ULTRASONIC INVESTIGATION
OF THE
INDIAN POINT UNIT 3
INTERMEDIATE SHELL LONGITUDINAL WELD #10

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BACKGROUND

During the first interval, third period inservice ultrasonic examination of the Indian Point Unit 3 reactor vessel, three indications were identified in the intermediate shell longitudinal weld at 300° vessel axis (weld #10) which required additional investigation, see Figure 1. Indication #10 was detected at 301° vessel axis via 2.25, MHz 45° shear wave scanning in the counterclockwise direction, had a peak amplitude of 200% of DAC, exhibited a length of 1.69", and was located 228.35" from the top of the vessel flange. Indication #16 was detected at 300.43° vessel axis via 2.25 MHz, 45° shear wave scanning in the counterclockwise direction, had a peak amplitude of 150% of DAC, exhibited a length of 2.27", and was located 226.67" from the top of the vessel flange. Indication #11 was detected at 300.1° vessel axis via 2.25 MHz, 60° shear wave scanning in the clockwise direction, had a peak amplitude of 75% of DAC, exhibited a length of 1.51" and was located 228.75" from the top of the vessel flange. All three indications had their major axes parallel to the longitudinal weld seam. Figure 2 is a plan view of the weld seam showing indication locations. The vessel wall thickness was measured at 9.0" in the area of interest.

REVIEW OF PRIOR NDE RECORDS

Inspection records for the Indian Point Unit 3 reactor vessel intermediate shell welds were reviewed in order to 1) identify what procedures were used for prior shop and field (PSI) examinations; 2) compare the earlier techniques with those applied for the current inservice examination; and 3) compare the earlier results with those collected during this examination.

Records reviewed included:

- Shop fabrication radiographic records
- Vessel post-hydro ultrasonic examination records, and
- Vessel preservice ultrasonic examination records

Shop Fabrication Radiographic Records

Radiographic records for the Indian Point Unit 3 intermediate shell longitudinal welds were reviewed at the site. The radiographic technique sheets and radiographs involved in this review were identified as CE contract #3366 and job #51231-006, dated June 13, 1967. The radiographic technique sheet specified the application of a 13 MEV linear accelerator with a 1.0 mm focal spot size (FSS), 7" x 17" AA film and a 10' focal spot to film distance (FFD). Exposures were made with the linear accelerator positioned on the outside of the shell section and film placed on the shell ID surface.

Film and radiographic reader sheets from intermediate longitudinal weld seams 2042-A (300° vessel axis), 2042-B (60° vessel axis), and 2042-C (180° vessel axis) were reviewed with special attention given to views between X-ray station markers 0-1, 1-2, 8-9 and 9-0. No apparent weld defects were noted in any of the weld seams in these locations although view 9-0 for weld seams 2042-A and 2042-C exhibited base metal indications. The base metal indications were located on both sides of the welds, 2 to 3 inches from the weld edges, and 4 to 6 inches from X-ray station marker "0". These indications appear to be grinding marks from the removal of temporary attachments and were more than likely removed during final conditioning of the shell outer diameter surface. These indications are not related to the indications recorded during the current vessel inservice examination.

Vessel Post-Hydro Ultrasonic Examination Records

The reactor vessel "shop UT map" was performed after the vessel hydrostatic test in 1969 at the Combustion Engineering fabricating facility in Chattanooga, Tennessee. The examination procedure used for the Indian Point Unit 3 post-hydro UT is identified as "Ultrasonic Testing INT Reactor Vessel - 3366/54F55179BP". This examination was performed in addition to Code required volumetric examinations by radiography on a "for information" basis. The stated purpose of the examination was to "map defects as detected by ultrasonics, in base material and weld seams after hydrostatic test for future in-service testing".

The examination procedure required complete straight beam examination coverage and angle beam examinations in one axial direction (toward the vessel flange) and one circumferential direction (clockwise) over the entire intermediate shell course and the lower shell course above the radial core supports. Calibration for the straight beam examination was established by setting the back reflection in an indication free area of the vessel to 90% of full screen height. Calibration for angle beam testing was established on a 10" thick calibration block by setting the response from a 3% deep, 3/16" wide and 2" long notch to 100% of full screen height.

