	0				Not Used	-

Calculate area required:

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

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

Area A1 = (2*d2-d1)*(Th min-tmh)
0.060 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
0.060 sq. in.

Compare area available to required area:

Avail		Required area
0.060 sq. in.	>	0.024 sq. in.

No additional reinforcement of the assumed hole is required.

Part 2 (Case 2) - Reinforcement for Maximum Assumed Hole Size (30")

Branch Connection Reinforcement Calculation per ASME Section III, NC-3643.3
Pipe Code CS-4

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 or (Tb+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

						Ref
Dob	30				Assumed, Bounding	-
Doh	30				Design	2
d1	30				Assumed, Bounding	-
		d1	Tb+Th+(d1/2)	Dob	NC-3643.3	18
d2	30	30	15.33	30	NC-3643.3	18
L	0.000				NC-3643.3	18
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)	4
tmh	0.090				See Part 1	-
P	90				NAMS	2
T	150				NAMS	2
S	15,000				See Part 1	11
y	0.4				See Part 1	18
A	0				See Part 1	18
a	90				Design	2
a radians	1.571				360 degrees = 2 p radians	-
		1/4"	0.7Tb		Fig NB-3352.4-2	18
tc	0	0	0		Not Used	-
w	0				Not Used	-

Calculate area required:

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

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

Area A1 = (2*d2-d1)*(Th min-tmh)
7.150 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
7.150 sq. in.

Compare area available to required area:

Avail		Required area
7.150 sq. in.	>	2.882 sq. in.

No additional reinforcement of the assumed hole is required.

The above cases show that hole sizes up to 30" diameter do not require additional reinforcement, provided the wall thickness in the surrounding areas is $\geq$0.328".

Part 3A - Plate Thickness for 5 inch x 5 inch Plate

Data used in the 5 inch x 5 inch plate and bolting analysis is summarized in this section.

Patch Plate Inputs:		Value	Units	REF
Design Temperature		150	F	2
Design Pressure		90	psig	2
Base Metal Information				
Pipe Nominal Wall		0.375	in	2
Material		SA/A-155 KC-65		2
Allowable Stress	Assume SA-106 Gr. B or equiv., Table I-7.1	15000	psi	5, Att. 1
Patch Information				
Width	Assume Width is the smaller plate dimension.	5	in	17
Height	Assume Height is the larger plate dimension.	5	in	17
Material		SA-106 Gr B		Assumption 1
Allowable Stress	Assume SA-106 Gr. B or equiv., Table I-7.1	15000	psi	5, Att. 1
Opening Dimensions				
Gasket Width		0.75	in	17
Plate overlap		0.125	in	
Width	=Patch Width - 2 (Overlap + Gasket Width)	3.25	in	17
Height	=Patch Height - 2 (Overlap + Gasket Width)	3.25	in	17
Bolting Information				
Diameter		0.25	in	17
Material		SA-193 Gr. B7		17
Allowable Stress	Table I-7.3	25000	psi	5
Yield Stress	Table I-1.3	105000	psi	5
Number of Bolts		4		17
Area of Bolt		0.0318	in^2	16
k for Thread Lubricant N-5000		0.15	-	14

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 max height/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% *(Height/Width, max)*((3*90)/(16*15000))^0.5+0	0.120	in	
	Meets plate thickness of	**0.375**	**in**	**OK**

