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Nuclear Safety Assurance Director
Waterford 3

W3F1-2012-0102

December 16, 2012

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

Subject: Waterford 3 Supplemental Response to an NRC Request for Additional Information (RAI) associated with W3-ISI-020, Request for Alternative to ASME Code Case N-770-1 Baseline Examination [TAC No. ME9801]
Waterford Steam Electric Station, Unit 3
Docket No. 50-382
License No. NPF-38

References:

1. Entergy letter dated October 16, 2012, “Waterford 3 Request for Alternative W3-ISI-020, ASME Code Case N-770-1 Baseline Examination Request for Alternative” (W3F1-2012-0085) (ML12296A241)

2. NRC email dated November 5, 2012, “RAI on Waterford 3's "Request for Alternative W3-ISI-020, ASME Code Case N-770-1 Baseline Examination Request for Alternative.” [TAC ME9801] (ML12310A454)

3. Entergy letter dated November 15, 2012, “Response to an NRC Request for Additional Information (RAI) associated with W3-ISI-020, Request for Alternative to ASME Code Case N-770-1 Baseline Examination” (W3F1-2012-0096) (ML12324A170)

Dear Sir or Madam:

Entergy Operations, Inc. requested NRC’s approval of Request for Alternative W3-ISI-020 for the Waterford Steam Electric Station, Unit 3 (Waterford 3) in Reference 1. The request is associated with the use of an alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Code Case N-770-1 as conditioned in 10 CFR 50.55a(g)(6)(ii)(F)(3). The NRC has authorized a similar proposed alternative at Arkansas Nuclear One, Unit 2.

Waterford 3 received a request for additional information (RAI) as documented in Reference 2. Entergy responded to the NRC's RAI in order to complete the review of Request for Alternative W3-ISI-020 as documented in Reference 3. Subsequent to the submittal of Reference 3, it was recognized that additional information was needed relative to one of the questions in the original NRC request for additional information. This specifically deals with Question 3.c.i, which has been discussed during teleconferences between the NRC staff and Entergy.

Additionally, during preparation of this supplemental response, it was identified that there is stainless steel butter applied to the safe end of the welds. This stainless steel butter was not factored in the weld volume information in the weld data table previously provided in Reference 3. Please disregard the Updated Weld Data Table contained in Attachment 3 of Reference 3. It has been verified that it is not necessary to forward a corrected copy of the table to the NRC. Condition Report CR-WF3-2012-07464 has been issued within the Waterford 3 Corrective Action Program to address the incorrect information previously provided.

Please find Waterford 3's supplemental response to the request for additional information in Attachments 1 through 3.

This letter contains no new commitments. If you have any questions or require additional information, please contact the Licensing Manager, Chester Fugate, at (504) 739-6685.

Sincerely,

CR/RJP

Attachments:
1. Supplemental Response to Request for Additional Information – Use of ASME Code Case N-770-1 Baseline Examination
2. Weld Data Table
3. RCP Cold Leg Dissimilar Metal Weld Design Drawings

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Attachment 1 to W3F1-2012-0102

Supplemental Response to Request for Additional Information

Use of ASME Code Case N-770-1 Baseline Examination

Request for Additional Information
Use of ASME Code Case N-770-1 Baseline Examination

3. **Section 5 of the proposed alternative, "Proposed Alternative and Basis for Use," states that the SI-UT-130 Rev. 3 UT procedure has been successfully qualified for single-sided axial scan examination, per the requirements of the ASME Code, Section XI, Appendix VIII**

   c. **Provide data for the circumferential scan coverage of the susceptible material for the inner 1/3 of wall thickness of each of the subject welds**

      i. **For each weld where the circumferential scan coverage of the susceptible material is less than 100 percent, please provide an axial cross sectional map indicating the unexamined zone and the size of largest potential flaw in the susceptible material within the unexamined zone**

Circumferential Scan Coverage for Axial Flaws- Structural Integrity Associates performed the Waterford 3 PDI examinations for the RCP cold leg suction and discharge nozzle welds and associated safety injection nozzle welds in accordance with the Performance Demonstration Qualification Summary (PDQS) for SI-UT-130 provided in Reference 3. For weld profiles that have a tapered surface, the PDQS states that the procedure is not qualified to detect axial flaws on the far side (stainless steel side) of a single sided access. This would limit the qualified exams from the near side (carbon steel side) to the weld centerline including the PWSCC susceptible weld material scanned within this detectable region. The tapered weld surface qualification process was based on the ability of the detection methods to use both electronic and mechanical (manual) skewing. The procedure PDQS requires both mechanical and 10 degrees of electronic skewing in both directions to provide assurance that all susceptible material was examined. The application of both mechanical and electronic skewing established the ability of the detection methods to identify flaws in the susceptible material for the areas for which the procedure is qualified.

