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G. E. VAUGHN
Vice President
Nuclear Services Department

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 1
DOCKET NO. 50-325/LICENSE NO. DPR-71
IGSCC INSPECTION RESULTS - REFUELING OUTAGE 7

References:

1. NRC Inspection Report No. 50-325/89-35, dated December 7, 1989

2. Letter from G. E. Vaughn (CP&L) to Nuclear Regulatory Commission dated January 7, 1991, "Examination/Evaluation Results for Weld No. 1B21N4D-5-SW1-2 Refueling Outage 7"

3. Letter from E. G. Tourigny (NRC) to L. W. Eury (CP&L) dated December 21, 1989, "Generic Letter 88-01, NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping (TAC Nos. 69128 and 69129)"

4. Letter from L. I. Loflin (CP&L) to Nuclear Regulatory Commission dated June 29, 1989, "Response to Staff's Request for Additional Information Pertaining to Carolina Power & Light Company's Response to Generic Letter 88-01, Units 1 and 2 (TAC Nos. 69128 and 69129)"

Gentlemen:

Carolina Power & Light Company (CP&L) has completed the BSEP Unit 1 Refueling Outage 7 activities associated with: (1) the replacement of the Reactor Coolant Recirculation System (RCRS) and Core Spray System piping and safe-ends and (2) the NUREG 0313, Revision 2 inspections of piping susceptible to Intergranular Stress Corrosion Cracking (IGSCC).

Enclosure 1 contains: (1) a description of the NUREG 0313, Revision 2 Inspection Scope and Results, including the Scope of Examinations, UT Process used, UT Results, and a discussion of the inspection results of RHR valve welds 1B32RD2B2-84-FWB33 and 1B32RD2A2-87-FWA33; (2) a description of the replacement of the RCRS and Core Spray piping and safe-ends; (3) an updated classification of the BSEP Unit 1 IGSCC susceptible welds based upon the RCRS and Core Spray piping and safe-end replacement completed during the BSEP Unit 1 Refueling Outage 7 (Table 2);

IE01 1/1 Change EG&G/Bryce ltr Encl 1 1 } w/out Prop
NRC POR 1 1 } Encls 3 & 4
NSIC 1 1 }

and (4) a conclusion that includes a basis for the continued operation of BSEP Unit 1 until the next refueling outage currently scheduled for September 1992. Enclosure 2 contains the analysis reports from Structural Integrity Associates, Inc. regarding modification of the RHR valves 1E11-F060A and F060B. Enclosures 3 and 4 provide the SMC O'Donnell & Associates, Inc. (ODAI) report on the Mechanical Stress Improvement Process application on the RCRS and Core Spray piping and safe-ends (proprietary) and the ODAI affidavit transmitting that report, respectively.

Please refer any questions regarding this submittal to Mr. M. R. Oates at (919) 546-6063.

Yours very truly,

G. E. Vaughn

DBB/jbw (968BNP)

Enclosures

ENCLOSURE 1
BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 1
NRC DOCKET 50-325/LICENSE NO. DPR-71
IGSCC INSPECTION RESULTS - REFUELING OUTAGE 7

(1) NUREG 0313, Revision 2, INSPECTION SCOPE AND RESULTS

Scope of Examinations

CP&L's approved (Reference 3) NUREG 0313 IGSCC Inspection Program was extensively revised because of the RCRS and Core Spray piping/safe-end replacement, and the commitment (Reference 1) made by CP&L to inspect the eleven* (11) dissimilar metal, and four (4) similar metal (Inconel) welds in BSEP Unit 1 that had not previously been inspected using transducers that produce a refracted longitudinal (RL) sound wave. Table 1 illustrates the revisions to the NUREG 0313 Inspection Program.

* Two (2) of the eleven dissimilar metal welds (1E21FF-4-FWRNA18 and 1E21FF-8-FWRNB18) were replaced as part of the Core Spray piping/safe-end replacement.

TABLE 1 - BSEP 1	IGSCC Inspection Categories						
STATUS	A	B	C	D	E	G	TOTAL
Prior to Refueling Outage 7	122	0	58	31	46	13	270
Refueling Outage 7 Inspections	40 (7)	10	8 (17)	11 (16)	5 (24)	13	87
Current Population	150	10	42	25	11	1	239

The inspections indicated in parenthesis (XX) above are the number of welds in each category that were originally scheduled to be inspected in accordance with the NUREG 0313 Inspection Program. The variations in actual inspections performed versus scheduled inspections were caused by the elimination or replacement of welds by the RCRS and Core Spray piping and safe-end replacement.

Table 2 (attached) provides a complete listing of the BSEP Unit 1, NUREG 0313, Revision 2, IGSCC Inspection Classifications, including weld numbers, IGSCC Category, joint configuration, system and inspection schedule.

UT Process

The UT examinations of the eighty-seven (87) welds identified in Table 1 were performed by General Electric (GE) UT personnel who are qualified in accordance with the EPRI/BWROG/NRC requirements, including the latest requalification program. The examination of these welds incorporated the use of two fully automated GE UT systems. One system was the GE "SMART UT" System, which uses the "Ultra Image III" computer driven data acquisition system with the ALARA remote scanning device. The second system used was GE's recently qualified "SMART 2000" System which also uses the ALARA remote scanning device. The "SMART 2000" System is a multi-channel system which digitizes the entire A-scan, and is able to perform examinations in approximately half the time required by the "SMART" System. The data retained by the "SMART 2000" is also far superior to the existing automated systems. Manual examinations were performed where automated equipment could not be used, and as required to supplement the automated system examinations.

UT Results

As indicated in Table 1, eighty-seven (87) welds were inspected per CP&L's approved (Reference 3) NUREG 0313, Revision 2, IGSCC Inspection Program. During the examination of the welds in the scope of inspections, an indication was identified in IGSCC Category 'G' Feedwater System (FWS) weld no. 1B21N4D-5-SW1-2. This indication, the resulting evaluation of the indication, and the inspection results of the remaining eight (8) FWS welds were discussed in detail in the Reference 2 submittal, dated January 7, 1991.

Of the remaining seventy-eight (78) inspections completed during BSEP Unit 1, Refueling Outage 7, indications were identified in two (2) of the remaining four (4) Category 'G' welds. These indications are discussed in detail below (see RHR Valve Welds 1B32RD2B2-84-FWB33 and 1B32RD2A2-87-FWA33). As stated in the Reference 2 submittal, the thirteen (13) Category 'G' welds being inspected during Refueling Outage 7 represented 100% of the Category 'G' welds, thus no sample expansion was required. No other flaws were identified in any of the remaining inspections, in any of the IGSCC inspection categories.

RHR Valve Welds 1B32RD2B2-84-FWB33 and 1B32RD2A2-87-FWA33

Welds 1B32RD2B2-84-FWB33 and 1B32RD2A2-87-FWA33 (ISI Ref Nos. 24A12 and 24B13 respectively) were inspected as part of a commitment made by CP&L in Reference 1, and in response to the NRC Staff's Request for Additional Information (Reference 4) concerning the limited inspections occurring on welds which were part of the IGSCC Inspection Program. In order to inspect these welds it was necessary to provide a surface suitable for ultrasonic examination. Several alternative inspection techniques were considered.

However, it was impossible to improve the inspectability with the application of alternate examination techniques only, and it was determined that the method of choice was to machine the valve body at the point nearest the weld joint in order to provide a "flat land" large enough to accommodate a 100% inspection from one side of the weld. This machining was accomplished in accordance with the design analysis performed by Structural Integrity Associates, Inc. (Enclosure 2).

An ultrasonic examination was performed of these welds with the "SMART UT" System utilizing 0° longitudinal wave, 45° shear wave, and 45° and 60° RL transducers. During the inspection of these welds, indications which were not contained in the weld metal or heat affected zone, were identified. These indications were determined not to be related to IGSCC (see Enclosure 5 for complete GE UT Reports). The valves were cast from A216 WCB carbon steel material, and because of the orientation and location of the indications, were suspected of containing inclusions typical of a cast component. A review of available data related to the manufacturing of the two RHR valves (1E11-F060A & 1E11-F060B) was performed. The results of that investigation are as follows.

- RHR Valve 1E11-F060A (Weld No. 1B32RD2B2-84-FWB33)
  Five (5) indications were detected during the UT examination of weld 1B32RD2B2-84-FWB33. The parameters of these indications are listed below.

UT Ind. Number	Distance from Zero Reference	Length	Distance from Weld Centerline
1	23.4"	0.40"	2.00"
2*	24.0"	0.80"	1.40"
3*	25.0"	0.35"	2.00"
4	46.4"	**1.30"	1.20"
5*	48.3"	0.45"	1.50"

* Flaws are imbedded in the base material and show no discernable connection to the ID surface by UT examination

** Valve geometry prohibited complete measurements

A complete review of the base metal (as-cast) radiographs (RT) and original documentation packages generated during the valve manufacturing process resulted in the identification of several inclusions which were acceptable by RT. A comparison of these base metal inclusions to the UT indications identified five inclusions with remarkably similar parameters. The parameters of the five base metal inclusions most closely related to the identified UT indications are listed below.

RT Ind. Number	Distance from Zero Reference	Length	Distance from Weld Centerline
1	23.6"	0.25"	1.75"
2	24.1"	0.50"	1.50"
3	25.1"	0.25"	1.75"
4	46.8"	1.25"	1.70"
5	49.0"	0.25"	1.30"

- RHR Valve 1E11-F060B (Weld No. 1B32RD2A2-87-FWA33)
Two (2) indications were detected during the UT examination of weld 1B32RD2A2-87-FWA33. The parameters of these indications are listed below.

UT Ind. Number	Distance from Zero Reference	Length	Distance from Weld Centerline
1*	7.6"	**1.50"	1.30"
2	65.7"	**1.50"	1.20"

* Flaw is imbedded in the base material and shows no discernable connection to the ID surface by UT examination

** Valve geometry prohibited complete measurements

A complete review of the base metal (as-cast) radiographs (RT) and original documentation packages generated during the valve manufacturing process resulted in the identification of an inclusion which was acceptable by RT in the area of UT Indication 1. The parameters of this inclusion are listed below.

RT Indication Number	Distance from Zero Reference	Length	Distance from Weld Centerline
1	8.25"	1.75"	1.00"

In regards to UT Indication 2, the review of the radiographs and documentation revealed that in the area from 65.34" to 68.00" circumferentially, and from 1.00" to 6.50" from the ensuing weld centerline, there were two (2) rejectable RT indications and one (1) rejectable MT indication which were subsequently ground out and weld repaired.

A flaw evaluation of the deepest flaw was performed by Structural Integrity Associates, Inc. (see Enclosure 2), in accordance with ASME Code, Section XI, 1986 Edition, and demonstrates that the valves can be returned to service for at least one operating cycle. Based upon our thorough review of the original documentation and radiographs, CP&L has concluded that the five (5) UT indications that have been identified on 1E11-F060A valve, and UT Indication 1 identified in the 1E11-F060B valve, are existing base metal flaws, and are not service induced. In regards to UT Indication 2 in the 1E11-F060B valve, CP&L has concluded that it is a base metal/weld metal acoustic interface signal produced by the extensive base metal repairs in the same area during the manufacturing process, and is also not service induced. Based on the acceptable flaw evaluation and the overwhelming evidence that these indications are not service induced, and thus have no crack growth mechanism, CP&L's position is that the valves can be returned to service without adverse effect to the health and safety of the public for at least one operating cycle. CP&L has also determined that the flawed areas of both valves will be scheduled for reinspection during the next BSEP Unit 1 Refueling Outage.

(2) REPLACEMENT OF REACTOR COOLANT RECIRCULATION AND CORE SPRAY SYSTEM PIPING AND SAFE-ENDS

The replacement of the RCRS and Core Spray System piping and safe-ends was performed by General Electric Company during this refueling outage.

The modification of the RCRS consisted of the replacement of the existing 304 SS risers and Inconel 600 safe-ends with 316NG SS material. In addition to the material change, the new safe-ends were designed to eliminate the thermal sleeve attachment weld and the crevice condition inherent to the old design which was a IGSCC initiation site. The existing Inconel 182 nozzle butter and cladding was removed and replaced with ER309L SS weld material.