Part 4A - Bolt/Gasket Loading for 5 inch x 5 inch Plate

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 Width + Opening Width	4	in	17
H	Pressure Height	= Gasket Width + Opening Height	4	in	17
Land	Gasket Width		0.75	in	17
b	1/2 Gasket Width	=Land/2	0.375	in	
A	Short Dimension Cover	=Patch Width - 2 (Overlap)	4.75	in	17
B	Long Dimension Cover	=Patch Height - 2 (Overlap)	4.75	in	17
C	Short Dimension Gasket ID	=Patch Width - 2 (Overlap + Gasket Width)	3.25	in	17
D	LongDimension Gasket ID	=Patch Height - 2 (Overlap + Gasket Width)	3.25	in	17
d	Bolt Diameter		0.25	in	17
N	Number of Bolts		4		17
PRESSURE AREA					
P Area	W*H		16	in^2	-
REQUIRED SEATING LOAD (Wm2)					
y			200	lb/in^2	18
G Area	=(A*B)-(C*D)-((N*PI*(d+0.125)^2)/4)		11.56	in^2	18
Wm2	=y* G Area		2312	lb	18
OPERATING SEATING LOAD (Wm1)					
P ext	Patch is on ID, Assume 15 psi external		15	psig	Ass. 3
P Area	=W*H		16	in^2	
m	Gasket Factor		1		18
Wm1	=(P ext*P Area)+(G Area*m*P ext), modified for rectangle		413	lb	18
REQUIRED BOLT STRESS/TORQUE					
Load	Greater of Wm1 or Wm2		2312	lb	18
Bolt Diameter			0.25	in	17
Load/Bolt	=Load / N		578	lb	-
Bolt Stress	=Load/Bolt/((3.14*Bolt Dia^2)/4)		11773	psi	-
Bolt Torque	=K*d* Load/(N*12)		1.81	ft-lbs	14
			2 ft-lbs specified		

Rounded up to next whole number

Part 5A - Bolting for 5 inch x 5 inch Plate

ICW Pipe -Pipe Code CS-4 (SA-106 Grade B Used, Assumption 1)
Bolts: SA-193 Grade B7, 1/4"-20 UNC-2A

		Value	Units	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	16
Dsmin	External Thread Minimum major diameter	0.2408	in	16
Yieldbolt	External Thread Yield Strength	105,000	psi	5
UTSbolt	External Thread Thread Ultimate Tensile Strength	125,000	psi	5
Enmax	Internal Thread Maximum pitch diameter	0.2224	in	16
Knmax	Internal Thread Maximum minor diameter	0.207	in	16
Yieldhole	Internal Thread Yield Strength	35,000	psi	5
UTShole	Internal Thread Ultimate Tensile Strength	60,000	psi	5

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	15
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	15

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

As	= 3.1416 n Le Knmax (1/(2n) + .57735(Esmin - Knmax))	0.061	sq in	15
An	= 3.1416 n Le Dsmin (1/(2n) + .57735 (Dsmin - Enmax))	0.089	sq in	15
J	= (As UTSbolt) / (An UTShole)	1.42	-	15
Q	Required Length of Internal Threads = J * Le	0.234	in	15

3. Load Required to Break Bolt/Screw

Pbolt	Pbolt = At * UTSbolt	3789	lbs	15

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	-

M=Developed Percent of Bolt Yield Strength	20%	%	-
K=Nut Factor (Fel-Pro N-5000)	0.15	-	14
Bolt Torque = M D Yieldbolt At K / 12	**2.00**	ft-lbs	14

	%Yield
Bolt Stress compared to bolt material strength	20%
External Thread Stress compared to bolt material strength	13%
Internal Thread Stress compared to hole material strength	27%

Part 6- Interaction Between Multiple Openings

ASME III, Section NC-3643.3(e) defines reinforcement requirements for multiple openings:

> When any two or more adjacent openings are so closely spaced that their reinforcement zones overlap, the two or more openings shall be reinforced in accordance with NC-3643.3(c) and (d), with a combined reinforcement that has strength equal to the combined strength of the reinforcement which would be required for the separate openings. No portion of the cross-section shall be considered as applying to more than one opening or be evaluated more than once in a combined area.

ASME III, Section NC-3643.3(f) defines reinforcement zone:

> The reinforcement zone is a parallelogram the length of which shall extend a distance d_2, on each side of the centerline of the branch pipe and the width of which shall start at the inside surface of the run pipe and extend to a distance, L, from the outside surface of the run pipe, when measured in the plane of the branch connection.

