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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
NRC GENERIC LETTER 94-03, "INTERGRANULAR STRESS CORROSION CRACKING OF CORE SHROUDS IN BOILING WATER REACTORS"

Gentlemen:

On July 25, 1994, the NRC staff issued NRC Generic Letter (GL) 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors." Reporting Requirement 2 of NRC Generic Letter 94-03 requires licensees to submit core shroud inspection plans, along with plans for evaluation and/or repair of the core shroud based on the inspection results. The Core Shroud Reinspection Plan for Carolina Power & Light Company's Brunswick Steam Electric Plant, Unit 1, Spring 1995 B110R1 Refueling Outage was discussed with the NRC staff during a January 17, 1995 meeting. By letter dated February 10, 1995, the Unit 1 Core Shroud Reinspection Plan was submitted to the NRC staff (BSEP 95-0080).

Enclosure 1 of this letter provides a revised inspection scope and associated technical basis for Core Shroud Welds H6a and H6b. This revised reinspection scope was discussed with the NRC staff in a conference call on April 18, 1995. As noted in Enclosure 1, CP&L believes that the revised reinspection scope provides sufficient information for the H6a and H6b welds to determine that adequate core shroud structural integrity remains to justify continued operation of Unit 1.

Please refer any questions regarding this letter to Mr. R. P. Lopriore at (910) 457-2212.

Sincerely,

John Paul Cowan

KAH/

Enclosure

cc: Mr. S. D. Ebneter, NRC Regional Administrator, Region II
Mr. C. A. Patterson, NRC Senior Resident Inspector - Brunswick Plant
Mr. D. C. Trimble, Jr., Acting NRR Senior Project Manager - Brunswick Plant
The Honorable H. Wells, Chairman - North Carolina Utilities Commission

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ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNIT 1
NRC DOCKET NO. 50-325
OPERATING LICENSE NO. DPR-71

NRC GENERIC LETTER 94-03, "INTERGRANULAR STRESS CORROSION CRACKING OF CORE SHROUDS IN BOILING WATER REACTORS"

REVISED UNIT 1 CORE SHROUD REINSPECTION SCOPE - WELDS H6a AND H6b
B110R1 REFUELING OUTAGE

This enclosure provides a revised reinspection scope and associated technical basis for Core Shroud Welds H6a and H6b. This revised reinspection scope was discussed with the NRC staff in a conference call on April 18, 1995. CP&L believes that the revised H6a/H6b reinspection scope provides the necessary information to show that sufficient structural integrity remains in the Unit 1 core shroud to justify continued operation of Unit 1.

Background

On July 25, 1994, the NRC staff issued NRC Generic Letter (GL) 94-03, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors." Reporting Requirement 2 of NRC Generic Letter 94-03 requires licensees to submit core shroud inspection plans, along with plans for evaluation and/or repair of the core shroud based on the inspection results. The Core Shroud Reinspection Plan for Carolina Power & Light Company's Brunswick Steam Electric Plant, Unit 1, Spring 1995 B110R1 Refueling Outage was discussed with the NRC staff during a January 17, 1995 meeting. On February 10, 1995, the Reinspection Plan was submitted to the NRC staff (BSEP 95-0080).

The Brunswick Core Shroud Reinspection Plan submitted to the NRC staff on February 10, 1995, indicated that CP&L was developing UT techniques to inspect the ID surface of the core shroud support ring welds H6a and H6b and associated fillet welds. Special tooling is needed at the Brunswick Plant since the UT scanner commonly being used in the industry for core shroud inspections would not work on the Brunswick Plant core shrouds due to interferences with the clamps installed on welds H2 and H3.

Based on equipment design information available at the time of our February 10 submittal, CP&L believed that the equipment being developed would be capable of completing UTs of 6 accessible areas of welds H6a and H6b between the jet pumps from the OD to look for cracks initiating from the ID of these welds. These UT inspections were planned to supplement the VT inspections performed on 48% of the OD of the welds during the last outage (B109R1). CP&L believed that the total area inspected would be approximately 60 inches (10 inches per accessible area) for weld H6a and 60 inches for weld H6b.

CP&L has completed UT examinations of the H6a and H6b weld areas; however, due to reliability problems with the examination equipment delivery system, CP&L was only able to complete examinations on three of the six accessible areas noted in our reinspection plan for welds H6a/H6b (75°, 225°, 315°). The results of the H6a and H6b weld examinations are provided in Table 1 of this enclosure.

Inspections of welds H1, H5 and H9 have also been completed. No indications were identified on the H9 weld. The H5 inspection results are still being evaluated; however, preliminary results indicate no growth occurred in the areas inspected during the last cycle of operation. H1 weld evaluation results are discussed later in this enclosure. Consistent with the reporting requirements of NRC Generic Letter 94-03 and our February 10, 1995 letter, these results will be included in the B110R1 refueling outage core shroud inspection report due to the NRC staff within 30 days of completion of the inspections.