The modification of the Core Spray System consisted of the replacement of the existing Inconel 600 safe-ends with 316NG SS material and the replacement of the existing carbon steel transition piece with a new forged carbon steel transition piece. The existing Inconel 182 nozzle butter and cladding was also removed and replaced with ER309L SS weld material.

The replacement materials were selected in accordance with the recommendations of NUREG 0313, Revision. 2. In addition, the replacement SS materials were electropolished and received preoxidation treatments. The welding process used to complete the replacement controlled the heat input in the weld below 1.8 megajoules, which reduces the residual welding stresses and enhances the materials resistance to IGSCC. Further IGSCC mitigation was accomplished by the application of the Mechanical Stress Improvement Process (MSIP) to all replacement welds except the two (2) carbon steel transition piece to carbon steel pipe welds on the Core Spray System. The MSIP was performed by SMC-O'Donnell and Associates, Inc. A pre and post-MSIP ultrasonic examination was performed on all welds which received MSIP with no rejectable indications being observed. As a result of the RCRS and Core Spray System piping and safe-end replacement, thirty-five (35) weld overlay repairs were removed from the NUREG 0313 Inspection Program.

(3) UPDATED CLASSIFICATION OF IGSCC SUSCEPTIBLE WELDS

An updated classification of the BSEP Unit 1 IGSCC susceptible welds is contained in Table 2. The table has been revised to reflect the new welds which are part of the RCRS and Core Spray piping and safe-end replacement, as well as any other required updates. The table has also been revised to reflect the actual weld numbers rather than ISI reference (abbreviated) weld numbers. Table 3 provides a cross-reference for those weld numbers which have cnanged as a result of this revision. Table 4 provides a list of welds that have been replaced or eliminated as a result of the RCRS and Core Spray System piping/safe-end replacement.

(4) CONCLUSION

Carolina Power & Light Company has completed the IGSCC inspections and the replacement of the RCRS discharge risers, safe-ends, and nozzle butter, and the Core Spray transition pieces, safe-ends and nozzle butter.

The Mechanical Stress Improvement Process was successfully applied to thirty (30) RCRS welds, and four (4) Core Spray System welds. Pre and post-MSIP ultrasonic examinations were completed on these thirty-four (34) welds with no rejectable indications observed.

Ultrasonic examinations were performed on eighty-seven (87) welds in IGSCC categories 'A', 'B', 'C', 'D', 'E' and 'G' of NUREG 0313, Revision 2, employing the GE "SMART UT", "SMART 2000", and Manual UT techniques. The scope of examinations were in accordance with Carolina Power & Light Company's approved NUREG 0313 Inspection Program.

Based on the results of the mitigative actions taken and the "state-of-the-art" inspections performed, Carolina Power & Light Company believes that the start-up and continued operation of BSEP Unit 1 until the next refueling outage, currently scheduled for September 1992, is justified and will not adversely affect the health and safety of the public, and Carolina Power & Light Company intends to proceed with the start-up of BSEP Unit 1 as currently scheduled on February 14, 1991.

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1B32RECIRC-22AM3BCA	A	SWEEPOLET	RCRS					
1B32RECIRC-22AM3BCB	A	SWEEPOLET	RCRS					
1B32RECIRC-22AM5BCA	A	SWEEPOLET	RCRS					
1B32RECIRC-22AM5BCB	A	SWEEPOLET	RCRS					
1B32RECIRC-22BM1BCA	A	SWEEPOLET	RCRS					
1B32RECIRC-22BM1BCB	A	SWEEPOLET	RCRS			X		
1B32RECIRC-22BM3BC	A	SWEEPOLET	RCRS		X			
1B32RECIRC-22BM4	A	SWEEPOLET	RCRS					
1B32RECIRC-22BM4BC	A	SWEEPOLET	RCRS					
1B32RECIRC-4A2	A	PIPE/ELBO	RCRS	X				
1B32RECIRC-4A3	A	ELBO/PIPE	RCRS					
1B32RECIRC-4A4	A	PIPE/TEE	RCRS					
1B32RECIRC-4A5	A	TEE/FLG	RCRS					
1B32RECIRC-4A6	A	TEE/VALVE	RCRS					
1B32RECIRC-4A7	A	VALV/PIPE	RCRS					
1B32RECIRC-4A8	A	PIPE/ELBO	RCRS					
1B32RECIRC-4A9	A	ELBO/PIPE	RCRS					
1B32RECIRC-4B2	A	PIPE/ELBO	RCRS					
1B32RECIRC-4B3	A	ELBO/PIPE	RCRS					
1B32RECIRC-4B4	A	PIPE/TEE	RCRS		X			
1B32RECIRC-4B5	A	TEE/FLG	RCRS					
1B32RECIRC-4B6	A	TEE/VALVE	RCRS			X		
1B32RECIRC-4B7	A	VALV/PIPE	RCRS			X		
1B32RECIRC-4B8	A	PIPE/ELBO	RCRS					
1B32RECIRC-4B9	A	ELBO/PIPE	RCRS					

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1G31PC7-1-FWRWCU949A	A	ELBO/PIPE	RWCU					
1G31PC7-1-SWRWCU950	A	PIPE/ELBO	RWCU					
1G31PC1-1-FWRWCUC2A	A	PIPE/VALV	RWCU					
1G31PC2-1-FWRWCUC3A	A	VALV/PIPE	RWCU					
1G31PC2-1-FWRWCU932	A	PIPE/ELBO	RWCU					
1G31PC3-1-SWRWCU933	A	ELBO/PIPE	RWCU					
1G31PC3-1-FWRWCU934	A	PIPE/ELBO	RWCU		X			
1G31PC4-1-SWRWCU935	A	ELBO/PIPE	RWCU					
1G31PC4-1-FWRWCU936A	A	PIPE/ELBO	RWCU					
1G31PC6-1-FWRWCU937A	A	ELBO/PIPE	RWCU					
1G31FF-1-FW1G311110	A	PIPE/ELBO	RWCU	*				
1G31FF-1-FW1G311109	A	ELBO/PIPE	RWCU	*				
1G31FF-1-FW1G311108A	A	PIPE/PIPE	RWCU	*				
1G31FF-1-FW1G311105	A	PIPE/PIPE	RWCU	*				
1G31FF-1-FW1G311092B	A	PIPE/VALV	RWCU	*				
1G31FF-1-FW1G311093	A	VALV/PIPE	RWCU	*		X		
1G31PC8-1-FW1G311094	A	PIPE/VALV	RWCU	*				
1G31-1095A	A	VALV/PIPE	RWCU	*				
1G31-999A	A	PIPE/ELBO	RWCU	*				X
1G31-1000	A	ELBO/PIPE	RWCU					
1G31-1002	A	PIPE/ELBO	RWCU					
1G31-1003	A	ELBO/PIPE	RWCU			X		
1G31-1005	A	PIPE/ELBO	RWCU					
1G31-1006	A	ELBO/PIPE	RWCU					
1G31-1008	A	PIPE/ELBO	RWCU		X			

* DESIGNATES PRESERVICE INSPECTION OF NEW WELD

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1G31-1009	A	ELBO/PIPE	RWCU					
1G31-1010	A	PIPE/ELBO	RWCU	X				
1G31-1011	A	ELBO/PIPE	RWCU				X	
1G31-1012	A	PIPE/TEE	RWCU					
1G31-1013	A	TEE/RED	RWCU					
1G31-1014	A	TEE/RED	RWCU					
1G31-1015	A	RED/PIPE	RWCU					
1G31-1016	A	PIPE/ELBO	RWCU					
1G31-1017	A	ELBO/PIPE	RWCU					
1G31-1018	A	PIPE/VALV	RWCU					
1G31-1019	A	RED/PIPE	RWCU					
1G31-1021	A	PIPE/VALV	RWCU					
1G31-1022	A	VALV/PIPE	RWCU					
1G31-1024	A	PIPE/ELBO	RWCU					
1G31-1025	A	ELBO/PIPE	RWCU	X				
1G31-1026	A	PIPE/ELBO	RWCU					
1G31-1027	A	ELBO/PIPE	RWCU			X		
1G31-1028	A	PIPE/ELBO	RWCU					
1G31-1029	A	PIPE/ELBO	RWCU					X
1G31-987	A	PIPE/TEE	RWCU					
1G31-986	A	TEE/VALV	RWCU					
1G31-988	A	TEE/PIPE	RWCU					
1G31-989	A	PIPE/ELBO	RWCU				X	
1G31-990	A	ELBO/PIPE	RWCU					
1G31-991	A	PIPE/ELBO	RWCU					

TABLE 2
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WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1G31-992	A	ELBO/PIPE	RWCU					
1G31-993	A	PIPE/ELBO	RWCU					
1G31-995	A	ELBO/PIPE	RWCU					
1G31-996	A	PIPE/FLNG	RWCU					
1G31-997	A	FLNG/PIPE	RWCU					
1G31-980	A	PIPE/ELBO	RWCU					
1G31-981	A	ELBO/ELBO	RWCU					
1G31-983	A	ELBO/ELBO	RWCU					
1G31-984	A	ELBO/PIPE	RWCU					
1G31-985	A	PIPE/EXCH	RWCU					
1RWCU-90A	A	EXCH/ELBO	RWCU					
1RWCU-145	A	ELBO/PIPE	RWCU					
1RWCU-150	A	PIPE/ELBO	RWCU		X			
1RWCU-96A	A	ELBO/EXCH	RWCU					
1G31-1032	A	ELBO/PIPE	RWCU					
1G31-1033	A	PIPE/ELBO	RWCU	X				
1G31-1034	A	ELBO/ELBO	RWCU					
1G31-1035	A	ELBO/PIPE	RWCU					
1G31-1036	A	PIPE/ELBO	RWCU					
1G31-1037	A	ELBO/ELBO	RWCU		X			
1G31-1038	A	ELBO/PIPE	RWCU					
1G31-1040	A	PIPE/ELBO	RWCU					
1G31-1041	A	ELBO/PIPE	RWCU					
1G31-1042	A	PIPE/ELBO	RWCU				X	
1G31-1043	A	ELBO/PIPE	RWCU					

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1G31-1044	A	PIPE/FLNG	RWCU					
1G31-1055	A	FLNG/PIPE	RWCU					
1G31-1056	A	PIPE/ELBO	RWCU					X
1G31-1057A	A	ELBO/PIPE	RWCU					
1G31-1058	A	PIPE/ELBO	RWCU					X
1G31-1059	A	ELBO/PIPE	RWCU					
1G31-1061	A	PIPE/ELBO	RWCU				X	
1G31-1062	A	ELBO/PIPE	RWCU			X		
1G31-1063	A	PIPE/ELBO	RWCU					
1G31-1064	A	ELBO/PIPE	RWCU					
1G31-1065	A	PIPE/ELBO	RWCU					
1G31-1066	A	ELBO/PIPE	RWCU		X			
1G31-1067	A	PIPE/ELBO	RWCU					
1G31-1068	A	ELBO/PIPE	RWCU					
1G31-1069	A	PIPE/ELBO	RWCU					
1G31-1070	A	ELBO/PIPE	RWCU					
1G31-1072	A	PIPE/ELBO	RWCU					
1G31-1073	A	ELBO/PIPE	RWCU					
1G31-1074	A	PIPE/ELBO	RWCU					
1G31-1075	A	ELBO/PIPE	RWCU					
1G31-1076	A	PIPE/ELBO	RWCU					
1G31-1077	A	ELBO/PIPE	RWCU	X				
1G31-34C	A	PIPE/VALV	RWCU					
1RWCU-675B	A	EXCH/ELBO	RWCU					
1G31FF-14-FWRWCUB4B	A	VALV/PIPE	RWCU	X				

TABLE 2
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WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1G31FF-14-FWRWCUB3B	A	PIPE/VALV	RWCU	X		X		
1B32FFA-12-FW701	A	PIPE/SE	RCRS	*				
1B32FFB-12-FW702	A	PIPE/SE	RCRS	*				
1B32FFC-12-FW703	A	PIPE/SE	RCRS	*				
1B32FFD-12-FW704	A	PIPE/SE	RCRS	*				
1B32FFE-12-FW705	A	PIPE/SE	RCRS	*				
1B32FFF-12-FW706	A	PIPE/SE	RCRS	*			X	
1B32FFG-12-FW707	A	PIPE/SE	RCRS	*				
1B32FFH-12-FW708	A	PIPE/SE	RCRS	*				
1B32FFJ-12-FW709	A	PIPE/SE	RCRS	*				
1B32FFK-12-FW710	A	PIPE/SE	RCRS	*				
1B11N2A-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2B-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2C-RPV-FWABA	A	SE/NOZZLE	RCRS	*		(X)		
1B11N2D-RPV-FWABA	A	SE/NOZZLE	RCRS	*		(X)		
1B11N2E-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2F-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2G-RPV-FWABA	A	SE/NOZZLE	RCRS	*		(X)		
1B11N2H-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2J-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N2K-RPV-FWABA	A	SE/NOZZLE	RCRS	*			(X)	
1B11N5A-RPV-FWRNA-16A	A	SE/NOZZLE	CS	*		(X)		
1B11N5B-RPV-FWRN[illegible]-16A	A	SE/NOZZLE	CS	*			(X)	
1E21FF-4-FW1E2180	A	TRANS/SE	CS	*		(X)		
1E21FF-8-FW1E2183	A	TRANS/SE	CS	*			(X)	

* DESIGNATES PRESERVICE INSPECTION OF NEW WELD
(X) DESIGNATES SECTION XI INSPECTION OF WELD THAT WILL ALSO MEET THE REQUIREMENTS OF NUREG 0313, REV 2.