From Part 2, Cases 1 and 2, d_2 is the hole size for the location.

Based on review of the UT readings (Att. 3):
The openings for closest holes are spaced sufficiently apart that the reinforcement zones do not overlap. Therefore, additional reinforcement criteria per ASME III, Section NC-3643.3(f) is not required.

6.0 Results

Pipe

The Minimum Wall Criteria is 0.090 Inches

The minimum wall criteria is controlled by the hoop stresses.

Calculation assumes general wall reduction due to Internal Corrosion
Additional local wall thinning may be acceptable with further analysis, provided the wall thickness of the surrounding area is greater than the above minimum wall criteria.

Reinforcement

Part 2, shows that hole sizes up to 30" diameter do not require additional reinforcement, provided the wall thickness in the surrounding areas is ≥0.328".

Plate Thickness

To consolidate stock, the required plate thickness is compared to design plate thickness of 0.375".

5 inch x 5 inch Plate

Required closure plate thickness is	**0.120**	**Inches**
Minimum Bolt Torque (1/4" -20UNC) is	**2.00**	**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

Based on review of the UT readings (Att. 3):
The openings for closest holes are spaced sufficiently apart that the reinforcement zones do not overlap. Therefore, additional reinforcement criteria per ASME III, Section NC-3643.3(f) is not required.

Calc PSL-2FSM-12-034, Att. 1, Rev 1, Page 1 of 1

Pipe Stress Input

Location

Unit	**2**
CR / CSI Loc No.	**NA**
Line Number	I-30"-CW-29
Description	CCW HX to Discharge Canal
Diameter	30"
Schedule	0.375"
Design Pressure	90 psi
Temperature	150°F
Piping Isometric and Revison	2998-G-125, CW-F-14
Original Design Spec and Edition	ASME Section III CL 3

Civil Pipe Stress Input

	Units	
Stress Code and Edition	-	ASME Sect III CL 3 1971 - Summer 1973 Add
Stress Iso and Revison	-	CW-172-11 R5
Nodes	-	8020
Stress Calc and Revison	-	3002 Rev. 5
Long Pressure Stress	psi	1733
EQ 8 Deadweight (P)+(Dead Weight) **	psi	97
EQ 9 Upset (P)+(DWt+OBE Inertia) **	psi	890
EQ 9 Emergency (P)+(DWt+DBE Inertia) **	psi	1173
EQ 10 Thermal Normal (Thermal) **	psi	563
EQ 10 Thermal Upset (Thermal) **	psi	615
Stress Allowable Hot: Sh	psi	15000
Allowable Stress Range for Exp. Stresses: Sa	psi	22500

Boxed Values are Moment Stress Only (Pressure Stress Has Been Subtracted Out)

Civil Input:
Prepared By: [signature] 9/13/13
Verified By: [signature] 9/13/13

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:	[signature]	Date:	12-15-11
Approved By:	[signature]	Date:	12.15.11