Examinations were performed using a type SAQ, 2.25 MHz, 1 1/8" diameter, style 50A300 Sperry transducer for the straight beam scans and a Type SOB, 2.25 MHz, 1"x1", style 50D268 Sperry wheel transducer for the angle beam scans. The test instrument was a Sperry UM 50B700 Reflectoscope.

The examination procedure is not specific with regard to the angle used for the angle beam examination, whether the angle beam calibration block was clad, with stainless steel, notch configuration, or recording levels. However, shop practice at that time included use of 45° shear waves for angle beam inspections, unclad calibration blocks, a vee-notch configuration and 100% of reference recording levels.

The table of results provided with the vessel post-hydro examination procedure indicates no straight beam or angle beam indications detected in the area of interest.

Vessel Preservice Ultrasonic Examinations Records

The Indian Point Unit 3 vessel preservice examination was performed by Westinghouse in the Spring (March-April) of 1975. Examinations were conducted using the remotely operated vessel inspection tool in accordance with the requirements of Inspection Procedure ISI-52, Revision 1, "Operating Procedure for Reactor Vessel Inspection Using the Westinghouse Remote Inspection Tool", dated January 7, 1975. The applicable Inservice Inspection Code was the 1970 Edition of Section XI of the ASME Boiler and Pressure Vessel Code.

The examination procedure and inspection program plan identified a scan pattern for the shell portion of the vessel whereby the lower shell course longitudinal welds, the intermediate-to-lower shell course circumferential weld, and the intermediate shell course longitudinal welds were examined in a continuous series of parallel circumferential scans. This procedure resulted in all the vessel shell plate material being scanned rather than the code required one base metal thickness on either side of the welds. These areas were examined using straight beam and 55° longitudinal wave and 60° shear wave angle beams in both circumferential and both axial directions. Calibration for the straight beam examination was established on 3/8" diameter side drilled holes at depths of 2, 4, 6 and 9 inches in a clad calibration block identified as #ISI-006A. Calibrations for the 55° longitudinal wave and 60° shear wave angle beam examinations were established on 3/8" diameter side drilled holes at depths of 2, 4 and 6 inches in calibration block #ISI-006B. Compensation for smooth cladding on the calibration block was accomplished by removing 3 to 4 dB of attenuation; i.e. increasing the sensitivity by 3 to 4dB.

Examinations were performed using Automation Industries style 57A9342, 2.25 MHz, 1 1/2" diameter transducers. The test instrument was an Automation Industries Model UM 771 Reflectoscope.

A review of computer printouts and the summary of results provided in the vessel preservice examination report indicates no straight beam or angle beam indications in the area of interest.

ADDITIONAL INVESTIGATIONS

In order to further evaluate the source of the three ultrasonic indications in weld #10 of the Indian Point Unit 3 reactor vessel, a three phase investigation program was initiated. The first phase of the program involved use of conventional data gathering techniques and included:

- 2.25 MHz straight beam scanning of the area of interest at sensitivities 6 to 10dB greater than that specified by ASME XI.

- 2.25 MHz, 45° and 60° shear wave scans of the area of interest in both circumferential directions at 0.1" increments at sensitivities 6 to 10dB greater than that specified by ASME XI.

- studies using angulated longitudinal waves to evaluate the directivity characteristics of the reflector.

The second phase of the program involved use of the Dynacon Ultrasonic Data Recording and Processing System (UDRPS) and included:

- 2.25 MHz straight beam scanning of the area of interest at 0.1" increments.

- 2.25 MHz, 45° and 60° shear wave angle beam scanning of the area of interest in both circumferential directions at 0.2" and 0.375" increments.

- 2.25 MHz, 30° shear wave angle beam scanning of the area of interest in both circumferential directions at 0.375" increments, selected in order to generate a creeping wave along the vessel O.D. surface.

- 2.25 MHz, 45° longitudinal wave angle beam scanning of the area of interest in the counterclockwise direction at 0.375" increments.

The third phase of the program involved application of 2.0 MHz 45° shear wave focused probes to interrogate the area of interest in both circumferential directions at 0.375" increments.