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1B32FFA-12-FWRRB10A	B	SWPL/PIPE	RCRS	*				
1B32FFB-12-FWRRB11A	B	SWPL/PIPE	RCRS	*				
1B32FFC-12-FWRRB12A	B	SWPL/PIPE	RCRS	*		(X)		
1B32FFD-12-FWRRB13A	B	SWPL/PIPE	RCRS	*		(X)		
1B32FFE-12-FWRRB14A	B	SWPL/PIPE	RCRS	*				
1B32FFF-12-FWRRA10A	B	SWPL/PIPE	RCRS	*				
1B32FFG-12-FWRRA11A	B	SWPL/PIPE	RCRS	*				
1B32FFH-12-FWRRA12A	B	SWPL/PIPE	RCRS	*				
1B32FFJ-12-FWRRA13A	B	SWPL/PIPE	RCRS	*			(X)	
1B32FFK-12-FWRRA14A	B	SWPL/PIPE	RCRS	*				
1B32RECIRC-28A2(IHSI)	C	PIPE/SE	RCRS					X
1B32RECIRC-28A3(IHSI)	C	PIPE/ELBO	RCRS	X				
1B32RECIRC-28A5(IHSI)	C	PIPE/TEE	RCRS					X
1B32RECIRC-28A6(IHSI)	C	TEE/PIPE	RCRS			X		
1B32RECIRC-28A9(IHSI)	C	VALV/PIPE	RCRS		X			
1B32RECIRC-28A10(IHSI)	C	PIPE/ELBO	RCRS			X		
1B32RECIRC-28A11(IHSI)	C	ELBO/PUMP	RCRS					X
1B32RECIRC-28A12(IHSI)	C	PUMP/PIPE	RCRS		X			
1B32RECIRC-28A13(IHSI)	C	PIPE/VALV	RCRS					X
1B32RECIRC-28A16(IHSI)	C	PIPE/TEE	RCRS	X				
1B32RECIRC-28A17(IHSI)	C	TEE/CROSS	RCRS	X				
1B32RECIRC-28A18(IHSI)	C	CROSS/RED	RCRS	X				
1B32RD2B2-84-FWB33(IHSI)	C	TEE/VALV	RCRS	X				

* DESIGNATES PRESERVICE INSPECTION OF NEW WELD
(X) DESIGNATES SECTION XI INSPECTION OF WELD THAT WILL ALSO MEET THE REQUIREMENTS OF NUREG 0313, REV 2.

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1B32RECIRC-28B2(IHSI)	C	PIPE/SE	RCRS					
1B32RECIRC-28B3(IHSI)	C	PIPE/ELBO	RCRS					
1B32RECIRC-28B5(IHSI)	C	PIPE/PIPE	RCRS	X	X			
1B32RECIRC-28B9(IHSI)	C	VALV/PIPE	RCRS					
1B32RECIRC-28B10(IHSI)	C	PIPE/ELBO	RCRS		X			
1B32RECIRC-28B11(IHSI)	C	ELBO/PUMP	RCRS		X			
1B32RECIRC-28B12(IHSI)	C	PUMP/PIPE	RCRS				X	
1B32RECIRC-28B13(IHSI)	C	PIPE/VALV	RCRS				X	
1B32RECIRC-28B14(IHSI)	C	VALV/ELBO	RCRS			X		
1B32RECIRC-28B15(IHSI)	C	ELBO/PIPE	RCRS			X		
1B32RECIRC-28B16(IHSI)	C	PIPE/TEE	RCRS					X
1B32RECIRC-28B17(IHSI)	C	TEE/CROSS	RCRS		X			
1B32RECIRC-28B18(IHSI)	C	CROSS/RED	RCRS			X		
1B32RD2A2-87-FWA32(IHSI)	C	TEE/VALV	RCRS	X		X		
1B32RECIRC-22AM1(IHSI)	C	VALV/PIPE	RCRS				X	
1B32RECIRC-22AM2(IHSI)	C	PIPE/VALV	RCRS					X
1B32RECIRC-22AM4(IHSI)	C	PIPE/CRSS	RCRS					
1B32RECIRC-22AM5(IHSI)	C	CRSS/PIPE	RCRS	X				
1B32RECIRC-22AM6(IHSI)	C	PIPE/CAP	RCRS				X	
1B32RECIRC-22BM1(IHSI)	C	CAP/PIPE	RCRS					
1B32RECIRC-22BM2(IHSI)	C	PIPE/CRSS	RCRS			X		
1B32RECIRC-22BM3(IHSI)	C	CRSS/PIPE	RCRS		X			
1B32RECIRC-22BM5(IHSI)	C	PIPE/VALV	RCRS					X
1B32RS2B2-10-FWB39(IHSI)	C	TEE/PIPE	RCRS					X
1E1110-1-10-FWRHRC1(IHSI)	C	PIPE/VALV	RHR	X				

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATIONS

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1B32RECIRC-28A1(MSIP)	C	NOZZLE/SE	RCRS	X				X
1B32RECIRC-28B1(MSIP)	C	NOZZLE/SE	RCRS		X			
1B11N8A-RPV-SWAB(MSIP)	C	NOZZLE/SE	JPI		X			
1B11N8B-RPV-SWAB(MSIP)	C	NOZZLE/SE	JPI	X		X		
1B32RECIRC-28A7(IHSI)	D	PIPE/ELBO	RCRS	X		X		X
1B32RECIRC-28B6(IHSI)	D	PIPE/TEE	RCRS	X		X		X
1B32RECIRC-28B7(IHSI)	D	PIPE/ELBO	RCRS	X		X		X
1B32RECIRC-28A9BC1	D	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-28A12BC	D	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-28A15BC1	D	WOL/PIPE	RCRS		X		X	
1B32RECIRC-28B9BC	D	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-28B12BC	D	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-28B15BC	D	WOL/PIPE	RCRS	X		X		X
1E1110-1-10-SWA	D	PIPE/WOL	RHR	X		X		X
1G31PCI-1-FWRWCUC1A	D	WOL/PIPE	RWCU	X		X		X
1G3115-1-15-FWRWCUB2A	D	VALV/PIPE	RWCU	X			X	
12B11N8A-JPI-FWRI22-1	D	SE/PNSEAL	JPI		X		X	
12B11N8B-JPI-FWRI22-2	D	SE/PNSEAL	JPI	X		X		X
1B21N4A-2-FWN4A45-3	D	EXT/SE	FW	X		X		X
1B21N4A-2-SW1-2	D	SE/SE.EXT	FW		X		X	
1B21N4A-2-SW2-3	D	TRANS/EXT	FW		X		X	
1B21N4B-3-FWN4B135-3	D	EXT/SE	FW	X	X		X	
1B21N4B-3-SW1-2	D	SE/SE.EXT	FW	X	X		X	

TABLE 2
BSEP UNIT 1 - IGSCC INSPECTION CLASSIFICATION

WELD NUMBER	IGSCC CATEGORY	JOINT CONFIG.	SYS	SCHEDULED INSPECTIONS				
				RFO 7	RFO 8	RFO 9	RFO10	RFO11
1B21N4B-3-SW2-3	D	TRANS/EXT	FW	X	X		X	
1B21N4C-6-FWN4C225-3	D	EXT/SE	FW	X		X		X
1B21N4C-6-SW1-2	D	SE/SE.EXT	FW	X		X		X
1B21N4C-6-SW2-3	D	TRANS/EXT	FW	X		X		X
1B21N4D-5-FWN4D315-3	D	EXT/SE	FW	X		X		X
1B21N4D-5-SW2-3	D	TRANS/EXT	FW		X		X	
1B32RECIRC-28A4(O'LAY)	E	ELBO/PIPE	RCRS	X		X		X
1B32RECIRC-28A14(O'LAY)	E	VALV/ELBO	RCRS		X		X	
1B32RECIRC-28A15(O'LAY)	E	ELBO/PIPE	RCRS	X		X		X
1B32RECIRC-28B4(O'LAY)	E	ELBO/PIPE	RCRS	X		X		X
1B32RECIRC-28B8(O'LAY)	E	ELBO/VALV	RCRS		X		X	
1B32RECIRC-22AM3(O'LAY)	E	VALV/PIPE	RCRS		X		X	
1B32RECIRC-4A1(O'LAY)	E	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-4A10(O'LAY)	E	PIPE/WOL	RCRS		X		X	
1B32RECIRC-4B1(O'LAY)	E	WOL/PIPE	RCRS	X		X		X
1B32RECIRC-4B10(O'LAY)	E	PIPE/WOL	RCRS		X		X	
1B32RECIRC-28A8(IHSI)	E	ELBO/VALV	RCRS		X		X	
1B21N4D-5-SW1-2	G	SE/SE.EXT	FW	X	X	X	X	X