FPL

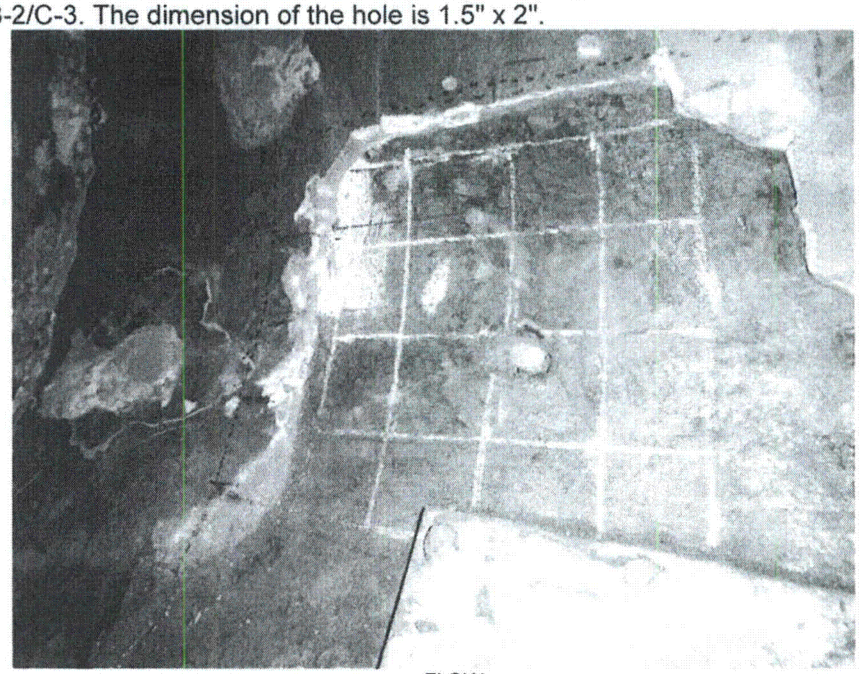
General Engineering Examination Report Saint Lucie

GIR Number #	
12-029	
WO #	WO# 40074449-06
Unit/Common/Other (Shop, etc)	Unit 2

Subject / Component:	Photo Attached:	Outage:
ICW / CW-29	Yes	SL2-20
Reference / Procedure:	Requestor:	Request Date:
NDE 5.28 Rev. 1	Rodriguez/SCE	8/13/12

Inspection Objective / Criteria:
Perform ultrasonic thickness examination of the pipe after concrete liner removal and surface preparation at the hole per AR# 01793151. Refer to Attachment 1.

Results / Objective Evidence:
A two inch grid was marked on the pipe and examined with a thickness gauge. The lowest reading in each grid has been typed into each block. Through wall hole is recorded on quadrant B-2/C-3. The dimension of the hole is 1.5" x 2".



FLOW

Equipment: Ultrasonic Model - Panametrics 37DL Plus SN# 041219511
Transducer model - Panametric 5 MHz 0.25" diameter SN# 736918

Examination Performed By — Date: 08.13.12

Reviewed By: Signature — Date: 8/14/12

GIR 12-029
~~Attachment #1~~
Page ~~1~~ 2 of ~~1~~ 2
8/15/12
8/14/12

WO # 40074449-06
UNIT 2
Photo # 131
DATE 08-14-2012

	A	B	C	D
1	~~403~~ 392	386	402	381
2	413	406	391	393
3	397	386	391	393
4	381	383	384	376

FLOW ←

- Through hole is recorded on Quadrant B-2/C-3
- Grid - 8 X 8 with 2" Spacing
- Hole - 1½" X 2" in length

PSL-2FSM-12-034, Rev. 1
Attachment-4
Page 1 of 1

Patch Plate Addition:

The purpose of this evaluation is to determine the impact on the affected pipe stresses and pipe support loads resulting from adding internal patch plates to the Unit-2 I-30"-CW-29 piping (ICW Piping). The subject piping is evaluated within calculation 3002, Rev. 5. Per NAMS, the piping is classified as Quality Group C, Seismic Category I, or Class 3 Code piping.

The patch plates are 3/8" thick held in place with 1/4"-20 studs (SA-193 Gr. B7), and vary in overall size, and total number of studs. Review of patch plate drawings within EC-277102 and EC-235340 reveals that the patch plates are 5"x5" and 8"x8" respectively. Conservatively considering a 16"x16" (patch plates are installed in close proximity to one another) plate results in an added weight of 35 lb (16"x16"x0.375"x0.284 lb/in^{3}x1.2 (bolting) = 32.7 lb). The ICW Piping is 30" OD having a wall thickness 0.375" (3/8"), and a weight of 118.7 lb/ft. The piping is shown on isometric drawing 2998-G-125, Sheet CW-F-14, Rev. 29. In accordance with the calculation of record 3002, a combined spectra was input utilizing the base mat and heat exchanger response spectra, the worst case OBE factor is 2.0g, and SSE is 3.15g. Therefore, to account for seismic excitation the evaluated weight will be 120 lb (35 lb x 3.15g = 110.25 lb). This additional weight will have negligible impact on support loading.