When the vendor performed the examination of these welds, they scanned from the carbon steel side of the weld. In addition to the scanning qualified by the procedure, scanning was also performed from the weld surface in an attempt to provide the maximum insonification of the susceptible weld material possible. Even though not within the qualified coverage of the procedure, UT beams were directed into the far side of the weld centerline to interrogate that area for potential flaws. This provided some additional assurance that a potential flaw would be detected in this region to provide defense in depth. This complete scan approach provides a high degree of assurance that the welds were examined to the maximum extent possible including the unqualified region in accordance with the procedure PDQS. As discussed before, no examinations were performed from the cast austenitic stainless steel (CASS) safe ends due to limitations in UT methods for this material and limited scanning area due to the short safe-end length.

Attachment 2 contains a table which includes the circumferential scan for axial flaw coverage of PWSCC susceptible welds received with both the PDQS qualified and unqualified examination volumes. The table also indicates if the PDQS taper weld limitation was applicable. In all cases, the full extent of the PDQS qualified detectable area (near side of scan) for the susceptible material is documented, as well as the additional non-qualified exam volumes obtained, which included 100% of the total PWSCC susceptible area.

Weld Flaw Location – Both the Reactor Coolant Pump (RCP) suction and discharge dissimilar metals have similar weld preps at the CASS safe-end and ferritic piping. The ferritic piping is buttered with an Alloy 82/182 filler metal. The CASS safe-end is buttered with a 308 Stainless Steel (SS) filler metal.

Westinghouse generic industry PWSCC flaw analyses considered an axial flaw in the center of the dissimilar metal (DM) weld as illustrated in the RCP suction and discharge drawings in Attachment 3 for the following reasons: The root of these welds requires an inside diameter (ID) backgroove to sound base and weld metal with a subsequent Alloy 82/182 backfill weld out. This process increases the residual stresses at the ID root. In addition, the weldment is diluted with the 308 SS on the stainless steel side. Therefore, if a PWSCC flaw were to initiate, it has a highest probability to occur in the centerline of the ID root weld. With an assumed flaw having a 2 to 1 aspect ratio and a 10% wall initial flaw depth, the assumed flaw would essentially cover the width of the root of the DM weld. This assumed flaw originating at the center of the DM weld is larger than and bounds a flaw originating from the corner near the stainless steel to DM weld root. As the flaw propagates through the weld, the axial length will continue to be conservatively greater than the width of the weld. Whereas if a flaw were assumed to initiate near the stainless steel to Alloy 82/182 weld interface, a corner type flaw would only grow in the direction of the susceptible material, resulting in a smaller flaw than the assumed centerline flaw. Additionally, the neighboring stainless weld has a beneficial effect on the DM weld for PWSCC (compressive residual stress). The only other possible crack initiation site is near Alloy 82/182 to clad interface. The axial flaw will arrest as it radially intersects the carbon steel pipe. Crack propagation beyond the carbon steel ID from the clad would have been readily detected from the past examination. Therefore, the most conservative crack location is at the centerline of the weld root.

Weld Flaw Detectability - The procedure is qualified through EPRI/PDI to detect flaws as shallow as 10% of the nominal pipe wall thickness as documented in Supplement 10, paragraph 1.2(c)(1) of Appendix VIII of ASME Section XI. However, Supplement 10 does not mandate a specific aspect ratio for flaws or a minimum or maximum reflective area. A 10% through wall flaw specified in Supplement 10 would have a specific reflective area which could be “credited” as the minimum detectable reflective area. Although it specifies a minimum flaw depth for detection and sizing, Supplement 10 does not mandate a specific aspect ratio (*a/l*) for the flaws nor a maximum reflective area. However, Supplement 8, Table VIII-S8-1 for Bolts and Studs does contain requirements for a reflective area. Therefore, using the requirements of ASME XI, Appendix VIII, Table VIII S8-1, a quantitative comparison can be made. This table shows a maximum reflective area of 0.059 in^2. The most conservative flaw aspect ratio of ASME Section XI, IWB-3514 would be 2 to 1. For a pipe thickness of 3.25” a 10% through wall flaw would be 0.325”. Using the equation $A_f = 1/4\pi r^2$ where r is the 10% flaw depth of 0.325, a 0.083 in^2 reflective area is determined. When compared to the greater than 4” diameter bolting configuration, there is a conservative margin of 40%. When compared to the 2” to 4” diameter bolting configuration, there is a margin greater than 3 times. A slightly larger flaw having a 3 to 1 aspect ratio would be fully constrained by the CASS backgroove. Such a flaw would produce a much larger reflective area, on the order of 1.5 times the size of a 10% 2 to 1 flaw, within the qualified examination volume, and thus increase the “detection margin” from the Supplement 8 defined areas proportionally. Therefore, a 10% 2 to 1 flaw is concluded to have sufficient reflective area to support detection within the qualified volume. Entergy has established the weld root cross-sections for the subject welds by use of design drawings and other design documents to properly characterize the expected flaw heights (Attachment 3).