B110R1 Inspection Results - Core Shroud Welds H6a and H6b

During VT inspection of approximately 48% of the OD of the H6a/6b welds during the last outage (B109R1), 3 small axial indications were found on H6a and H6b welds. Creeping wave UT, designed to detect surface cracking on the OD of the shroud, was employed on the scanner package during inspections this outage. No additional OD cracks were found in the three areas inspected this outage.

UT examinations of the three H6a/H6b weld areas scanned this outage total approximately 53 inches, 88% of the planned inspection area (60 inches). Five (5) indications were recorded in these areas. Two indications, H6a at 225.5 degrees and H6b at 75.5 degrees, are imbedded flaws that were not connected to either the ID or OD surface. These flaws are considered original fabrication flaws and are not IGSCC-related.

Three indications were observed which contained ID surface-connected flaws, totaling approximately 7.3% of the 53 inches of total area scanned (see Table 1). One indication was observed in the H6a weld area at the 315° azimuth. This indication has been preliminarily sized as 0.346" long by 0.354" deep. The actual length of the indication could not be determined since the indication continued out of the scan window; however, the indication is bounded by the V8 vertical weld and would be limited to about 3" in length. Rollout drawings of the core shroud and detailed scan area drawings for the H6a/H6b weld locations inspected during this outage are provided as Figures 1 through 8.

Two indications were observed in the H6b scan areas; one at 225° azimuth and the other at the 315° azimuth. The indications were 1.3" long by 0.276" deep (225°) and 2.3" long by 0.551" deep (315°), respectively. Actual length for the indication at the 225° azimuth could not be determined because the indication continued out of the scan window.

During the current Unit 1 outage (B110R1), CP&L has also completed planned reinspections of the H1 weld and preliminary evaluations of the data. CP&L scanned approximately 9.5" in each of four areas (30°, 60°, 140°, 260°) to determine crack growth. Comparison of the data from this inspection with that taken last outage (B109R1 outage) shows an average change in depth of 0.006" if only the positive growth values are used. If all data is used, the average change in depth is negative. Actual changes in measured depths range from 0.006" apparent "growth" to 0.088" apparent "shrinkage" . The uncertainty of the equipment used in the initial baseline of the crack depth during the B109R1 outage was 0.1". The uncertainty of the equipment used this outage for comparison of crack depth is 0.028" for ID connected indications and 0.011 for OD connected indications. Evaluation of the data indicates that the observed crack "growth" is actually within the uncertainties of the equipment. CP&L believes that the data indicates that the IGSCC-related flaws are not growing.

Acceptability of Revised Reinspection Scope - Core Shroud Welds H6a & H6b

The Brunswick core shroud reinspection plan for the B110R1 outage was developed to ensure that representative samples of the welds and plate/ring materials are obtained. Accordingly, the three H6a/H6b weld locations inspected during this outage include samples from both of the lower shroud course plates, all three shroud support course plates, and three of the six ring segments. Carbon content in the plates is similar; ranging from 0.048 wt.% to 0.067 wt.% (See Table 2).

CP&L has performed preliminary analyses of the structural adequacy of the core shroud for both the upset and faulted loading conditions, which bound the emergency loading conditions. These analyses were performed using the BWRVIP developed "DISTRIBUTED LIGAMENT LENGTH (DLL) EVALUATION" program. Only Limit Load analysis was performed as the fluence levels at the H6a/H6b weld locations are well below the LEFM threshold fluence level. Loads included consideration of power uprate conditions and asymmetric loads induced by a reactor recirculation system line break.

Applied stresses are higher at H6b than at H6a; therefore, the H6b weld was analyzed as the limiting case. Load cases were analyzed using the deepest reported indication (0.551"). This indication was conservatively assumed to be 360°, even though UT results clearly show that the welds are not cracked 360°.

Using the assumptions noted above, two cases were analyzed. The first case assumed a theoretical crack growth rate of 5×10^{-5} in./hr. (equal to 0.6"/cycle for BNP), and the other assumed a calculated crack growth rate of 8.3×10^{-6} in./hr. (equal to the 0.1"/cycle, based on the instrument uncertainty for the equipment used during the B109R1 outage). No additional instrument uncertainty was included since the UT equipment used during the B110R1 outage consistently sized the flaws conservatively in qualification testing.

The results of the two analyses are summarized in Table 3. The analyses indicate that the core shroud is structurally adequate and continued operation of Unit 1 is justified.

CP&L operates both Units 1 and 2 with hydrogen water chemistry at moderate injection rates, which is considered to be effective in mitigating IGSCC related crack initiation and propagation in the annulus and in areas below the core plate. The creeping wave UT results from H6a and H6b support this conclusion.

Based on the completed analyses and the conservatisms noted above, CP&L believes that the reinspection scope of the core shroud performed for the H6a/H6B welds is adequate to ensure core shroud structural integrity exists.