SUMMARY OF RESULTS

Phase 1

High sensitivity straight beam scans of the area of interest revealed an indication at a depth of 7.8" from the inner diameter surface with a maximum amplitude of 20% of the distance- amplitude-curve (DAC). The indication was detected at 300° vessel axis with peak amplitude location at 227.5" from the

top of the vessel flange. The indication could be followed for a length along the weld axis of 1.51" to 20dB drop points. Concurrent with the peak amplitude of this indication a reduction in backwall signal response was observed.

High sensitivity 45° shear wave scans of the area of interest in both the clockwise and counterclockwise directions confirmed the presence of the indication echo noted in the initial evaluation. This analysis also revealed the presence of leading ("first echo") and trailing ("third echo") echoes which were associated with the indications originally recorded ("second echo"). Peak amplitudes of the first and third echoes were on the order of 6dB to 10dB lower than the peak amplitude of the second echo. The dynamics of these echoes were such that as the transducer was moved away from the weld centerline, the first would appear and peak at approximately 165 microseconds. As this first echo began to diminish in amplitude with continued motion of the transducer, the second echo would begin to appear further out in time and peak at approximately 190 microseconds. And finally, as the second echo would begin to diminish in amplitude the third would begin to appear and peak at approximately 210 microseconds. The 60° shear wave angle beam examination results in the area of interest exhibited similar behavior. The reflector could be seen in both the clockwise and counterclockwise scan directions and three distinct echoes could be observed as the transducer moved across the reflector. The second echo exhibited the largest amplitude. The first and third echo amplitudes were on the order of 6 to 10dB lower than that of the second. The three echoes exhibited nominal transit times of 220 microseconds, 240 and 275 microseconds for the first, second, and third, respectively. When the peak transit time data were overlayed with the straight beam results, it began to appear that the source of the three echoes was actually three different beam paths to the same reflector at 7.8" from the vessel inner diameter surface. Appendix A provides examples of conventional ray trace diagrams where peak amplitude locations of the three echoes are plotted for indications #10, #11 and #16 using the Westinghouse Computer Aided Mapping Program (CAMP). The peak amplitude location of the straight beam indication is also superimposed on these plots for reference.

This behavior is consistent with prior experience concerning the angle beam echodynamic response of reflectors near the surface opposite that from which the examinations are performed. It has been observed when reflectors are near the opposite surface, evaluation by conventional ray tracing methods is complicated because of the interaction between the ultrasonic beam, the reflector, and the opposite surface. In these cases, ultrasound can return to the transducer by various propagation paths. Thus a single reflector may produce three or more echoes at different transit times. As the angle beam transducer is moved away from the reflector the echoes which can be observed, as a minimum, include a direct echo, corner effect echo, direct echo after reflection, and the echo after reflection. These are graphically illustrated in Figure 3. Other echoes are possible, such as a direct return from the reflector to the backwall or those which may result from mode conversion effects. Each possibility can be explained by the physical laws of ultrasonics, but are difficult to predict specifically because of the interactions between beam angle, reflector geometry and proximity of the reflector to the surface.

During these high sensitivity studies it was also observed that the reflector could be seen using 45° shear wave angle beam scanning in one axial direction. When the area was interrogated with the 45° transducer aimed toward the bottom of the vessel, two echoes with relatively little travel were observed at transit times of approximately 175 and 190 microseconds.

Studies were conducted using refracted longitudinal waves through a complement of angles to evaluate the reflectivity characteristics of the reflector. These studies were accomplished by peaking on the straight beam indication and angulating the array plate in 0.6° steps. After each step the indication was peaked by moving the transducer array in the appropriate circumferential direction. These studies showed that the reflector at 7.8" depth provided a good response from 0° to 26° refracted angle in the clockwise and counterclockwise direction (before these studies were terminated). Further studies with the UDRPS data acquisition system confirmed the reflector was also apparent with 45° longitudinal waves directed in the counterclockwise direction.