Entergy previously provided information in letter 2CAN121201 dated December 4, 2012 [ADAMS Accession ML12340A449] indicating that analyses had concluded a postulated initial flaw that is 16.7% through wall would grow to the ASME Code allowable flaw size of 75% through wall in approximately 54 months from the inspection. The largest undetected flaw that could exist due to the examination limitations is 10% through wall, providing a margin of 6.7%. Based on the completion of the previous inspections in October 2009, the crack growth analysis supports operation of Waterford 3 until the next scheduled refueling outage in the spring of 2014.

In conclusion, the weld coverage table included in Attachment 2 shows the circumferential coverage (PDQS qualified and non-qualified) obtained for the Waterford 3 Safety Injection nozzle and RCP cold leg DM welds. In all cases for the RCP cold leg DM welds, the full extent of the PDQS qualified detectable area (near side of scan) for the PWSCC susceptible material was equal to 100% of the circumferential scan for axial flaws. Based on the above it was determined that a 10% axial flaw could potentially be present in the PWSCC material before it could be detected via the qualified exam coverage. Weld profile drawings for the RCP suction and for the discharge lines are provided in Attachment 3. These drawings depict the weld area dimensions associated with each RCP DM weld based on the construction drawings for the end preparations as well as an assumed weld flaw having a 2 to 1 aspect ratio that represents a 10% detectable flaw. This flaw profile is considered appropriate based on the considerations discussed above regarding the potential flaw having enough reflective area for the exam to detect it and the conservative assumptions associated with assuming this flaw would develop at the centerline of the DM weld and be limited to a 2 to 1 aspect ratio.

Attachment 2 to W3F1-2012-0102

Weld Data Table

Weld Data Table

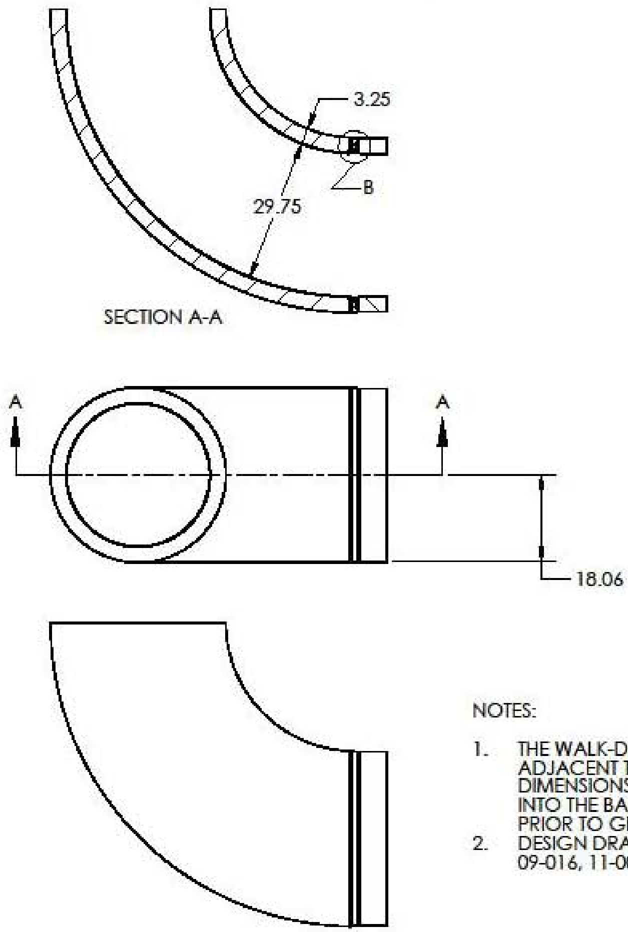
Component ID	Component Description	MRP-139 Volume Coverage		N-770-1 Volume Coverage of PWSCC susceptible material			Tapered Weld PDQS Limitation	Fig (Note1)
		Axial Scan for Circ Flaws	Circ Scan for Axial Flaws	Axial Scan for Circ Flaws	PDQS qualified Circ Scan for Axial Flaws	Non-PDQS Qualified Circ Scan for Axial Flaws		
07-002	30” RCP 1A Inlet Elbow (CS) to Safe-end (Cast SS)	100%	80%	100%	84.8%	100%	Yes	501
08-014	30” RCP 1A Outlet Safe-end (Cast SS) to Pipe(CS)	100%	78%	100%	67%	100%	Yes	502
09-016	30” RCP 1B Inlet Elbow(CS) to Safe-end (Cast SS)	100%	83%	100%	68%	100%	Yes	501
10-002	30” RCP 1B Outlet Safe-end (Cast SS) to Pipe (CS)	100%	81%	100%	69%	100%	Yes	502
11-002	30” RCP 2A Inlet Elbow (CS) to Safe-end (Cast SS)	100%	80%	100%	65%	100%	Yes	501
12-012	30” RCP 2A Outlet Safe-end (Cast SS) to Pipe (CS)	100%	76%	100%	100%	100%	No	502
13-016	30” RCP 2B Inlet Elbow (CS) to Safe-end (Cast SS)	100%	79%	100%	67.2%	100%	Yes	501