TABLE 1

Weld	Center Azimuthal Location	Scan Coverage (in)	Indications
H6A	75.5°	17.8	No reportable indications
	225.5°	17.8	Volumetric indication - not ID or OD connected with remaining ligament of 0.819". Embedded at ring. Not IGSCC.
	315.5°	17.8	#1: 0.346"L x 0.354"D at plate. Runs out of scan window but bounded by vertical weld V8, which gives flaw a max length of approx. 3".
H6B	75.5°	17.7	Volumetric indication - not ID or OD connected with remaining ligament of 1.209". Embedded at weld fusion line. Not IGSCC.
	225.5°	17.8	1 - 1.3"L x .276"D at plate. Runs out of scan window.
	315.5°	17.8	1- 2.3"L x .551"D at plate.

TABLE 2

Weld	Plates Inspected	Carbon Content (% by Wt.)	Fluence (1 additional cycle) (n/cm^2)
H6A	P7	0.048 - 0.058 (plate material) 0.063 - 0.067 (ring material)	8.2 E 18
	P8		
H6B	P9	0.053 - 0.056 (plate material) 0.063 - 0.067 (ring material)	7.8 E 18
	P10		
	P11		

TABLE 3

H6B Safety Factors for Wall Thickness
Using NRC Crack Growth Values

(1) Loading Condition	Required Safety Factor	Weld Designation	(2) Crack Growth Allowance (in.)	(3) Allowable Flaw Size (in.)	Remaining Wall Thickness (in.)	Safety Factor
Normal/Upset	2.77	H6b	0.6	0.551	0.349	5.71
Faulted	1.39	H6b	0.6	0.551	0.349	3.53

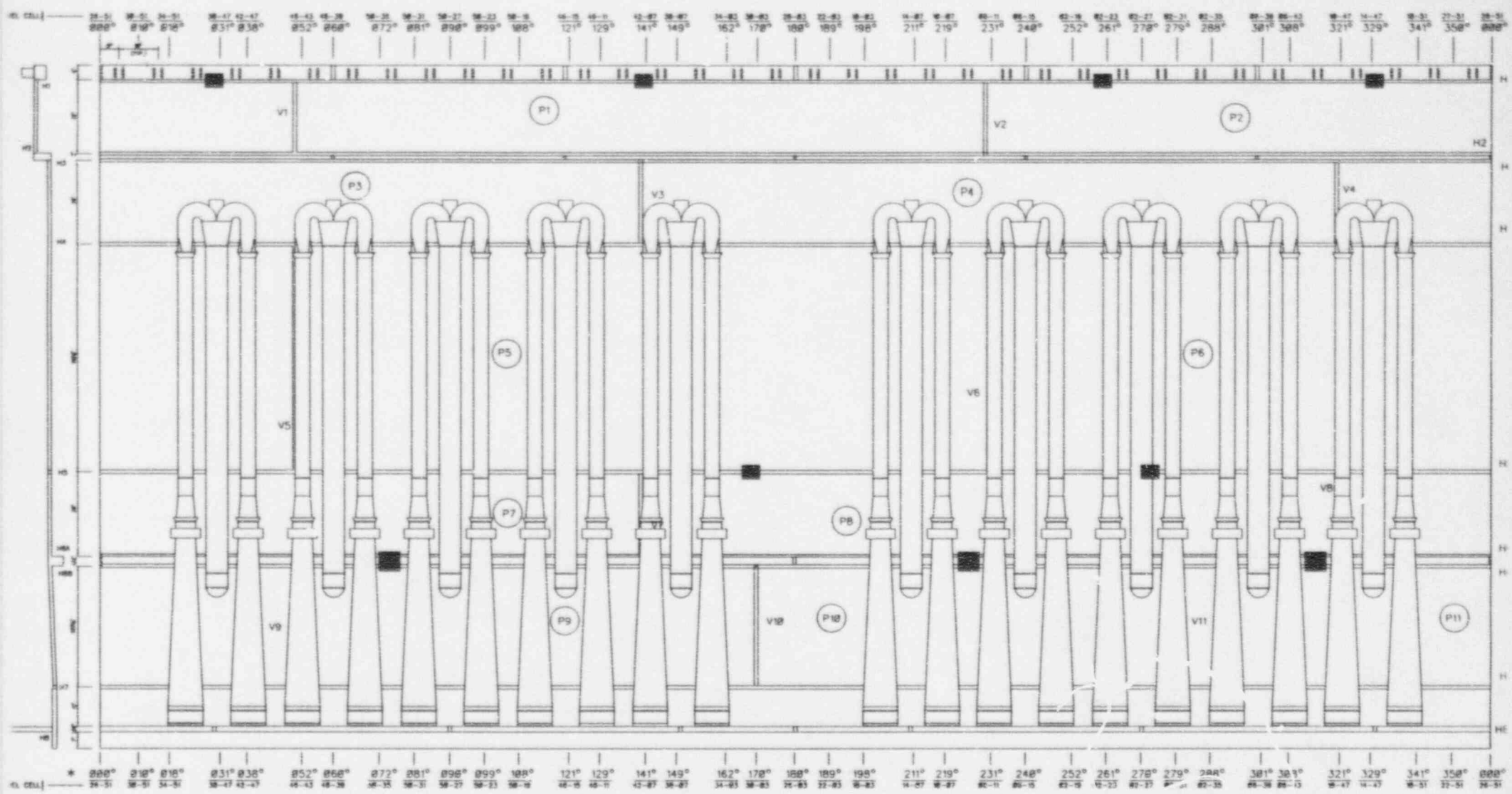
H6B Safety Factors for Wall Thickness
Using BNP U1 Calculated Crack Growth Values