Phase 2

Straight beam studies using the UDRPS system confirmed the presence of a reflector at approximately 300° vessel axis, 7.8" deep (nominally), which ran parallel to the length of the weld seam for a length of approximately 4.5". The reflector was also imaged at a point in time past the first backwall reflection, indicative of illumination of the reflector by sound reflecting from the backwall. These observations are illustrated in Figures C-1 through C-3. Furthermore, the block map in Figure C-4 illustrates the "stringer-like" nature of the reflector with little or no change in depth or position with respect to the weld centerline along its length. These observations suggest a volumetric-type reflector.

The 45° and 60° shear wave studies using the UDRPS system confirmed the presence of at least three distinct echoes associated with the reflector as observed in the Phase 1 effort. By virtue of the higher sensitivity afforded by the UDRPS system, other echoes may also be observed in the angle beam data. These echoes all appear to be multipath and mode converted responses from the reflector because corresponding signals do not appear in the straight beam data, they do not correlate spatially either between examinations using the same angle from opposing direction or between examinations using different angles, and their relative positions and amplitudes are consistent with ray tracing models for multipath and mode converted signals. No features such as diffraction peaks or sattelite pulses were observed in the angle beam data.

In order to confirm the volumetric nature of the reflector and provide confidence that there was no extension to the outer diameter surface, a 30° shear wave examination was conducted in both circumferential directions. The objective of this examination was to transmit 30° shear waves to the vessel outer diameter surface which would mode convert into high angle longitudinal waves at 65° to 70° and higher angle bulk or creeping waves. Concurrent with this examination, the efficacy of this technique was demonstrated on a curved 9" thick calibration block at the Waltz Mill Service Center where the same incident angle was demonstrated to detect notches in a 9" thick calibration block with large signal amplitudes at gain settings significantly lower than those used during the UDRPS examination.

Scans with the 30° shear wave technique in the counterclockwise direction resulted in indications at transit times indicative of direct reflection of the 30° shear wave and 65° longitudinal wave beam components. There was no evidence of a corner reflection using the 30° shear waves or any other evidence of extension of the reflector to the vessel outer diameter surface. See Figures C-17 through C-20.

The 45° longitudinal wave investigation clearly imaged the reflector at a depth of approximately 7.8" when scanning in the counterclockwise direction. No information was noted in the clockwise direction. Results are presented in Figures C-21 through C-23.

Phase 3

Parameters for the 45° shear wave focused probe examination were established at the Westinghouse Waltz Mill Service Center using a clad 9" thick reference block from a 4-loop reactor vessel which contained a variety of reflectors. The transducer was 90 mm in diameter with a lens cut to accommodate an 70.0" concave cylindrical interface. The design focal depth was 6.7" and the focal length ranged from 5.1" to 8.3". During these parametric studies at the Service Center, this transducer was demonstrated capable of resolving a 1/8" diameter side drilled hole located 1/8" from the block outer diameter surface, a 3/4" deep slot in the side of the block located 1/8" from the block outer diameter surface, and outer diameter surface notches having depths of 0.1", 0.3", 0.5" and 1.5".

The scans in the field with the 45° shear wave focused transducer detected no indications.

CONCLUSIONS

A review of all data gathered during this investigation indicates the three indications initially recorded in weld #10 of the Indian Point Unit 3 reactor vessel actually result from a single reflector which is volumetric in nature. The reflector is imaged over a wide range of interrogation angles, appears longest with high sensitivity straight beam scans and appears to be a slag