TABLE 3
IGSCC SUSCEPTIBLE WELD NUMBER CROSS REFFRENCE

"OLD" ISI REF. NO.	"NEW" WELD NUMBER	"OLD" ISI REF. NO.	"NEW" WELD NUMBER
22AM3BCA	1B32RECIRC-22AM3BCA	28A9	1B32RECIRC-28A9
22AM3BCB	1B32RECIRC-22AM3BCB	28A10	1B32RECIRC-28A10
22AM5BCA	1B32RECIRC-22AM5BCA	28A11	1B32RECIRC-28A11
22AM5BCB	1B32RECIRC-22AM5BCB	28A12	1B32RECIRC-28A12
22BM1BCA	1B32RECIRC-22BM1BCA	28A13	1B32RECIRC-28A13
22BM1BCB	1B32RECIRC-22BM1BCB	28A16	1B32RECIRC-28A16
22BM3BC	1B32RECIRC-22BM3BC	28A17	1B32RECIRC-28A17
22BM4	1B32RECIRC-22BM4	28A18	1B32RECIRC-28A18
22BM4BC	1B32RECIRC-22BM4BC	24A12	1B32RD2B2-84-FWB33
4A2	1B32RECIRC-4A2	28B2	1B32RECIRC-28B2
4A3	1B32RECIRC-4A3	28B3	1B32RECIRC-28B3
4A4	1B32RECIRC-4A4	28B5	1B32RECIRC-28B5
4A5	1B32RECIRC-4A5	28B9	1B32RECIRC-28B9
4A6	1B32RECIRC-4A6	28B10	1B32RECIRC-28B10
4A7	1B32RECIRC-4A7	28B11	1B32RECIRC-28B11
4A8	1B32RECIRC-4A8	28B12	1B32RECIRC-28B12
4A9	1B32RECIRC-4A9	28B13	1B32RECIRC-28B13
4B2	1B32RECIRC-4B2	28B14	1B32RECIRC-28B14
4B3	1B32RECIRC-4B3	28B15	1B32RECIRC-28B15
4B4	1B32RECIRC-4B4	28B16	1B32RECIRC-28B16
4B5	1B32RECIRC-4B5	28B17	1B32RECIRC-28B17
4B6	1B32RECIRC-4B6	28B18	1B32RECIRC-28B18
4B7	1B32RECIRC-4B7	24B13	1B32RD2A2-87-FWA33
4B8	1B32RECIRC-4B8	22AM1	1B32RECIRC-22AM1
4B9	1B32RECIRC-4B9	22AM2	1B32RECIRC-22AM2
1RWCU-949A	1G31PC7-1-FWRWCU949A	22AM4	1B32RECIRC-22AM4
1RWCU-950	1G31PC7-1-SWRWCU950	22AM5	1B32RECIRC-22AM5
1RWCU-C2A	1G31PC1-1-FWRWCUC2A	22AM6	1B32RECIRC-22AM6
1RWCU-C3A	1G31PC2-1-FWRWCUC3A	22BM1	1B32RECIRC-22BM1
1RWCU-932	1G31PC2-1-FWRWCU932	22BM2	1B32RECIRC-22BM2
1RWCU-933	1G31PC3-1-SWRWCU933	22BM3	1B32RECIRC-22BM3
1RWCU-934	1G31PC3-1-FWRWCU934	22BM5	1B32RECIRC-22BM5
1RWCU-935	1G31PC4-1-SWRWCU935	20A1	1B32RS2B2-10-FWB39
1RWCU-936A	1G31PC4-1-FWRWCU936A	20A2	1E1110-1-10-FWRHRC1
1RWCU-937A	1G31PC6-1-FWRWCU937A	28A1	1B32RECIRC-28A1
1RWCU-1110	1G31FF-1-FW1G311110	28B1	1B32RECIRC-28B1
1RWCU-1109	1G31FF-1-FW1G311109	4N8A	1B11N8A-RPV-SWAB
1RWCU-1108A	1G31FF-1-FW1G311108A	4N8B	1B11N8B-RPV-SWAB
1RWCU-1092B	1G31FF-1-FW1G311092B	28A7	1B32RECIRC-28A7
1RWCU-1093	1G31FF-1-FW1G311093	28B6	1B32RECIRC-28B6
1RWCU-1094	1G31PC8-1-FW1G311094	28B7	1B32RECIRC-28B7
1RWCU-1095A	1G31-1095A	28A9BC1	1B32RECIRC-28A9BC1
1RWCU-B4B	1G31FF-14-FWRWCUB4B	28A12BC	1B32RECIRC-28A12BC
1RWCU-B3B	1G31FF-14-FWRWCUB3B	28A15BC1	1B32RECIRC-28A15BC1
28A2	1B32RECIRC-28A2	28B9BC	1B32RECIRC-28B9BC
28A3	1B32RECIRC-28A3	28B12BC	1B32RECIRC-28B12BC
28A5	1B32RECIRC-28A5	28B15BC	1B32RECIRC-28B15BC
28A6	1B32RECIRC-28A6	20A1BC	1E1110-1-10-SWA

TABLE 3
IGSCC SUSCEPTIBLE WELD NUMBER CROSS REFERENCE

"OLD" ISI REF. NO.	"NEW" WELD NUMBER	"OLD" ISI REF. NO.	"NEW" WELD NUMBER
1RWCU-C1A	1G31PC1-1-FWRWCUC1A	28B4	1B32RECIRC-28B4
1G31-B2A	1G3115-1-15-FWRWCUB2A	28B8	1B32RECIRC-28B8
JPI-22-1	12B11N8B-JPI-FWRI22-1	22AM3	1B32RECIRC-22AM3
JPI-22-2	12B11N8B-JPI-FWRI22-2	4A1	1B32RECIRC-4A1
28A4	1B32RECIRC-28A4	4A10	1B32RECIRC-4A10
28A14	1B32RECIRC-28A14	4B1	1B32RECIRC-4B1
28A15	1B32RECIRC-28A15	4B10	1B32RECIRC-4B10
28A8	1B32RECIRC-28A8		

TABLE 4
IGSCC SUSCEPTIBLE WELDS REPLACED/ELIMINATED BY RCRS AND CORE SPRAY PIPING/SAFE END REPLACEMENT

12ARA1*	12ARE1*	12BRJ1*
12ARA2	12ARE2	12BRJ2
12ARA3	12ARE3	12BRJ3
12ARA4	12ARE4	12BRJ4
12ARA5*	12ARE5*	12BRJ5*
12ARA6*	12ARE6*	12BRJ6*
12ARB1*	12BRF1*	12BRK1*
12ARB2	12BRF2	12BRK2
12ARB3	12BRF3	12BRK3
12ARB4	12BRF4	12BRK4
12ARB5*	12BRF5*	12BRK5*
12ARB6*	12BRF6*	12BRK6*
12ARC1*	12BRG1*	1B11N5A-RPV-FWRNA16*
12ARC2	12BRG2	1E21FF-4-FWRNA18*
12ARC3	12BRG3	1E21FF-4-FW1CS15*
12ARC4	12BRG4	1B11N5B-RPV-FWRNB16*
12ARC5*	12BRG5*	1E21FF-8-FWRNB18*
12ARC6*	12BRG6*	1E21FF-8-FW1CS31*
12ARD1*	12BRH1*	
12ARD2	12BRH2	
12ARD3	12BRH3	
12ARD4	12BRH4	
12ARD5*	12BRH5*	
12ARD6*	12BRH6*	

* WELDS REPLACED AS PART OF THE RCRS/CORE SPRAY REPLACEMENT (REMAINING WELDS WERE ELIMINATED)

ENCLOSURE 3
BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 1
NRC DOCKET 50-325 / LICENSE NO. DPR-71
IGSCC INSPECTION RESULTS - REFUELING OUTAGE 7

Non-Proprietary

ANALYSIS REPORTS - STRUCTURAL INTEGRITY ASSOCIATES, INC.

per Dale Bate of CP&L 1/29/91 to Tde of NRC

SIR-90-003 - "Redesign of Area Between the RHR System Return Valves and Reactor Recirculation System Tees," dated January 12, 1990

RAM-91-004 - "Redesign of Area Between the RHR System Return Valves and Reactor Recirculation System Tees - As-Built Reconciliation for Unit 1," dated January 14, 1991

SIR-91-003 - "Evaluation of Flaw Indications in RHR Valves F060A and F060B - Brunswick Steam Electric Plant, Unit 1," dated January 21, 1991

ATTACHMENT 2

STRUCTURAL INTEGRITY ASSOCIATES, INC.

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Fossil Plant Operations
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January 12, 1990
RAM-90-004
SIR-90-003, Rev. 0

Mr. Terry Pitchford
Carolina Power & Light Company
Brunswick Steam Electric Plant
Leonard Street Extension
Southport, NC 28461

Subject: Redesign of Area Between the RHR System Return Valves and Reactor Recirculation System Tees

References:
1. "Design Report - Recirculation Piping - Loop A and B - B31.1 Power Piping Code", General Electric Company, Revision 0, October 1, 1985.
2. Carolina Power & Light Company Drawing No. 0-FP-06014, Revision A, January 18, 1989.
3. USAS B16.5-1968, "Steel Pipe Flanges and Flanged Fittings", USA Standard.
4. ASA B16.10-1957, "Face-to-Face and End-to-End Dimensions of Ferrous Valves", American Standard.
5. ASME Boiler and Pressure Vessel Code, Section III, 1986 Edition.
6. ANSI B16.34-1981, "Valves - Flanged and Buttwelding End", American National Standard.

Dear Terry:

Carolina Power & Light Company (CP&L) is undertaking more extensive in-service inspection of the reactor recirculation (RR) and residual heat removal (RHR) systems at the Brunswick Steam Electric Plant, Unit 2, in order to comply with the requirements of U.S. NRC NUREG-0313, Revision 2. In order to ultrasonically (UT) examine the weld between the reactor recirculation system tees and the residual heat removal system return valves, the valve bodies must be reduced in thickness at the weld location in order to provide at least a 2-1/2 inch "flat" land for manipulating the transducer. Structural Integrity Associates (SI) was contracted by CP&L to provide the technical justification for reducing the valve body thickness at this location.

The General Electric Company (GE) performed a reanalysis of the RR system in 1985, and documented their results in the Reference 1 Design Report. Although the purpose of the GE Design Report

was to qualify the RR system, it also provided stress information at the location currently being evaluated. Per Figure 14 [1], nodes 769 and 509 (Loops A and B) are of interest herein. Pages 234 and 283 [1] report the maximum stress ratio (i.e., computed stress/allowable stress) for all reported load combinations of 0.511, with a modeled thickness of 1.388 inches. Therefore, if a wall thickness of 1.388 inches is maintained, modification of the GE Design Report is not required.

Drawing number 0-FP-06014 [2] provides a general arrangement of the valves to be examined. Per note number 1, they were designed to B16.5 [3]. Since the Reference 2 drawing was initially issued in 1971, the 1968 version of the standard is the "Code-of-record". Reference 3 further references B16.10-1957 [4] for face-to-face and end-to-end dimensions. These two documents, therefore, form the basis for the original design of the valves.

Per Reference 3, Table 27, the minimum thickness required is 2.28 inches for the 24 inch 900 pound gate valves. This is confirmed per the Reference 2 drawing, that states "2-1/2 min. wall (2.280 min. wall USAS B16.5)". Per Reference 4, Table 5, the standard end-to-end dimension is 61 inches, or 30.5 inches from the centerline of the valve to the edge of the weld preparation. The geometry of the weld preparation is governed by Figure 10 of Reference 3 (included here as attached Figure 1).

Reviewing the drawing for the subject valves, however, indicates that the actual end-to-end dimension is 59 inches. It is not clear from this review what the original basis was for this exception to the design Code. However, at this time, the current standards governing valve design can be applied to determine a less restrictive length requirement. The 1986 version of Section III of the ASME Boiler and Pressure Vessel Code was chosen [5]. The design for the valve body is as follows:

- Per NB-3512.1, "Standard Design Rules" are contained in NB-3530 through NB-3550.
- NB-3542 references B16.34 [6] for minimum body thickness. This standard requires a minimum thickness of 2.28 inches.
- NB-3544.8 provides weld transition and contour requirements similar to those required in Reference 3, but does not provide specific requirements on end-to-end dimensions.
- NB-3545 provides limits on primary and secondary stress to ensure that basic ASME Section III safety margins are maintained.

- Primary membrane stresses are limited by the body-neck crotch region, which is stated to be the most highly stressed portion of the valve body under internal pressure. The only effect of thickness reduction at the weld joint on this stress limit is whether the "area" in the pressure area method used to calculate crotch general primary membrane stress has been reduced. Per NB-3545.1(a)(3) and Figure NB-3545.1(a)-1 (included here as Figure 2),

$$L_A = 0.5d - T_b = 9.16"$$

where: L_A = the reinforcement limit along the valve body from the outside surface of the neck

$d \cong 24"$

$T_b \cong 2.84"$ (average)

- Per the attached as-built sketch (Figure 3), the length of full thickness valve wall available for "L_A" equals 2-9/16" + 9" + 0.5", or 12-1/16". Therefore, 2-1/2" can be removed in order to provide a flat land for UT inspection, without violating the above L_A requirement.

- Concerns regarding secondary stresses are again focused in the crotch region. There is no apparent effect of valve end-to-end length or thickness of the weld ends in these calculations. Therefore, the modification described herein will have no effect on secondary stresses or the associated fatigue evaluation.

It is, therefore, acceptable to machine the valve body per the attached Figure 4, provided that a minimum length of 9.5 inches is maintained from the outside diameter of the neck to the top of the transition contour.

If you have any questions on the information contained in this letter report, please do not hesitate to contact us.