(1) Loading Condition	Required Safety Factor	Weld Designation	(4) Crack Growth Allowance (in.)	(3) Allowable Flaw Size (in.)	Remaining Wall Thickness (in.)	Safety Factor
Normal/Upset	2.77	H6b	0.1 (1 cycle)	0.551	0.849	13.72
Faulted	1.39	H6b	0.1 (1 cycle)	0.551	0.849	8.31
Normal/Upset	2.77	H6b	0.3 (3 cycles)	0.551	0.649	10.52
Faulted	1.39	H6b	0.3 (3 cycles)	0.551	0.649	6.39

(1) Includes Power Uprate pressures and asymmetric loading for the shroud.
(2) NRC mandated allowance of 5×10^{-5} in/hr for one cycle of operation = 0.6"/cycle for BNP.
(3) Flaw size used is the maximum observed crack depth for the H6b weld and is assumed 360° thru-wall.
(4) The crack growth used for BNP U1 is 0.1"/cycle and is based on the results of the H1 weld inspections.

Rollout Drawing of the OD of the Core Shroud for BNP U1

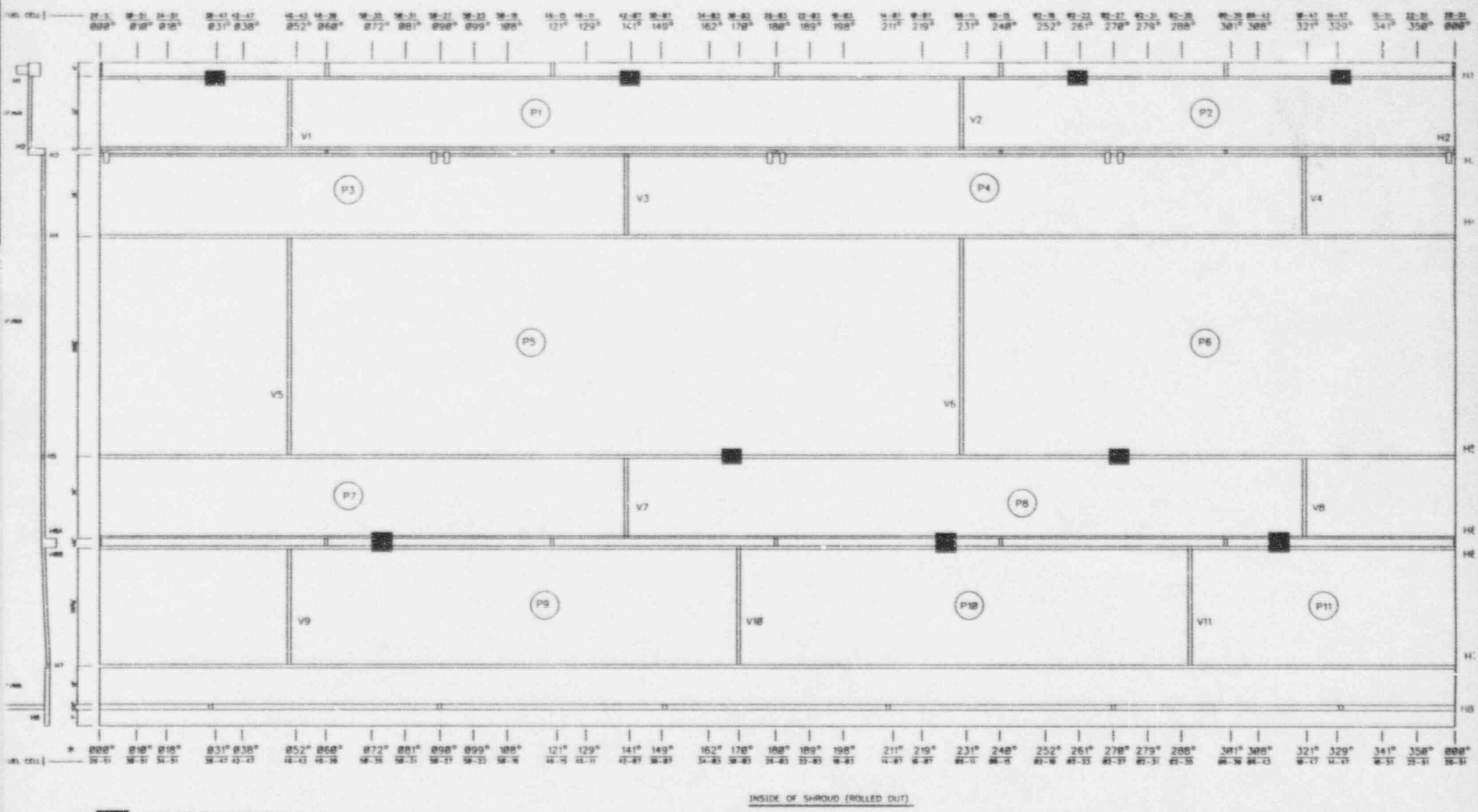
Figure 1