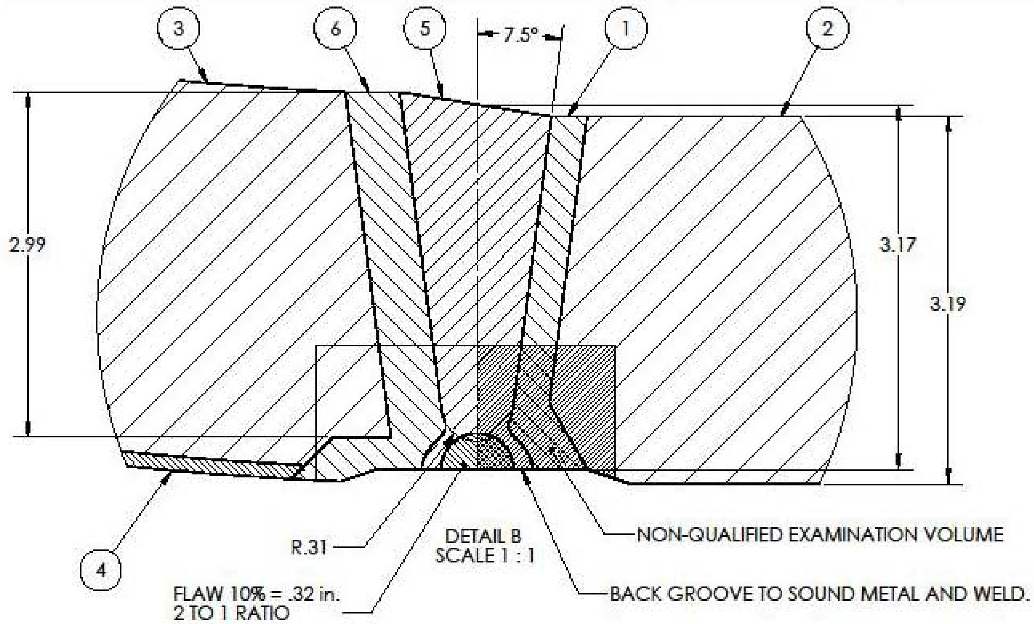
Component ID	Component Description	MRP-139 Volume Coverage		N-770-1 Volume Coverage of PWSCC susceptible material			Tapered Weld PDQS Limitation	Fig (Note1)
		Axial Scan for Circ Flaws	Circ Scan for Axial Flaws	Axial Scan for Circ Flaws	PDQS qualified Circ Scan for Axial Flaws	Non-PDQS Qualified Circ Scan for Axial Flaws		
14-002	30" RCP 2B Outlet Safe-end (Cast SS) to Pipe (CS)	100%	80%	100%	67%	100%	Yes	502
08-009	12" RCS 1A CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
10-008	12" RCS 1B CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
12-009	12" RCS 2A CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
14-006	12" RCS 2B CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A