stringer at a depth of 7.8" from the inner diameter surface. The straight beam results illustrate the "stringer-like" nature of the reflector with little or no change in depth or location with respect to the weld centerline along its axis. The reflector shadows the backwall echo indicating significant cross-section to the sound beam and multiple reflections can be observed between the outer diameter and the "back side" of the reflector. Angle beam results confirm a reflector at approximately the same depth, azimuth and elevation as the straight beam results. Slight variations are observed in the positioning of the reflector, however, these are not unexpected due to shear wave beam angle variations which may result due to cladding effects, local deviation of the scan surface from a perfect circular arc and slight offsets between examinations which may have been introduced. 45° and 60° UDRPS plots are provided in Figures C-5 through C-16. The angle beam results are consistent with the echodynamic response expected from a volumetric reflector near the surface opposite from which examinations are performed. This may be illustrated by a brief example of the detailed analysis logic. Observing the blockmaps from each examination in Appendix C, the direct response from the reflector is seen as the shallowest linear cluster of detections. Other linear clusters are seen over the same weld length at greater depths and having some azmuthal offset from the direct response. For each examination angle these offsets are in opposing direction for secondary echoes from opposing examination directions. The depths of these clusters of detections correspond to the multipath analysis example provided in Figure 4. Review of the 45° shear wave angle beam blockmaps in Figures C-7 and C-10 show that the depths and directions of offsets of the detection clusters are consistent with this model. An analysis of the 60° shear wave data results in a similar correlation. In fact, the 45° and 60° indications originally detected were not direct responses from the reflector but a result of corner effects and/or mode conversion effects created because of the proximity of the reflector to the vessel outside diameter surface. In all cases, the amplitudes of the direct echoes were below the 50% DAC recording levels specified in Section XI of the ASME Code. Further support of the volumetric nature of the reflector is provided based on the fact it was detected in one direction using a 45° shear wave scan parallel to the weld. There is no evidence of any extension of the reflector to the vessel outer diameter surface. This observation is confirmed

by the 0°, 45° focused probe and 30° shear wave examinations. Multiple reflections were observed between the vessel backwall and the "back side" of the reflector with high sensitivity straight beam scans. The 45° focused probe examinations showed no evidence of a corner reflector and the 30° shear wave examination, used to interrogate the material between the reflector and the outer diameter surface with mode converted longitudinal waves showed no indications in the ligament area.

In the absence of any angle beam features, i.e. diffraction peaks or sattelite pulses, which could be used for sizing, the reflector through-wall dimension (2a) was determined based on time of flight measurements from the straight beam data. The UDRPS straight beam map, Figure C-1, provides the data used for this analysis. The direct response from the reflector (d_0) is 7.7" from the vessel inside diameter surface and the backwall echo (T) appears at 8.9". Multiples from the reflector are also apparent at (d_1) 10.03", (d_2) 10.83", and (d_3) 11.97". The second multiple reflection (d_2) was selected to determine the size. This approach provided the most conservative result. Recognizing the distance to the second multiple past the backwall reflection represented two round trips, the through-wall dimension is expressed as:

$$2a = T - d_0 - \left(\frac{d_2 - T}{2}\right) = 0.235"$$

The length of the reflector, based on 50% DAC measurements from the conventional analysis was 4.48", refer to Figure 1. Thus, for the purposes of ASME XI evaluation per IWB-3500, the reflector is considered subsurface, with 2a = 0.24", and l = 4.48". The aspect ratio (a/l) is 0.026 which has a corresponding allowable flaw size in terms of a/t equal to 2.37%. The calculated size in terms of a/t is 1.7%, thus the reflector is acceptable to the 1974 Edition of ASME XI with Addenda through Summer 1975.

Review of shop and PSI UT NDE records indicate that differences in ultrasonic techniques applied during the vessel shop map and preservice examinations versus those used for the 10th year ISI easily account for the fact that the reflector was not recorded during prior ultrasonic examinations. In the case of the shop UT map, 45° angle beam examinations were calibrated on a notch,

3% of the calibration block wall thickness, in an unclad block. The recording level was 100% of the notch response. Conservatively, this procedure results in a recording level on the order of 12dB less sensitive than that applied for the inservice examination. Furthermore, 45° shear wave scanning was not performed in the counterclockwise direction, the direction in which the reflector was detected with the highest amplitudes during the inservice examination. The vessel PSI was performed using interrogation angles of 55° in the longitudinal mode and 60° in the shear mode with the recording levels based on 100% of a DAC established on 3/8" diameter side drilled holes in a clad calibration block. In this case, no 45° shear wave examinations were performed and the difference in recording levels (50% DAC for ISI versus 100% DAC for PSI) account for the fact the indication was not observed with the 60°S scans during PSI.