Attachment to BSEP 95-0192

Rollout Drawing of the ID of the Core Shroud for BNP U1

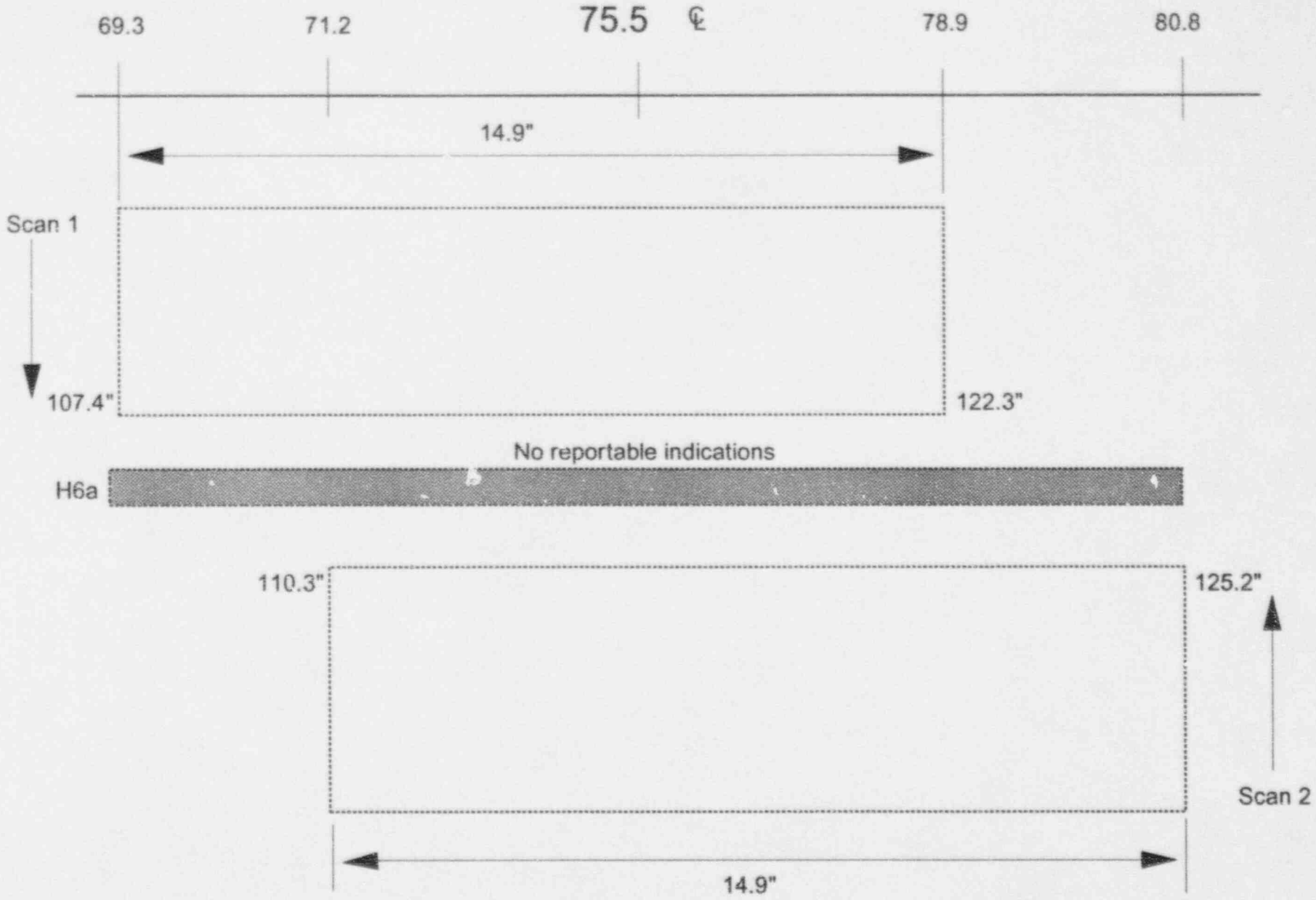
Figure 2



Attachment to BSEP 95-0192

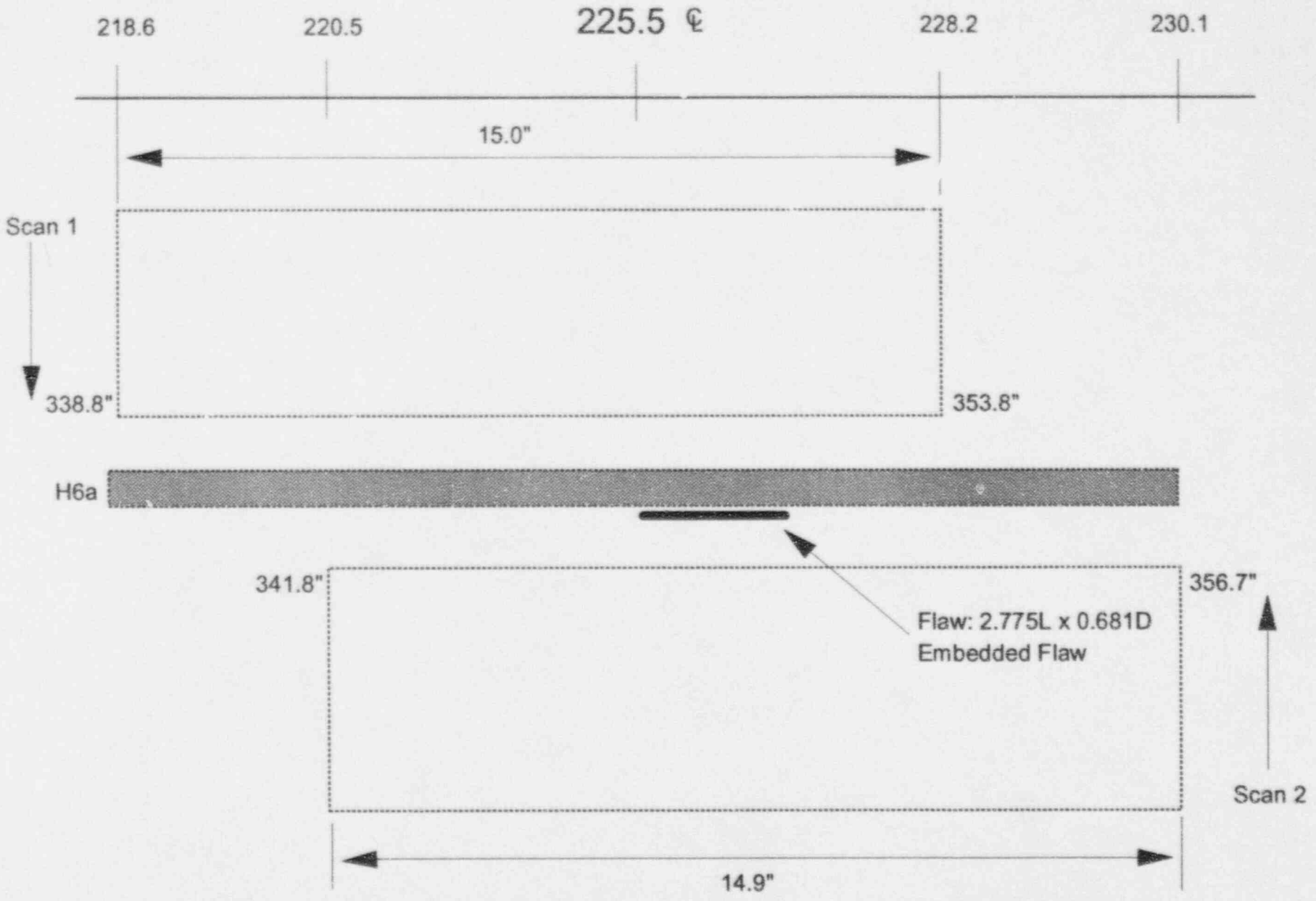
Core Shroud H6a Weld @ 75 Deg

Figure 3



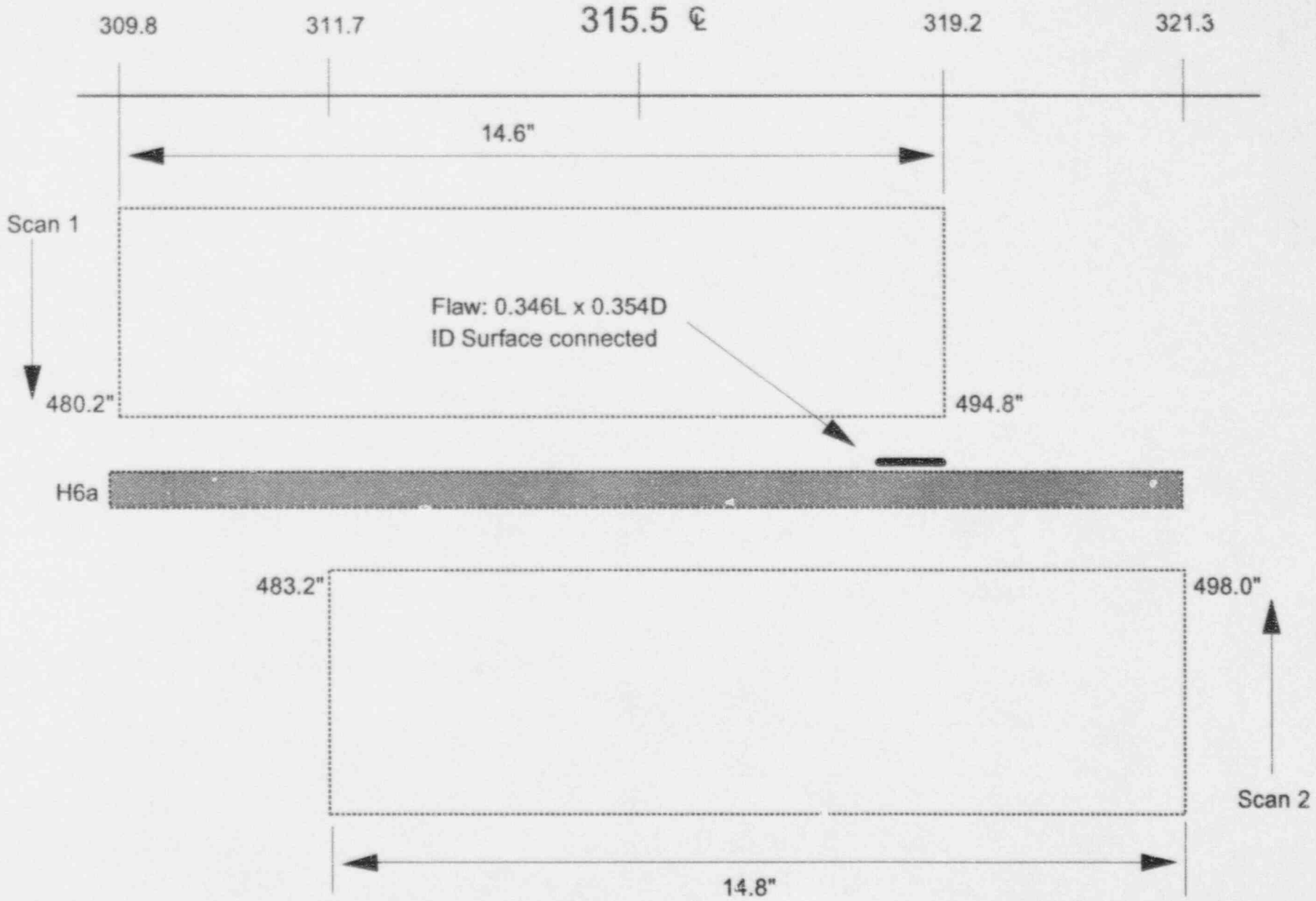