Very truly yours,

R. A. Mattson

Reviewed by:

P. C. Riccardella

Approved by:

A. J. Giannuzzi
Project Manager

/mc

cc: CPL-09Q Project File

Figure 1

WELDING ENDS

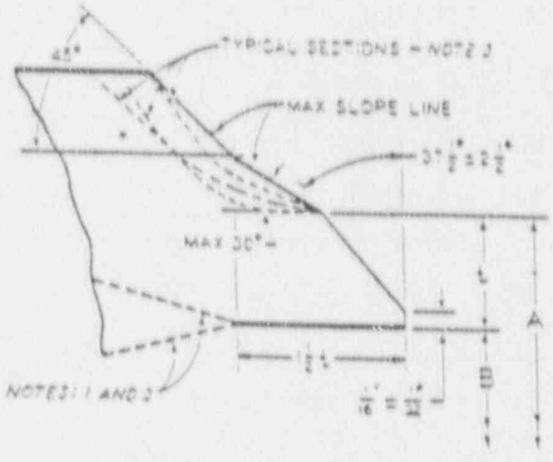


FIG. 9 FOR WALL THICKNESS (t) 3/16 TO 3/4 IN., INCLUSIVE, INSIDE CONTOUR FOR USE WITH SPLIT BACKING RING OR WITHOUT BACKING RING

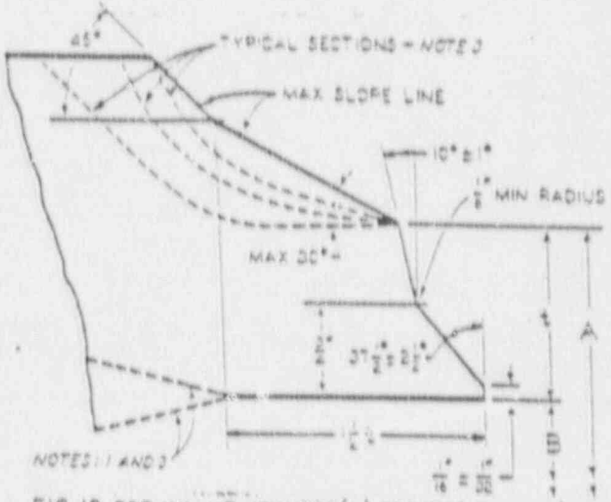


FIG. 10 FOR WALL THICKNESS (t) GREATER THAN 3/4 IN., INSIDE CONTOUR FOR USE WITH SPLIT BACKING RING OR WITHOUT BACKING RING

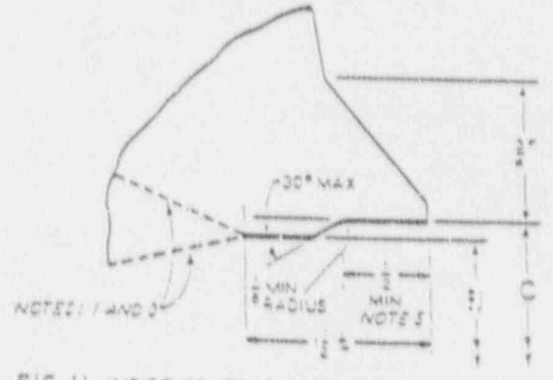


FIG. 11 INSIDE CONTOUR FOR USE WITH RECTANGULAR BACKING RING

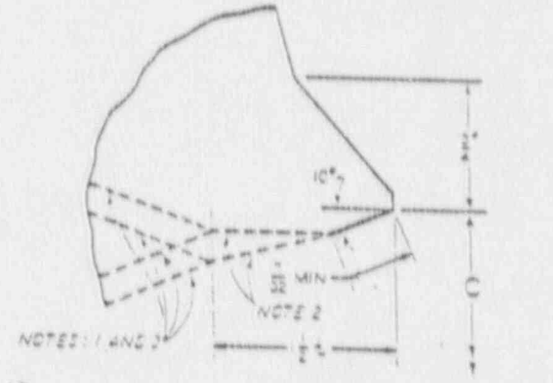


FIG. 12 INSIDE CONTOUR FOR USE WITH TAPER BACKING RING

A = Nominal outside diameter of welding end.
B = Nominal inside diameter of pipe.
C = A + 0.031 + 1.751 + 0.010
t = Nominal wall thickness of pipe.
0.031 = Minus tolerance on OD of pipe to ASTM Specification A 106, etc.
1.75 = Minimum wall of 87 1/2% of nominal wall (permitted by ASTM Specification A 106, etc.) multiplied by two to convert into terms of diameter.
0.010 = Plus tolerance on diameter C (See Par. 7.4.3)

Note 1 Runout of a machined surface to inside diameter of valve to have no abrupt change in section. Inside diameter of valve may be either larger or smaller than pipe inside diameter.

Note 2 The outside and inside of ends of valves shall be extended back in any manner within the maximum and minimum slope lines indicated. The transition shall be a shape avoiding sharp re-entrant angles and abrupt changes in slope. The profile of the outside contour shall be as furnished by the manufacturer provided above conditions are met.

Note 4 See Par. 6.6 and 7.4 for details and tolerances.

Note 5 ½ in. depth based on use of ¼ in. wide backing ring.

Note 6 See Fig. 13 and 14 for welding end details of welding neck flanges.

Note 7 For dimensions see Table 11.

FIGURE 1

(CONCLUDED)

WELDING ENDS

Table 11 (Cont'd) Dimensions of Welding Ends (See Figures 9 to 14 inclusive)

1	2	3	4	5	6	7
Nominal Pipe Size	Schedule No.	A		B[1]	C[1,3]	t[3]
		Welding Neck Flanges[2,4]	Welding End Valves[2,4]			
14	STD	14.000	14 1/4	13.250	13.303	0.375
	40			13.124	13.192	0.438
	XS			13.000	13.084	0.500
	60			12.814	12.921	0.593
	80			12.500	12.646	0.750
	100			12.126	12.319	0.937
	120			11.814	12.046	1.093
	140			11.500	11.771	1.250
	160			11.188	11.498	1.406
16	STD	16.000	16 1/4	15.250	15.303	0.375
	40			15.000	15.084	0.500
	60			14.688	14.811	0.656
	80			14.314	14.484	0.843
	100			13.938	14.155	1.031
	120			13.564	13.827	1.218
	140			13.124	13.442	1.438
	160			12.814	13.171	1.593
18	STD	18.000	18 9/32	17.250	17.303	0.375
	XS			17.000	17.084	0.500
	40			16.876	16.975	0.562
	60			16.500	16.646	0.750
	80			16.126	16.319	0.937
	100			15.688	15.936	1.156
	120			15.250	15.553	1.375
	140			14.876	15.225	1.562
	160			14.438	14.842	1.781
20	STD	20.000	20 5/16	19.250	19.303	0.375
	XS			19.000	19.084	0.500
	40			18.814	18.921	0.593
	60			18.376	18.538	0.812
	80			17.938	18.155	1.031
	100			17.438	17.717	1.281
	120			17.000	17.334	1.500
	140			16.500	16.806	1.750
	160			16.064	16.535	1.968
24	STD	24.000	24 3/8	23.250	23.303	0.375
	XS			23.000	23.084	0.500
	30			22.876	22.975	0.562
	40			22.626	22.757	0.687
	60			22.064	22.265	0.968
	80			21.564	21.827	1.218
	100			20.938	21.280	1.531
	120			20.376	20.788	1.812
	140			19.876	20.350	2.062
	160			19.314	19.859	2.343

[1] All dimensions given in inches.

Designations per Appendix B and C and USAS B36.10

STD = Standard Wall Thickness
XS = Extra Strong Wall Thickness
XXS = Double Extra Strong Wall Thickness

[2] For tolerances see Par. 7.4

[3] It should be recognized that there is no fixed relation between B16.5 pressure classes and pipe schedules. Most pressure classes of valves can be machined to match any one of several schedules of pipe, but not all the schedules that are known in this tabulation. For unusual cases individual manufacturers must be consulted to determine whether sufficient material is available for all dimensions on the inside of the product.

[4] When the thickness of the welding end of a valve or flange is greater than that of the pipe and the additional thickness increases the outside diameter, a taper weld having a slope not exceeding 3 to 1 may be employed or, alternatively, the greater outside diameter may be tapered, at the same maximum slope or less, from a point on the welding bevel equal to the OD of the mating pipe. Similarly, when the greater thickness is provided on the inside of the valve or flange, it shall be tapered from the welding end at a slope not exceeding 3 to 1.

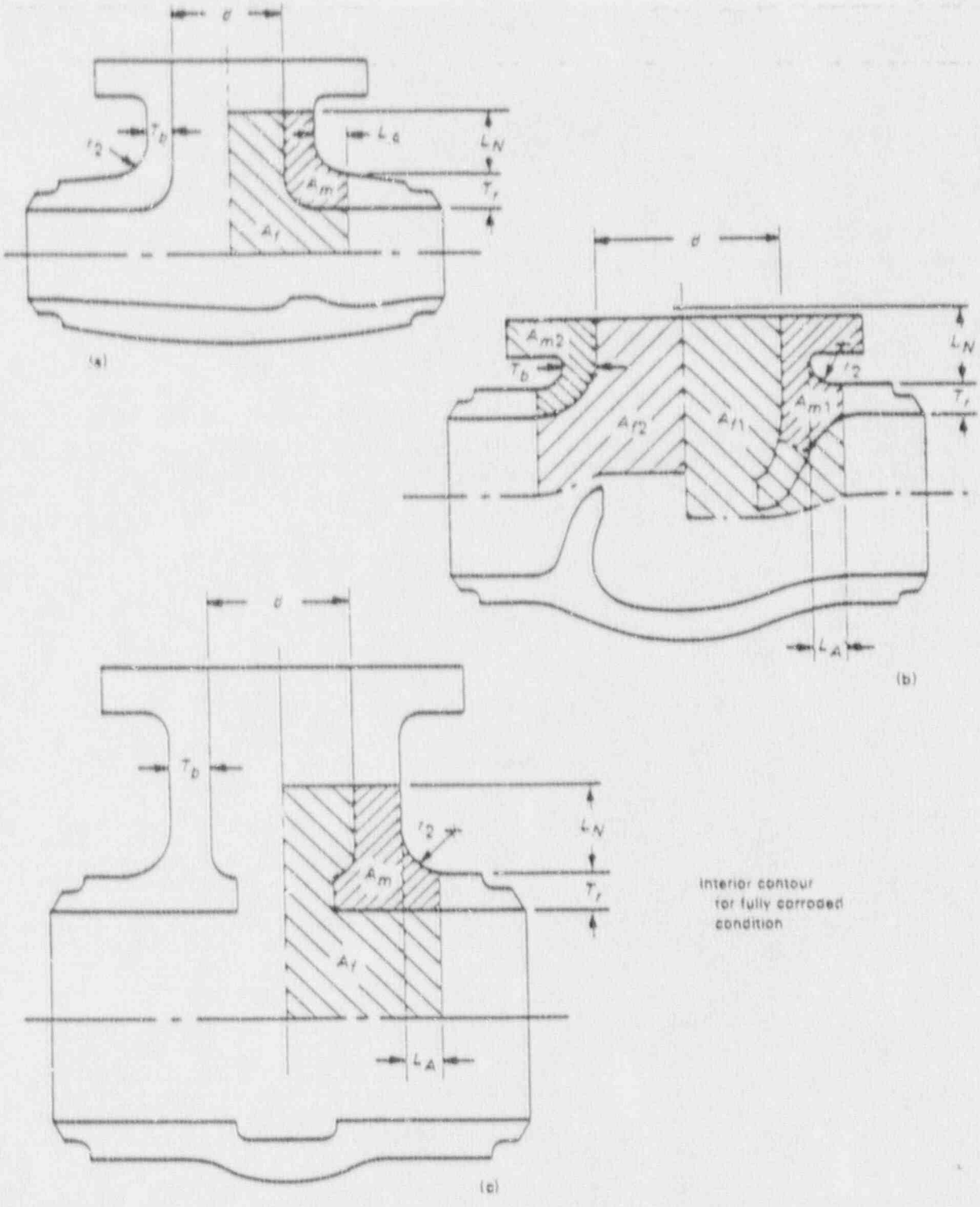
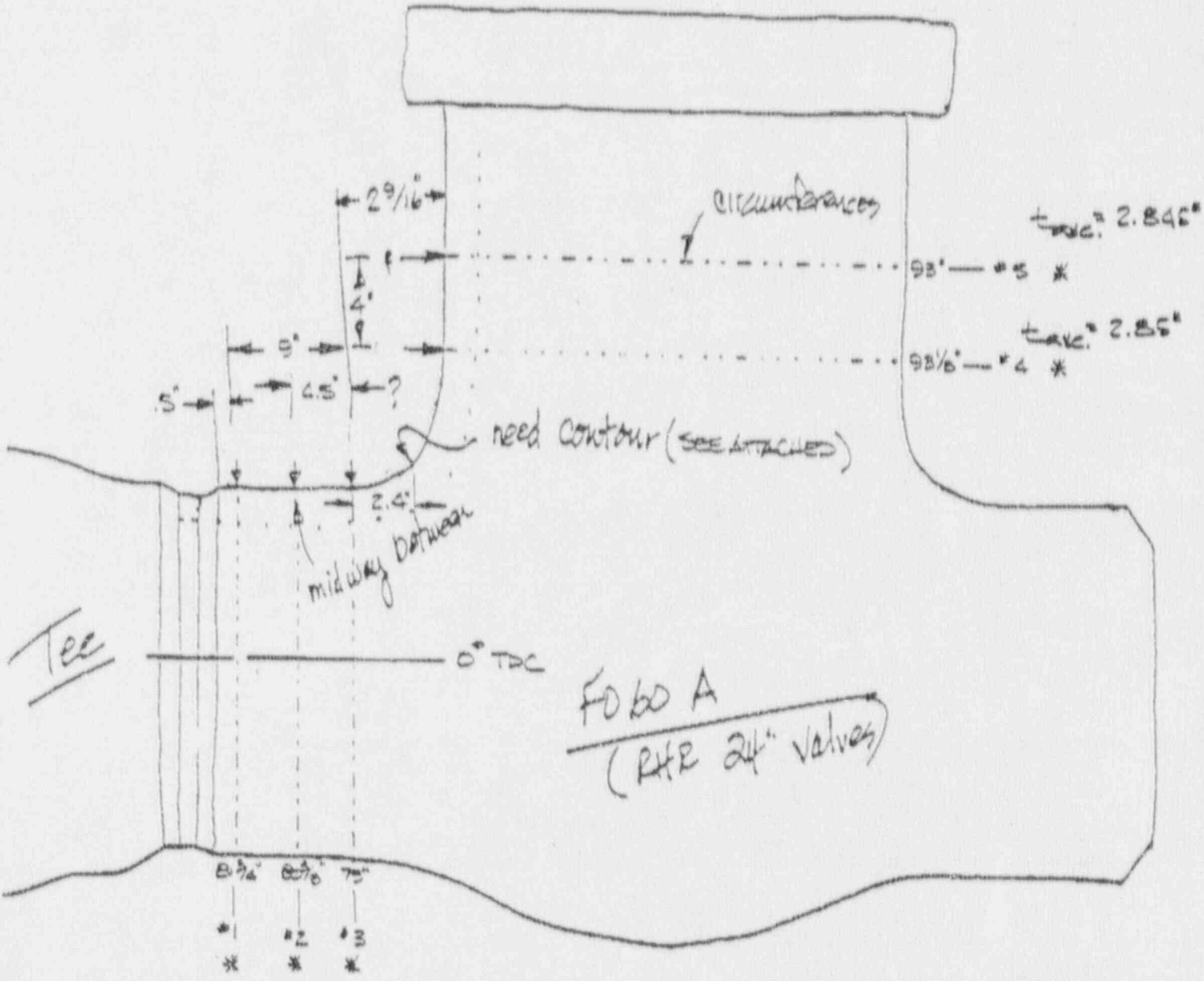