Considering the radiographic technique, the location of the reflector is such that it is nearest the source side, thus decreasing the probability of detection. There is also evidence from the ultrasonic investigation that the shape of the reflector is not circular in cross-section but may be a half moon or "U" shape, see figures C-2 and C-3. Thus the effective section thickness in a plane parallel to the interrogating radiation might not have been reduced sufficiently to provide a strong image on the radiographic film.

INDIAN POINT UNIT 3
REACTOR VESSEL

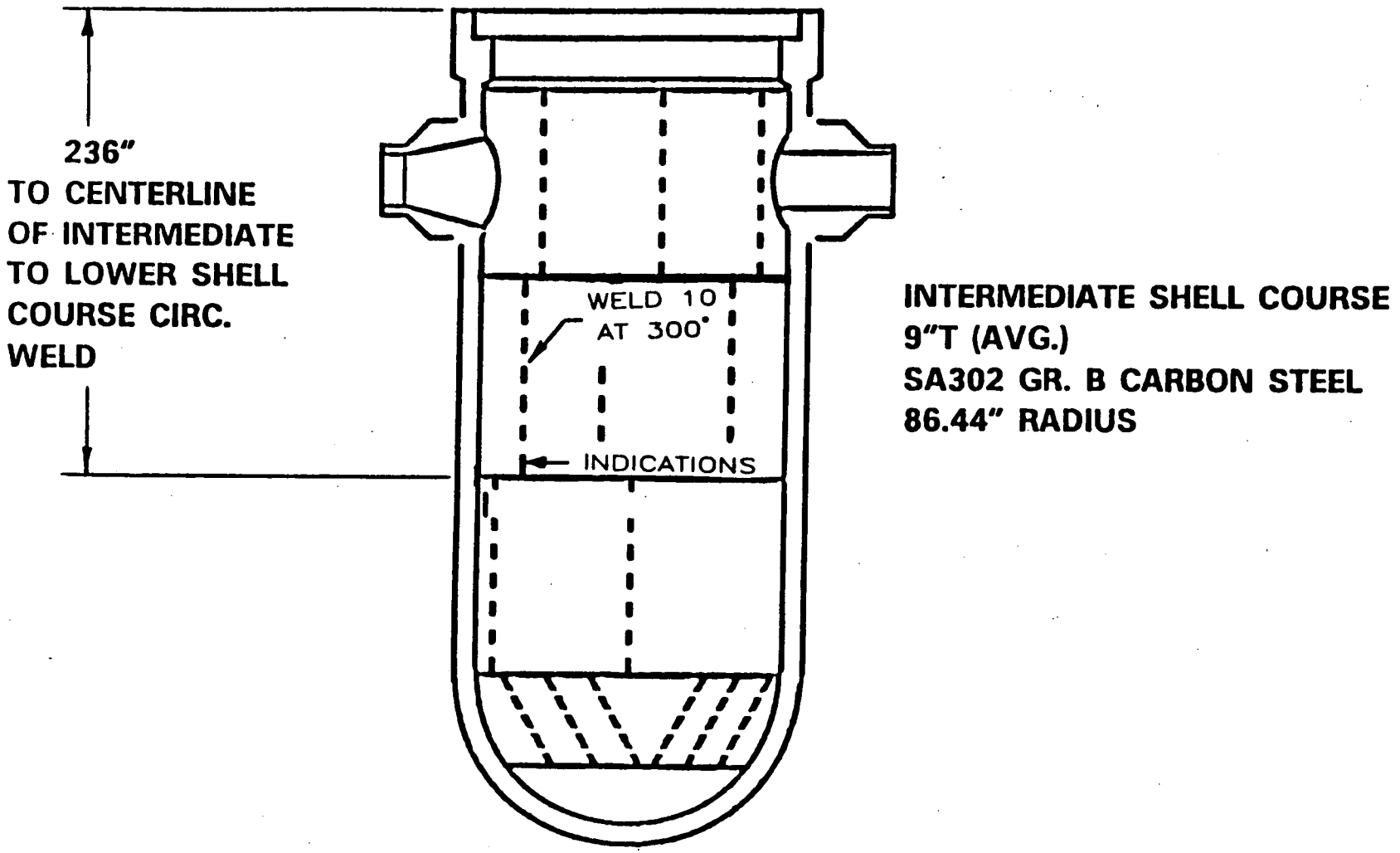

Figure 1: Indian Point Reactor Vessel