In accordance with Specification SPEC-M-004, the SA-193 Gr. B7, 1/4-20 studs have Tensile Stress of 125 ksi, and a Yield Stress 105 ksi, and As is 0.0318 in^2. Thus the shear stress on a 1/4-20 stud resulting from the seismic loading of the patch plate is 3773.6 psi < 21,000 psi (Shear Allowable per AISC 9th Edition) with the entire load on one bolt (flow force is negligible). The effect on the pipe stresses due to added patch plate (weight increase) will be evaluated using the results of the analysis of record as shown below:

Weight ratio factor = (added patch plate weight)/(analysis of record piping weight) = (120 lb +119 lb) / 119 lbs = 2.01.

Since the percent increase in the pipe stresses is directly proportional to the weight increase, conservatively the deadweight and seismic stresses (maximum stress), including the unaffected pressure stresses, will be adjusted by the weight ratio factor.

In addition, to account for the effect of any frequency change due to the increased weight, the maximum seismic stresses below will also conservatively be increased by a dynamic factor of 1.5. The patch plate locations are coincident with Node 8020 of calculation 3002, Rev. 5

Analysis of record EQ. 8 stress = 1733 psi + 97 psi = 1830 psi
New EQ. 8 stress = 1830 x (2.01) = 3678.3 psi < 1.0 SH = 15,000 psi; thus o.k.

Analysis of record EQ. 9 stress (Seismic OBE) = 1733 psi + 890 psi = 2623 psi
New EQ. 9 upset stress = 2623 x (2.01) x (1.5) = 7908 psi < 1.2 SH = 18,000 psi; thus o.k.

Analysis of record EQ. 9 stress (Seismic SSE) = 1733 psi + 1173 psi = 2906 psi
New EQ. 9 faulted stress = 2906 x (2.01) x (1.5) = 8762 psi < 2.4 SH = 36,000 psi; thus o.k.

Based on the above, the affected piping section meets the stress requirements of the design criteria for each individual patch plate location.

Prepared By: [signature] Date: 9/11/13

Verified By: [signature] Date: 9/11/13

Approved By: [signature] Date: 9/19/13

St. Lucie Unit 2
Additional Details and Justification for St. Lucie Unit 2 Relief Request Nos. 15 and 1