FIG. NB-3545.1(a)-1 PRESSURE AREA METHOD

Flow

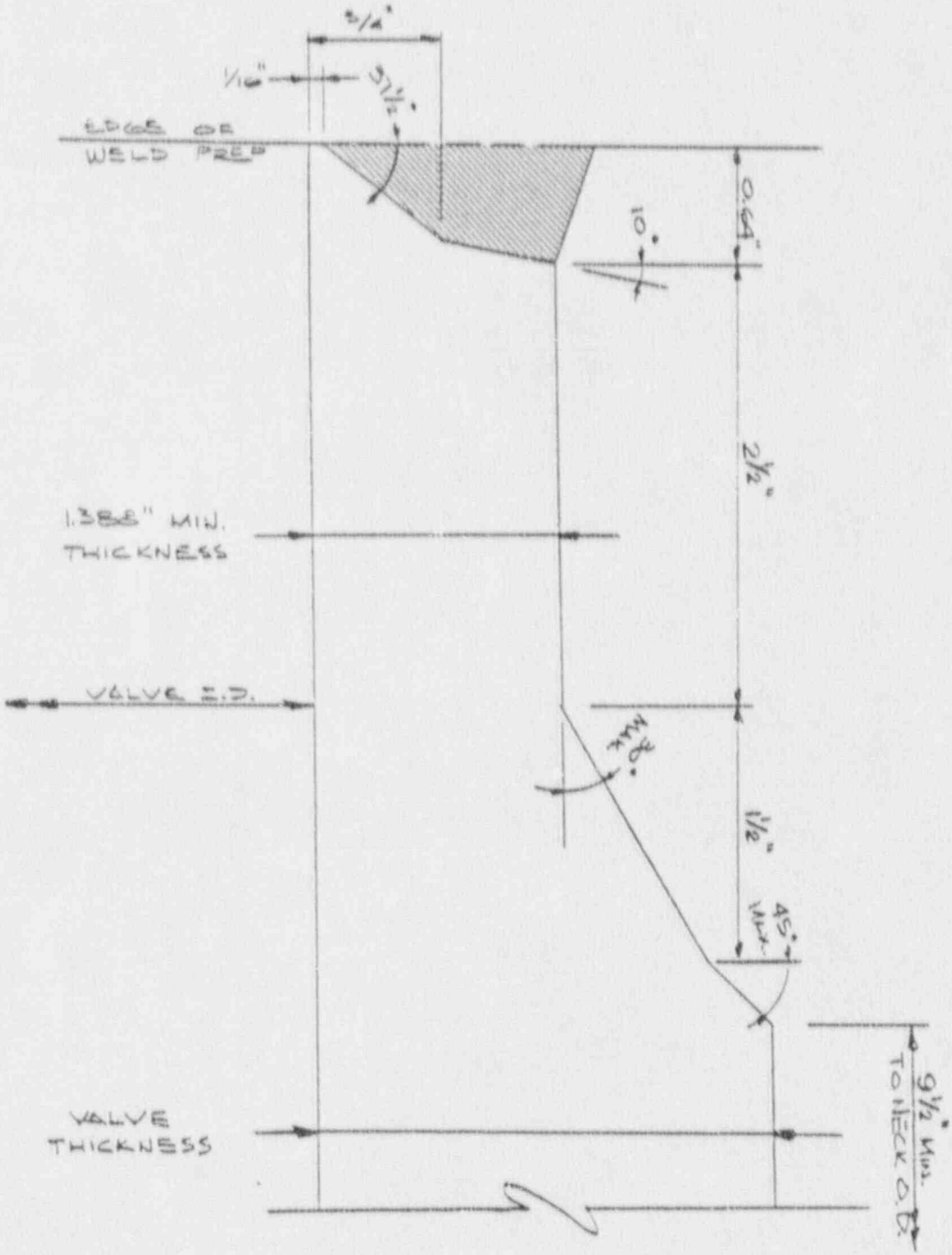
FIGURE 3



* thicknesses & circumferences — thicknesses to be taken @ the 90° A&S on the flats
(SEE ATTACHED FOR THICKNESS)

12-27-89

FIGURE 4


3/4"
1/16"
3 1/2"
EDGE OF WELD PREP
10°
0.69"
2 1/2"
1.388" MIN. THICKNESS
VALVE I.D.
1 1/2"
45° MAX.
VALVE THICKNESS
9 1/2" MIN. TO NECK O.D.

ATTACHMENT 2

STRUCTURAL INTEGRITY ASSOCIATES, INC.

3150 Almaden Expressway
Suite 226
San Jose, CA 95118
(408) 978-8200
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Fossil Plant Operations
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(216) 864-8886
FAX (216) 869-5461

January 14, 1991
RAM-91-004

Mr. Roy R. Johnson, Project Manager
Carolina Power & Light Company
Brunswick Steam Electric Plant
Leonard Street Extension
Southport, NC 28461

Subject: Redesign of Area Between the RHR System Return Valves and Reactor Recirculation System Tees - As-Built Reconciliation for Unit 1

Reference: Structural Integrity Associates Report SIR-90-003, Revision 0, dated January 12, 1990

Dear Roy:

The referenced report provided Carolina Power & Light Company (CP&L) with the technical justification for reducing the valve body thickness at the subject location. The modifications described in the report have been implemented, and CP&L has forwarded Unit 1 as-built data for both the Loop "A" and Loop "B" locations (Attachments 1 and 2, respectively). All of the geometric requirements contained in the referenced report were satisfied for Loop "A", and most were satisfied for Loop "B". For Loop "B", the actual "B" and "C" dimensions did not meet the requirements of Figure 4 of the referenced report. In addition, a localized thin spot on the valve body was required in order to remove PT indications (see Attachment 2).

The requirement for the "C" dimension to be set to 2 1/2" was in order to allow UT examination of the tee-to-valve weld. Since CP&L approved the difference, we assume that the dimension is acceptable (see the first paragraph of the referenced report).

Based upon a review of Figure 1 of the referenced report, which forms the basis for the specified "B" dimension, it is felt that use of a "B" dimension of 1 1/4" in lieu of the 1 1/2" requirement is acceptable.

Per Attachment 2, a cavity has been removed from the valve body in order to remove PT indications. The distance from the end of the machined area to the outside surface of the neck is 8.0" (9.75" - 1.75"), versus the 9 1/2" minimum dimension shown in Figure 4 of the referenced report. However, the actual distance from the edge of the grind out area to the outside of the neck is 10.50" per Attachment 2. Therefore, this requirement is satisfied.

Based upon the above review, the as-built configuration is in compliance with the referenced report.

If you have any questions on this letter, or the attachments thereto, please do not hesitate to contact us. It is suggested that this letter be filed with CP&L's records pertaining to the Unit 1 RHR and reactor recirculation systems.

Very truly yours,

R. A. Mattson

Reviewed by:

P. C. Riccardella

Approved by:

A. J. Giannuzzi
Project Manager

/jj
attachment

cc: CPL-16Q-102
CPL-16Q-401

STRUCTURAL INTEGRITY ASSOCIATES, INC.

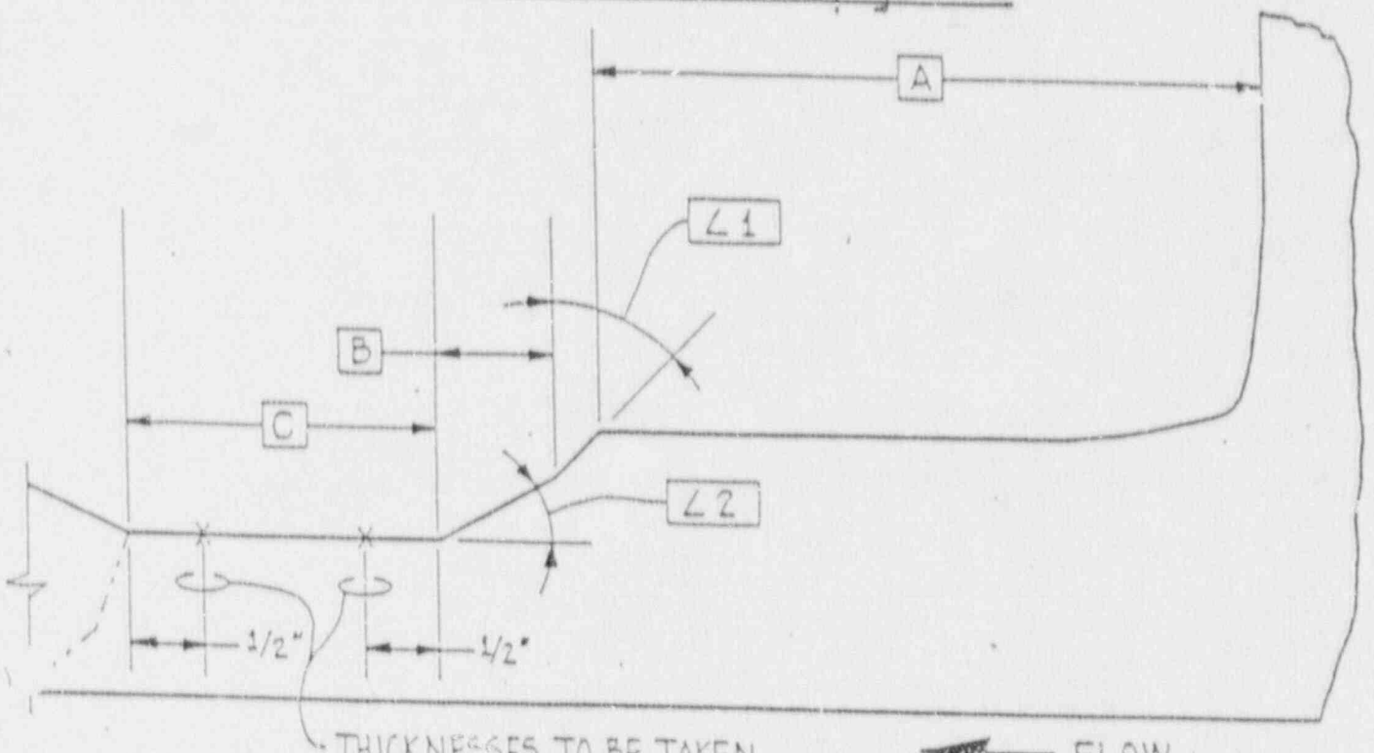
DATA SHEET 10-1

PAGE 2 OF 2

MACHINING DETAILS FOR 'A' RHR VALVE @ 90°

PLANT MOD 89-094
FIELD REV 0
PAGE NO. E 37

ATTACHMENT 1 page 1 of 2



THICKNESS READINGS

	PRELIM. (STEP 9.3.3)		INTER (STEP 9.3.5)		FINAL (STEP 9.3.11)	
	UPSTRM	DNSTRM	UPSTRM	DNSTRM	UPSTRM	DNSTRM
0°	2.7"	2.5"	2.05"	1.95"	1.84	1.52
90°	2.8"	2.45"	2.10"	1.95"	1.88	1.56
180°	3.2"	2.8"	2.20"	2.10"	1.82	1.50
270°	2.9"	2.6"	2.10"	2.05"	1.84	1.52