Note 1:
501 refers to Drawing 1201260.501 contained in Attachment 3
502 refers to Drawing 1201260.502 contained in Attachment 3

Attachment 3 to W3F1-2012-0102

RCP Cold Leg Dissimilar Metal Weld Design Drawing





NOTES:

1. THE WALK-DOWN DIMENSIONS REPORTED IN THE ADJACENT TABLE ARE LARGER THAN DESIGN WELD DIMENSIONS ABOVE DUE TO THE HAZ EXTENDING OUT INTO THE BASE MATERIAL AND WELD CAPS INSTALLED PRIOR TO GRINDING .
2. DESIGN DRAWING IS FOR RCP SUCTION DMW, 07-002, 09-016, 11-002, 13-016.

RF-13 Dissimilar-Metal Weld Walk-Down Data Sheet – RCP Inlet (FOR INFO ONLY)				
Weld Description	07-002 – RCP-1A	09-016 – RCP-1B	11-002 – RCP-2A	13-016 – RCP-2B
Buttering Width	0.275	0.3	0.275	0.45
DM Weld Width	2.45	2.1	2.6	2.45
Safe-End Width	2.9	2.45	0.65	2.1
Pipe Thickness	3.55	3.52	3.58	3.52
Pipe to Weld Interface Thickness (edge of butter)	3.28	3.58	3.475	-
DM Weld Thickness	3.35	3.65	3.53	-
Top of Safe-End Thickness	3.18	3.3	3.25	3.38
Safe-End to Weld to Taper	3.06	3.1	3.25	3.35

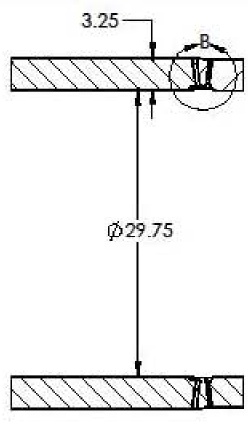
DESIGN INPUT DOCUMENTS
CE DRAWING 74470-731-001
CE DRAWING 74470-771-006
CE DRAWING 74470-771-007
CE DRAWING 74470-771-014
ENTERGY DESIGN INPUT RECORD EC8027 W3-DIR
SI DRAWING 0801357.520

	PARTS LIST	MATERIAL
1	SAFE END BUTTER	E308-15
2	SAFE END	SA-351 Gr.CF8M
3	ELBOW	SA-516, GRADE 70
4	CLADDING	STAINLESS STEEL
5	DM WELD	ALLOY 82/182
6	BUTTER	ALLOY 82/182

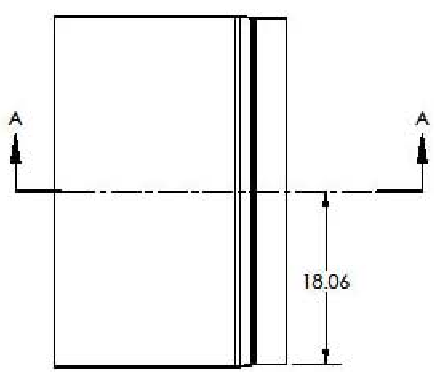
Structural Integrity Associates, Inc.

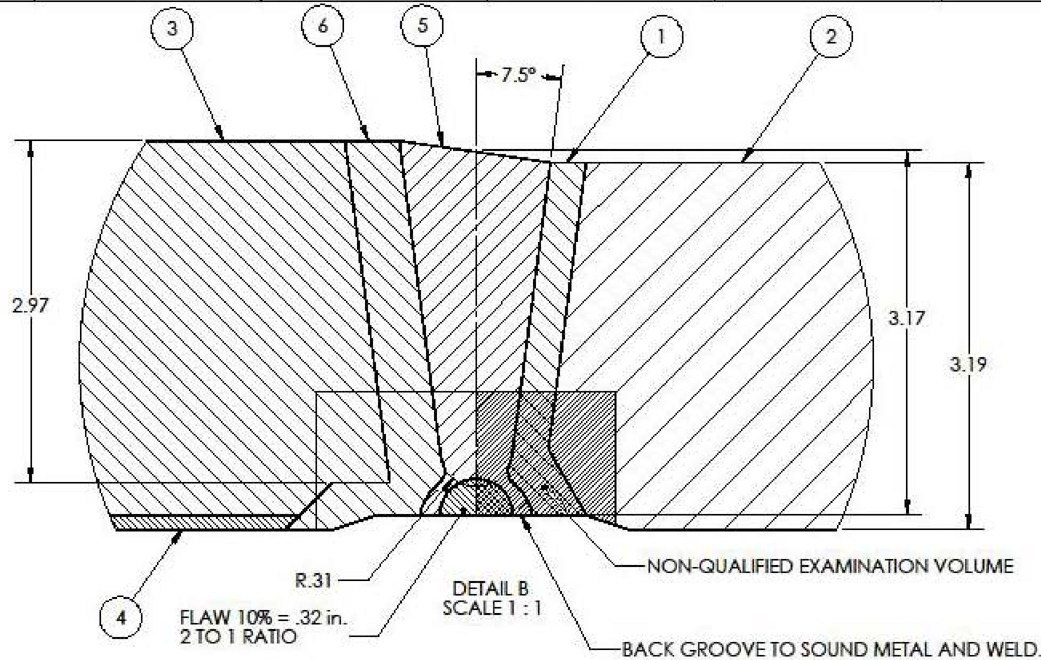
TITLE: REACTOR COOLANT PUMP SUCTION DISSIMILAR METAL WELD