Core Shroud H6a Weld @ 225 Deg

Figure 4



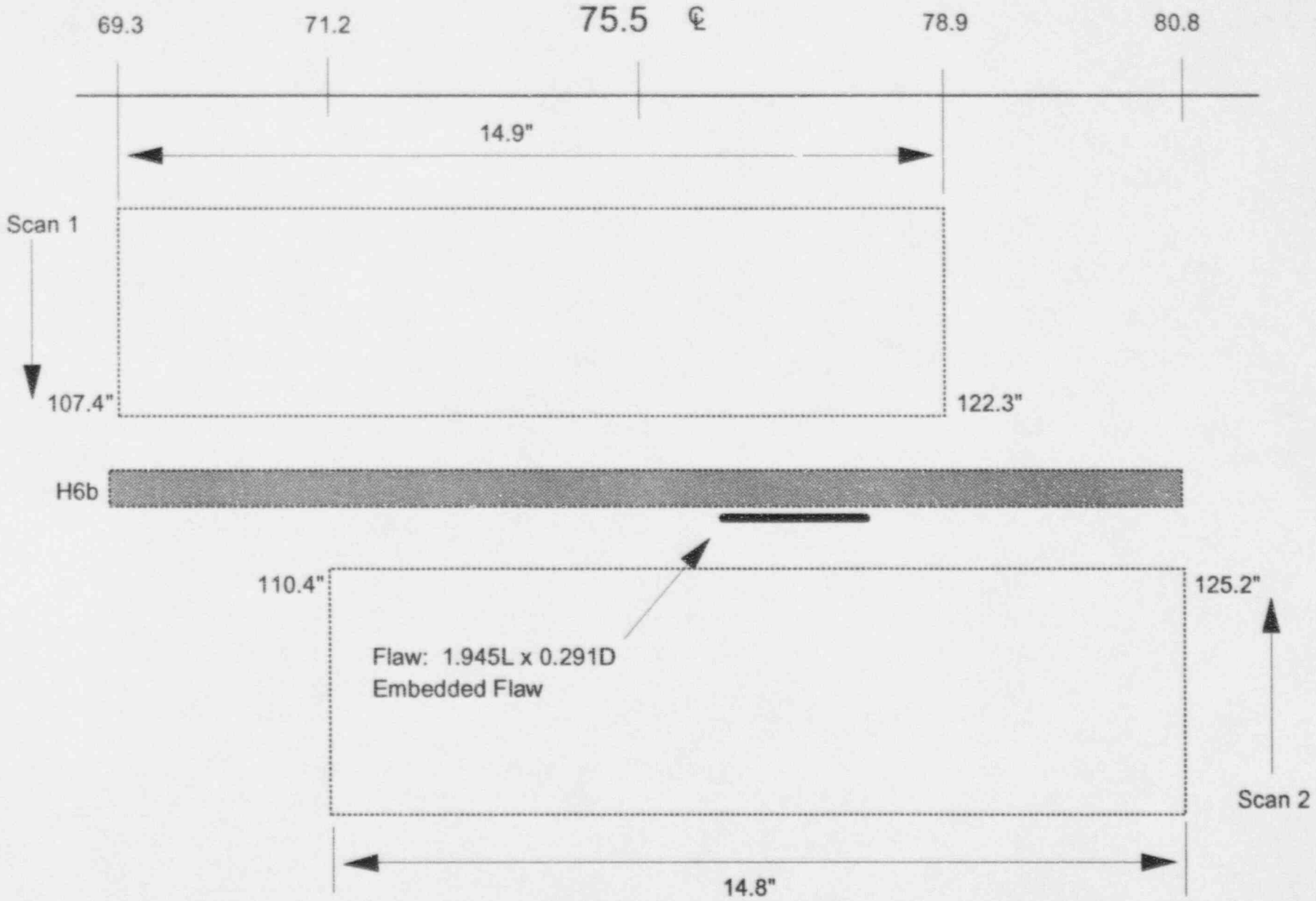
Core Shroud H6a Weld @ 315 Deg

Figure 5



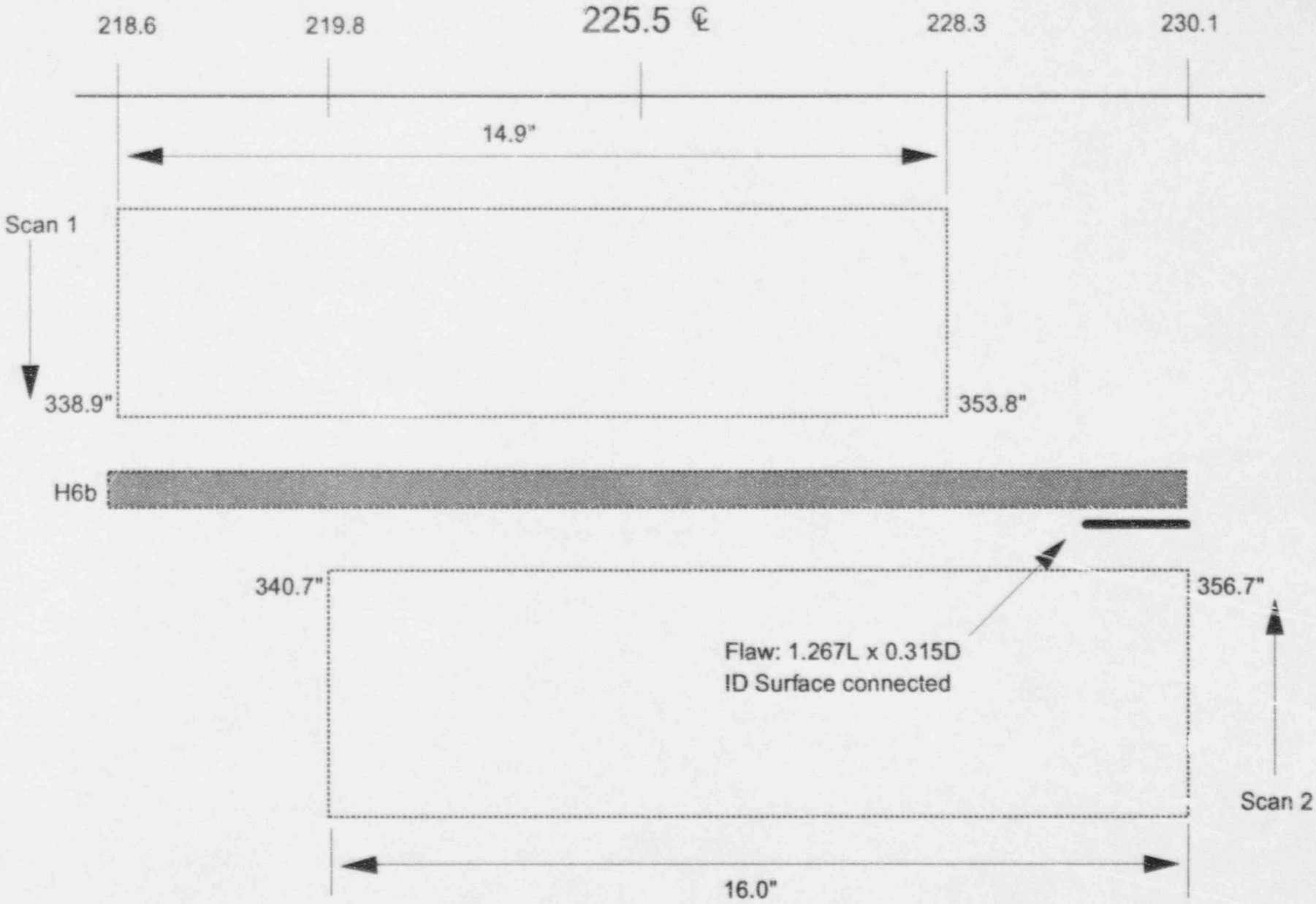
Core Shroud H6b Weld @ 75 Deg

Figure 6



Core Shroud H6b Weld @ 225 Deg

Figure 7



Core Shroud H6b Weld @ 315 Deg

Figure 8