NOTE

TOLERANCE NOT PROVIDED FOR DIMENSIONS 'B' & 'C'. OM/M ENGINEER TO DETERMINE ACCEPTIBILITY OF FINAL 'B' & 'C' DIMENSIONS.

DIMENSIONS

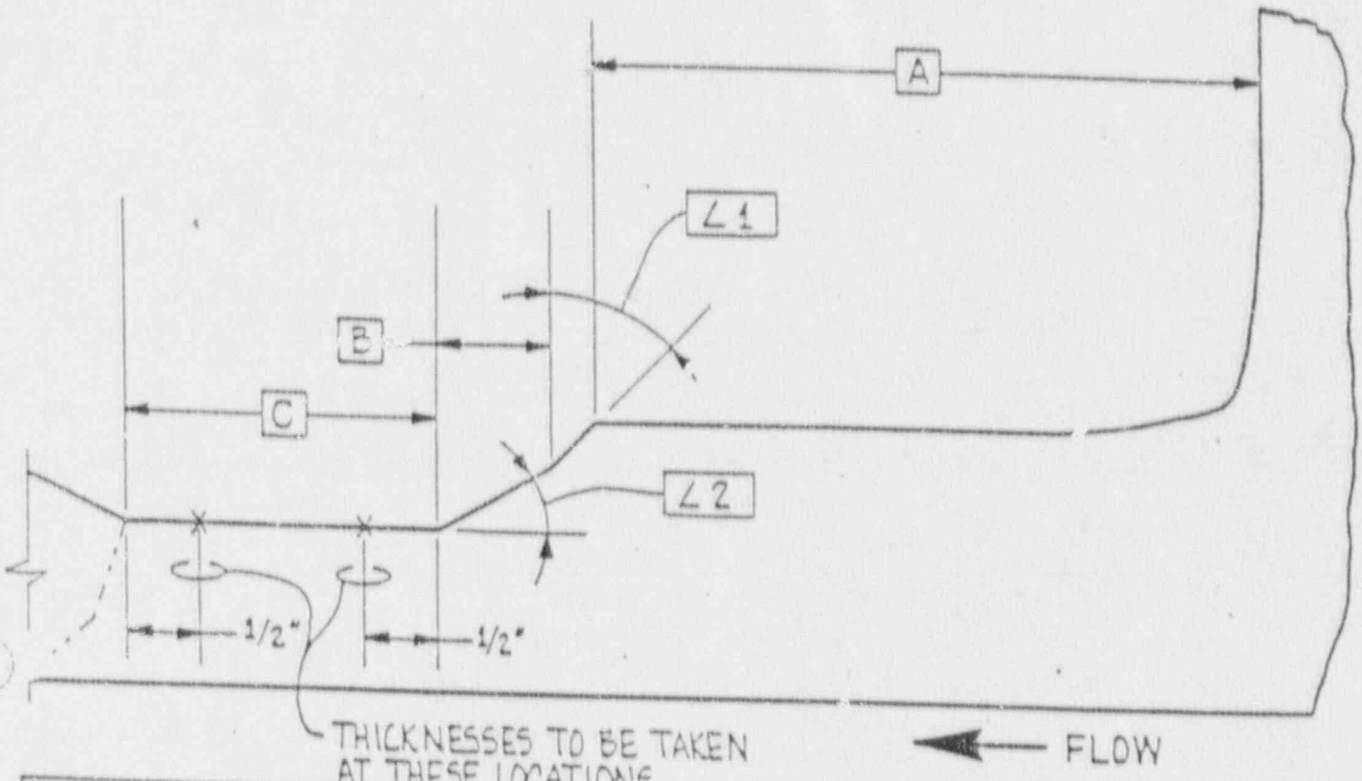
DIMENSION	DESIGN	ACTUAL	TAKEN BY / DATE	INSTR. NO.	CAL DATE	DUE DATE
A	9 1/2" MIN.	9 3/4"	[illegible] 1-4-91			
B	1 1/2" (SEE NOTE)	1 1/2"	[illegible] 1-4-91		N/A	
C	2 1/2" (SEE NOTE)	2 1/2"	[illegible] 1-4-91			
∠1	44° ± 1	45°	[illegible] 1-4-91	1-4-91 Protractor Protractor, 6" Scale		
∠2	29° ± 1	29°	[illegible] 1-4-91	& Tape Measure Only 1-4-91 [illegible]		

DATA SHEET 10-1 PAGE 2 OF 2

MACHINING DETAILS FOR 'B' RHR VALVE @ 270°

PLANT MOD	89-094
FIELD REV	0
PAGE NO.	E41

ATTACHMENT 1 page 2 of 2



THICKNESS READINGS

	PREUM (STEP 9.3.3)		INTER (STEP 9.3.5)		FINAL (STEP 9.3.7)	
	UPSTRM	DNSTRM	UPSTRM	DNSTRM	UPSTRM	DNSTRM
0°	3.15	2.85	2.125	1.975	1.700	1.425
90°	2.75	2.5	2.100	1.900	1.750	1.500
180°	2.6	2.4	2.150	2.025	1.750	1.550
270°	2.65	2.4	2.175	2.075	1.750	1.500

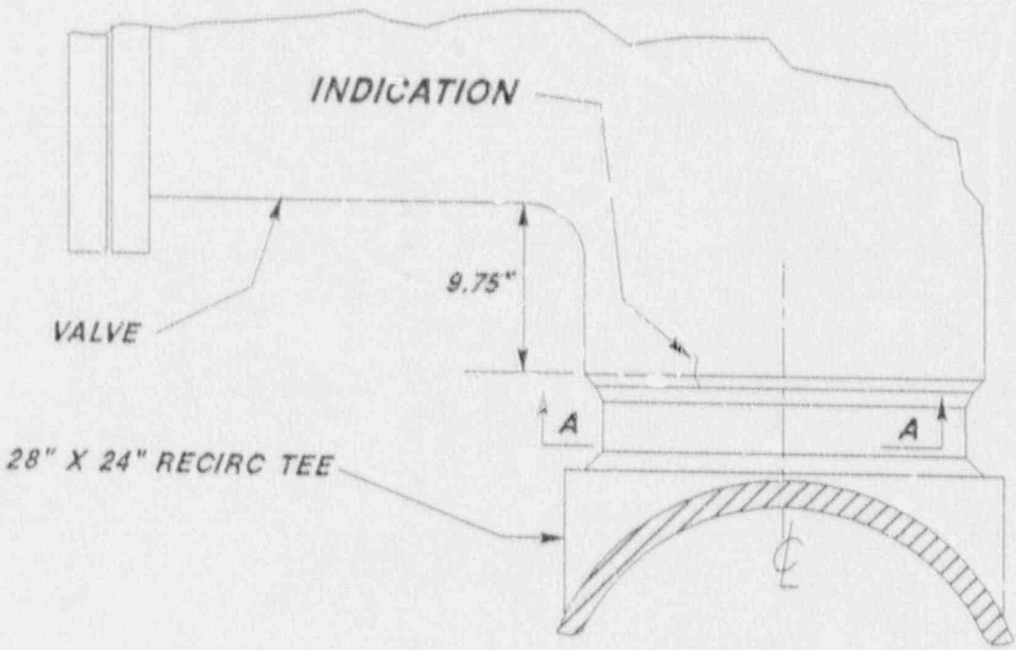
NOTE

TOLERANCE NOT PROVIDED FOR DIMENSIONS 'B' & 'C'. OM/M ENGINEER TO DETERMINE ACCEPTIBILITY OF FINAL 'B' & 'C' DIMENSIONS.

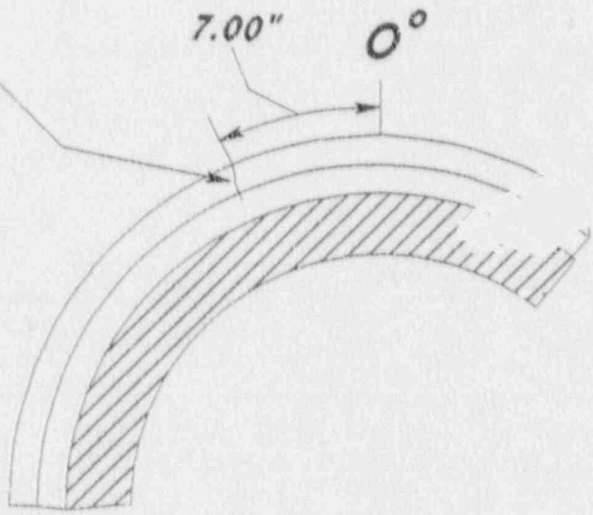
DIMENSIONS

DIMENSION	DESIGN	ACTUAL	TAKEN BY / DATE	INSTR. NO.	CAL DATE	DUE DATE
A	9 1/2" MIN.	9 3/4	J.D. Spangler 1-1-91			
B	1 1/2" (SEE NOTE)	1 1/4	J.D. Spangler 1-1-91		N/A	
C	2 1/2" (SEE NOTE)	2 5/8	J.D. Spangler 1-1-91		N/A	
∠1	44° ± 1	45°	J.D. Spangler 1-1-91	PROTRACTOR, 6" SCALE & TAPE MEASURE		2-1-91 ONLY
∠2	29° ± 1	29°	J.D. Spangler 1-1-91			