UNLESS OTHERWISE SPECIFIED:		NAME	DATE	DRAWING NO.
DIMENSION TOLERANCES PER REFERENCES	DRAWN BY:	RJL	12/11/2012	1201260.501
	REVIEWED BY:			PROJECT NO.: 1201260.00
	APPROVED BY:			PLANT: WATERFORD STEAM ELECTRIC STATION UNIT 3
				MATERIAL: SEE PARTS LIST ABOVE
				FINISH: N/A
NUCLEAR SAFETY RELATED YES ☒ NO ☐				DWG SIZE: B / REVISION: 0 / QTY: 1
				WT. N/A / SCALE: 1:24 / SHEET 1 OF 1



SECTION A-A





DETAIL B
SCALE 1 : 1

NOTES:

1. THE WALK-DOWN DIMENSIONS REPORTED BELOW ARE LARGER THAN DESIGN WELD DIMENSIONS ABOVE DUE TO THE HAZ EXTENDING OUT INTO THE BASE MATERIAL AND WELD CAPS INSTALLED PRIOR TO GRINDING.
2. DESIGN IS FOR RCP DISCHARGE DMW 08-014, 10-002, 12-012, 14-002.

PARTS LIST		MATERIAL
1	SAFE END BUTTER	E308-15
2	SAFE END	SA-351 Gr.CF8M
3	PIPE	SA-516, GRADE 70
4	CLADDING	STAINLESS STEEL
5	DM WELD	ALLOY 82/182
6	BUTTER	ALLOY 82/182

RF-13 Dissimilar-Metal Weld Walk-Down Data Sheet – RCP Outlet (FOR INFO ONLY)

Weld Description	08-014 RCP-1A	10-002 RCP-1B	12-012 RCP-2A	14-002 RCP-2B
Buttering Width	0.275	0.275	0.5	0.275
DM Weld Width	1.7	1.8	1.6	2.15
Safe-End Width	1.55	2.3	0.9	2.05
Pipe Thickness	-	3.3	-	3.35
Butter Thickness	3.354	3.3	3.2	-
Safe-End Thickness	-	3.5	3.38	3.32

DESIGN INPUT DOCUMENTS
CE DRAWING 74470-731-001
CE DRAWING 74470-771-006
CE DRAWING 74470-771-007
CE DRAWING 74470-771-014
ENTERGY DESIGN INPUT RECORD EC8027 W3-DIR
SI DRAWING 0801357.520

Structural Integrity Associates, Inc.

TITLE: REACTOR COOLANT PUMP DISCHARGE DISSIMILAR METAL WELD

UNLESS OTHERWISE SPECIFIED:
DIMENSION TOLERANCES PER REFERENCE

NUCLEAR SAFETY RELATED YES ☒ NO ☐

	NAME	DATE
DRAWN BY:	RJL	12/11/2012
REVIEWED BY:		
APPROVED BY:		

DRAWING NO. 1201260.502
PROJECT NO.: 1201260.00
PLANT: WATERFORD STEAM ELECTRIC STATION UNIT 3
MATERIAL: SEE PARTS LIST ABOVE
FINISH: N/A

DWG SIZE:	REVISION:	QTY:
B	0	1
WT. N/A	SCALE: 1:12	SHEET 1 OF 1