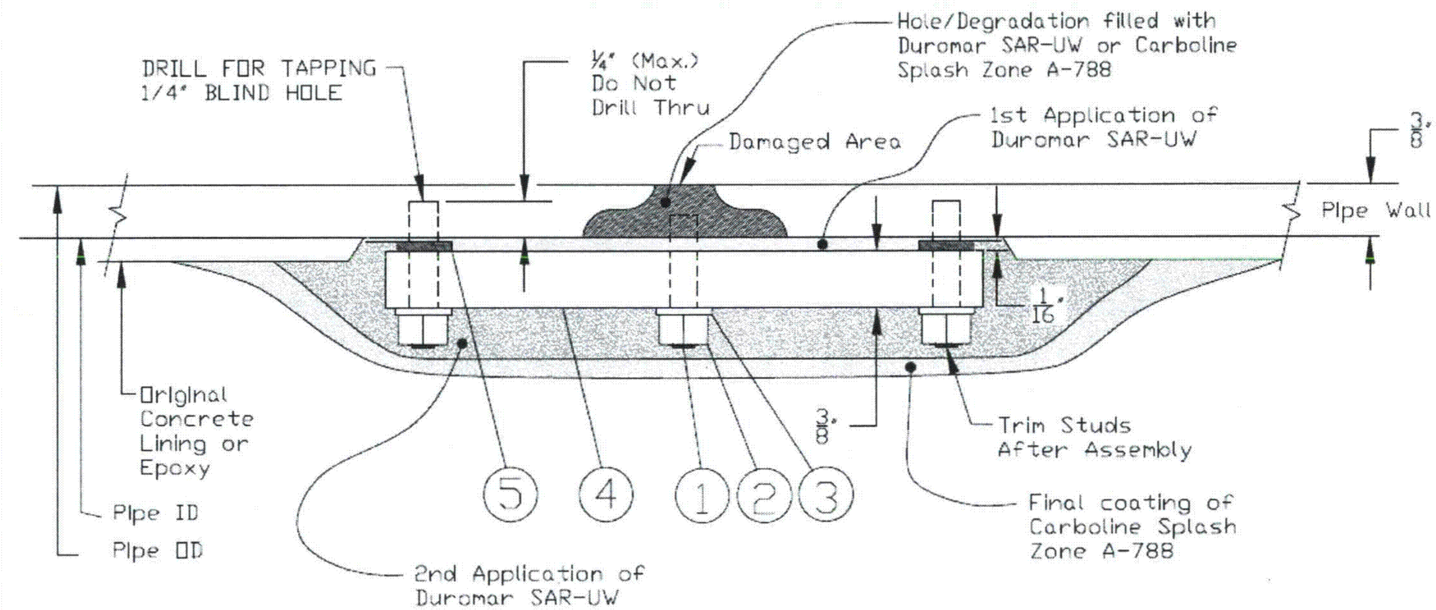
1. Gasket and Epoxy Material

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" [3.a] 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" (Figure 1 below) 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 [3.b] 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.

As stated 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 [3.c] provides allowable thickness range of 125 mils to 2" (0.125" to 2"). Product Data Sheet for Duromar SAR- UW [3.d] 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.



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 EC280123-M-001.DWG

Figure 1 Typical Bolted Patch Plate Sketch

St. Lucie Unit 2
Additional Details and Justification for St. Lucie Unit 2 Relief Request Nos. 15 and 1

2. Bolted Patch Plate Repair Design Considerations and Limitations

As shown in the calculations (Attachments 2 and 3) 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.

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.

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 are7.5" x 11.5" and 11" x 11" (specifically calculations for Unit 1)[3.d], 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.

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.

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 [3.f] to the elevation difference in the piping, which is -12 feet [3.g and 3.h]. 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[3.i] because there is little heat load on the Component Cooling Water Heat Exchangers during normal operation. DBD-ICW-1[3.j] provides the recorded minimum and maximum ocean water temperatures as 52° to 87°F.

3. References

a. EPRI Report NP-6608 dated May 1994, Shelf Life of Elastomeric Components.
b. Letter form Jerry Arnold of Carboline to Garth Dolderer of FPL dated August 28, 2013.
c. Splash Zone A-788 Carboline Product Data dated March 2013.
d. Duromar SAR-UW Product Data Sheet Rev. 05/13.
e. St. Lucie Letter No. L-2013-261 10 CFR 50.4 10 CFR 50.55a, dated August 30, 2013 to the USNRC Re: St. Lucie Unit 1, Docket No. 50-335, "RAI Response to Fourth Ten-Year Interval Unit 1 Relief Request No. 7, Revision 0.
f. Calculation 129154-M-0014 Rev. 2, Hydraulic Analysis of Plant St. Lucie ICW System.
g. Drawing 8770-G-125 Sh. CW-F-3 Rev. 23.
h. Drawing 8770-G-125 Sh. CW-F-10 Rev. 5.
i. PI-Process Book EWS-St. Lucie 1 TCW/CCW Temps Trend 8/28/13.
j. DBD-ICW-1, Rev. 4 Intake Cooling Water System.