RHR VALVE 1E11-F060b
PT INDICATION



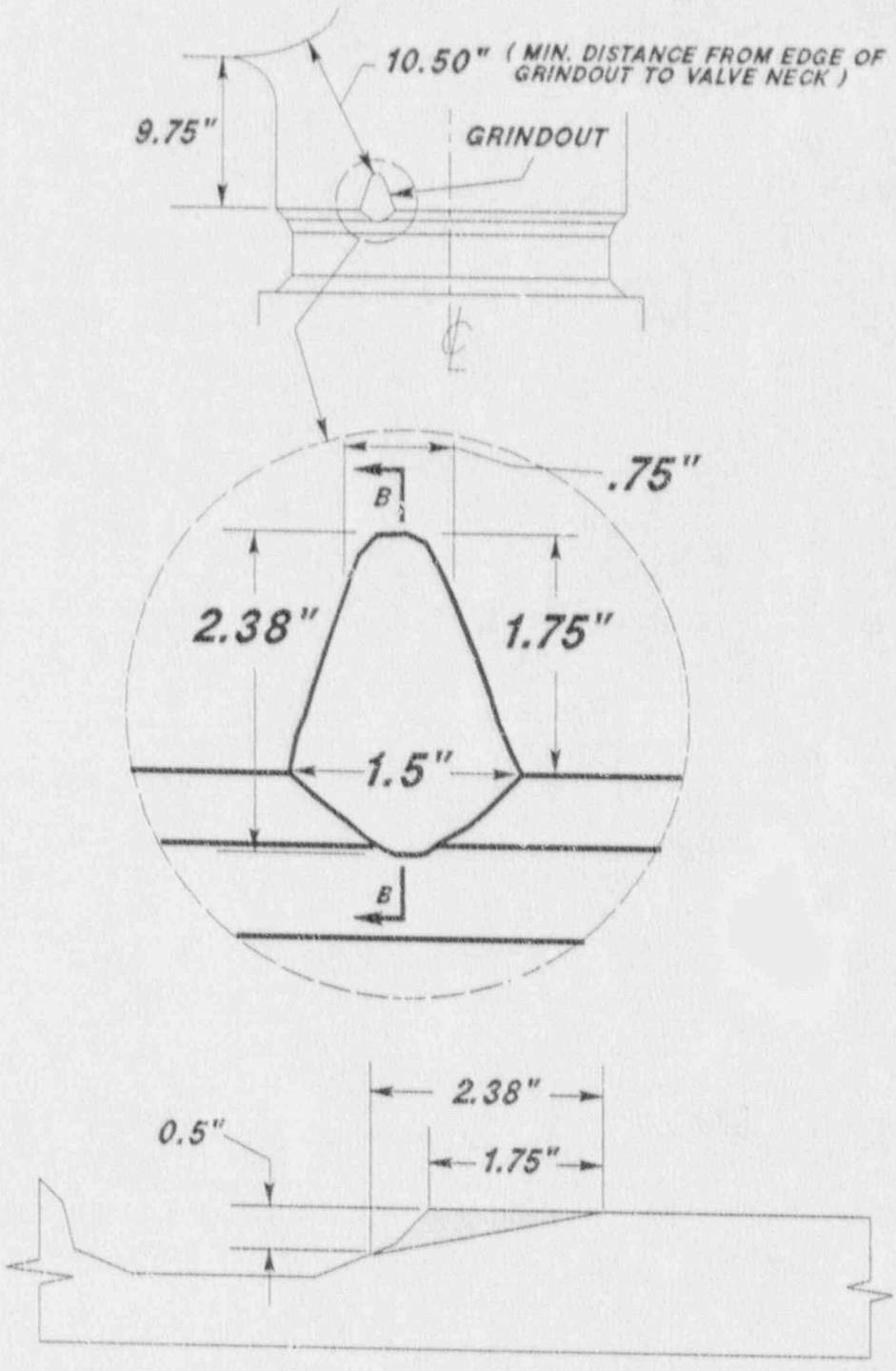
INDICATION
(SEE PAGE 2 FOR GRINDOUT DETAIL)



VIEW 'A - A'

NOT TO SCALE

RHR VALVE 1E11-F060B
PT INDICATION



VIEW 'B - B'

NOT TO SCALE

ATTACHMENT 2

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January 21, 1991
JFC-91-006
SIR-91-003

Mr. Roy R. Johnson, Project Manager
Carolina Power & Light Company
Brunswick Steam Electric Plant
Leonard Street Extension
Southport, NC 28461

Subject: Evaluation of Flaw Indications in RHR Valves F060A and F060B - Brunswick Steam Electric Plant, Unit 1

References:

1. General Electric Company, Brunswick Steam Electric Plant Unit 1 ISI Report, Report Nos. R-111 and R-112.
2. ASME Boiler and Pressure Vessel Code, Section XI, 1989 Edition with 1990 Addendum, IWB-3600 and Appendices H and A.
3. "Evaluation of Flaws in Ferritic Piping", Novetech Corporation, EPRI Report NP-6045, October, 1988.

Dear Roy:

Carolina Power & Light Company (CP&L) is undertaking more extensive inservice inspection of the reactor recirculation (RR) and residual heat removal (RHR) systems at the Brunswick Steam Electric Plant (BSEP), Unit 1, in order to comply with the requirements of U.S. NRC NUREG-0313, Revision 2. During the process of ultrasonically (UT) examining the welds between the reactor recirculation system tees and the residual heat removal system return valves, flaw indications were detected in the valve bodies away from the welds [1]. Structural Integrity Associates (SI) was contracted by CP&L to provide the technical justification for accepting the flaw indications as-is.

Figure 1 shows the geometry in question, and was provided by CP&L. The Reference 1 report describes the flaw indications detected during inservice inspection. This letter report and attached appendices documents the flaw analyses performed in order to justify plant startup and continued operation.

Structural Evaluation

Based upon the geometry shown on Figure 1, an axisymmetric solid-of-revolution finite element model was developed for evaluation of stresses caused by internal pressure (1000 psig) and steady state temperature (532°F, with 70°F being stress-free). The Algor SUPERSAP Program was used for analysis. Appendix A contains the detailed calculations documenting the stress analysis performed. Since an axisymmetric analysis was performed, the reactor recirculation system piping was modeled as an equivalent sphere of radius equal to the pipe diameter. Material properties were chosen at 550°F. Since all reported flaws were oriented in the axial direction, only hoop stresses are of interest in the flaw evaluation. All hoop stresses in the area of interest are provided on pages 9, 10, and 11 of Appendix A for the 1000 psig pressure load, and on pages 14, 15, and 16 for the steady state thermal analysis. Appendix B summarizes the stresses of interest which will be used in the flaw evaluation. These stresses were adjusted for the maximum operating pressure of 1250 psig, and to include ASME Code safety factors.

Fracture Mechanics Flaw Evaluation

The preceding geometry and stress results for the BSEP, Unit 1 RHR valve were employed to perform fracture mechanics flaw evaluations. The worst case (deepest) axial flaw indication, 1.1 in. deep, with the length in the valve undetermined because of geometry, was evaluated in accordance with ASME Section XI [2]. In accordance with IWB-3650, Appendix H, for evaluating ferritic piping, safety factors of three on hoop pressure stress and one on hoop thermal stress were applied. Because of the distance of the flaw indications from the weld center-line, weld residual stresses were assumed to be negligible.

Material properties were derived from CMTR's (certified material test reports) for the "B" valve, which contained the deepest indication, for both elastic-plastic (EPFM) and linear elastic fracture mechanics (LEFM) analyses. Charpy toughness values of 21, 32, and 31 ft-lb were reported for tests at -20°F, indicating relatively good toughness for this A216-WCB casting material. Using Section XI, Appendix H methods for correlating J_{IC} and K_{IC} with Charpy upper shelf, and an assumed minimum upper shelf of 35 ft-lb (based on the -20°F results), a J_{IC} value of 350 in-lb/in^2 and a K_{IC} value of 102.1 ksi$\sqrt{\text{in}}$ were justified. A corresponding J-Resistance curve from Reference 3 was employed for the EPFM analysis, with a Ramberg-Osgood stress-strain curve derived from the CMTR results.

EPFM analyses show that an infinite length axial crack in the reduced section of the valve, using average stresses in that section, is acceptable for a depth in excess of the 1.1 in. maximum reported indication depth. LEFM was used as a cross-check, with the stress distributions at the valve cross-section corresponding to the deepest indication location, to show that an axial crack 1.1 in. deep would be acceptable over the length of the valve reduced section and taper. An infinitely long axial flaw 1.25 in. deep was found to be

acceptable for the adjacent thicker section of the valve which was not inspectable because of the configuration. Fatigue crack growth for the deepest portion of the indication, due to 117 startup/shutdown cycles and corresponding pressure and thermal stress cycles over the life of the plant, was predicted by using the ASME Section XI fatigue crack growth law to be on the order of 0.01 inches. This amount of predicted growth is assumed negligible, and is consistent with the conclusion that these flaw indications are original fabrication discontinuities, and are not service-induced.

In summary, ASME Section XI safety margins are met for the largest indication, which envelopes the other indications. The reported indications are considered acceptable as-is. Detailed flaw evaluation calculations are found in Appendix C to this letter report.

Summary and Conclusions

Based upon the information provided herein, coupled with that provided by CP&L, it is concluded that the UT flaw indications found on RHR valves F060A and F060B are not service-induced, and are acceptable as-is for one more refueling cycle. It is recommended that these flaws be reinspected at the next refueling outage to confirm that there is not a crack growth mechanism.

Should you require further information, and have questions on the attached, please contact us.

Very truly yours,

J. F. Copeland
Associate

R. A. Mattson
Associate

/jj

Attachment

cc: Dale Bates - CP&L

STRUCTURAL INTEGRITY ASSOCIATES, INC.

RHR VALVE TO RECIRC TEE CONFIGURATION
(TYPICAL AT 0° AND 180°)

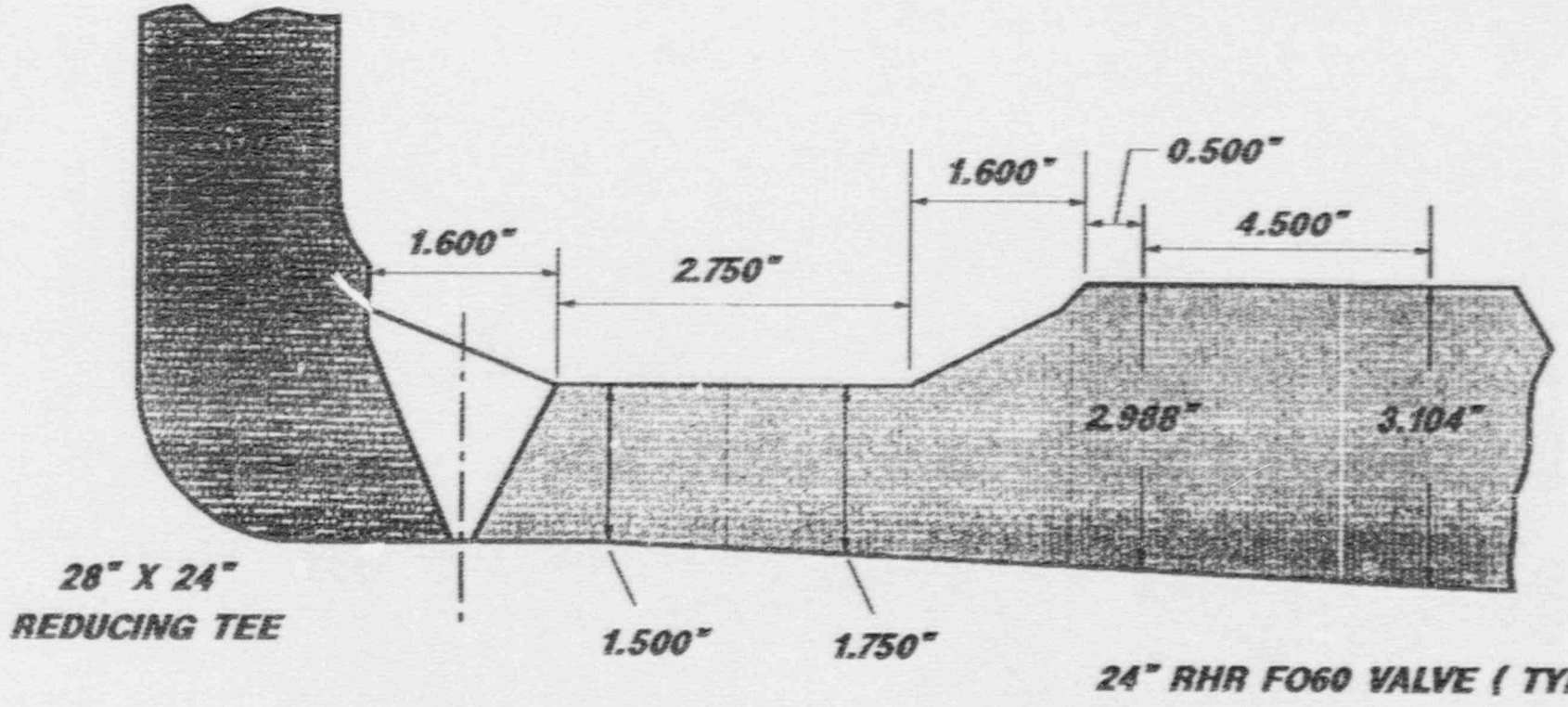

Figure 1

APPENDIX A

Stress Analysis of RHR Valve to Recirculation System Tee