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI

WELD 10 INDICATION MAP

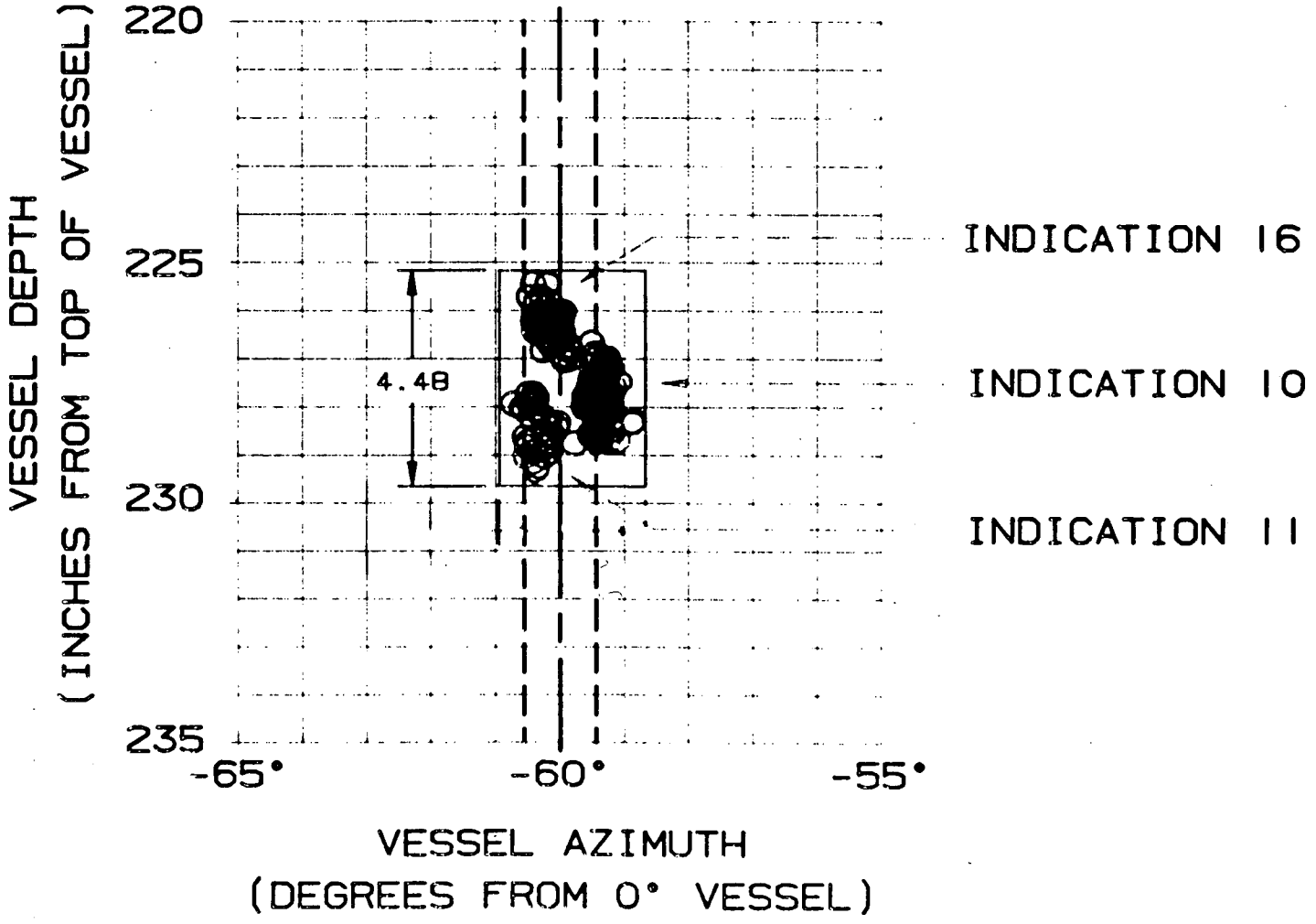

Figure 2: Weld 10 Indication Map

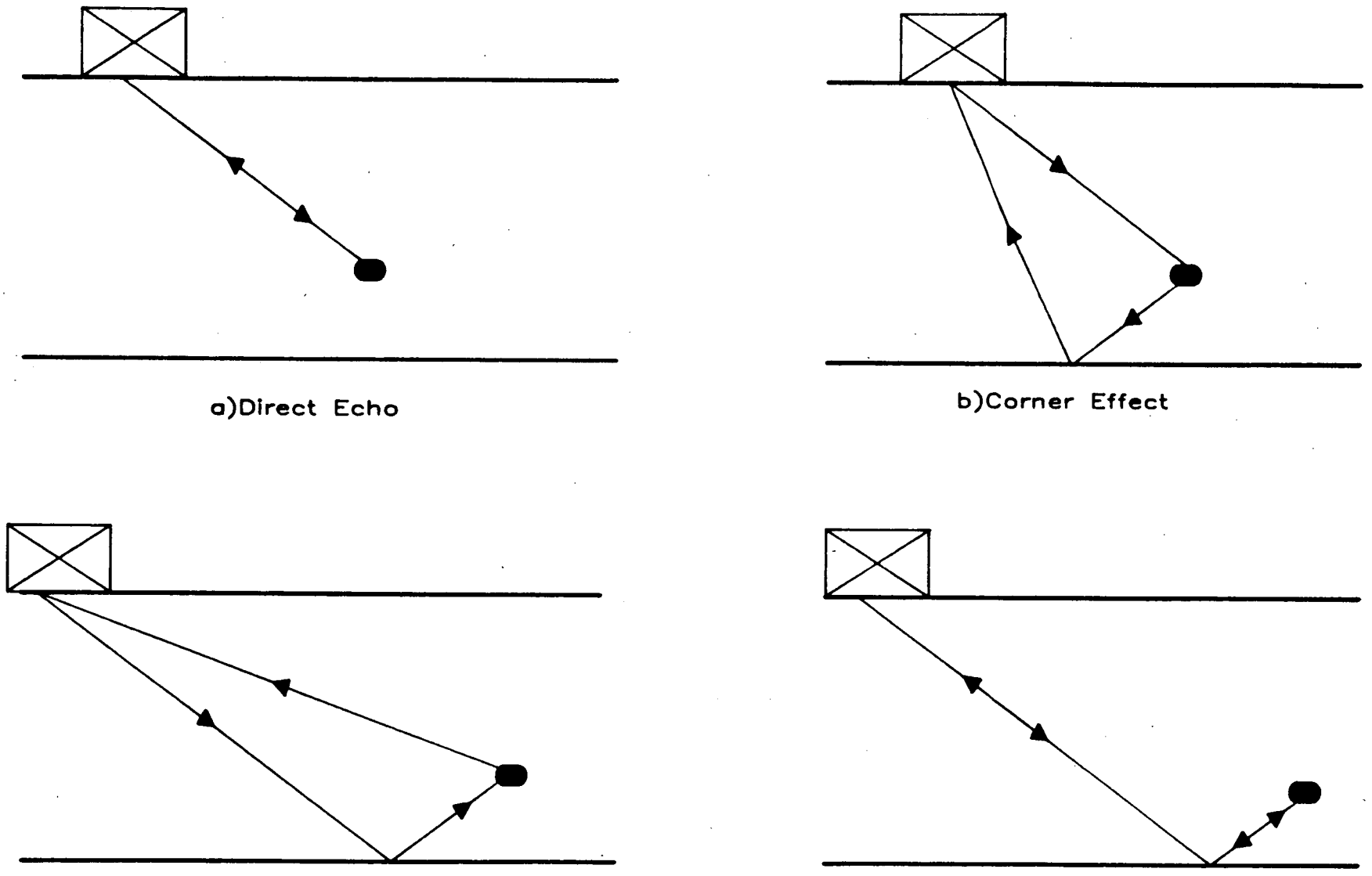

Figure 3: Possible Responses From Reflector Near Opposite Surface (Illustrative Only)

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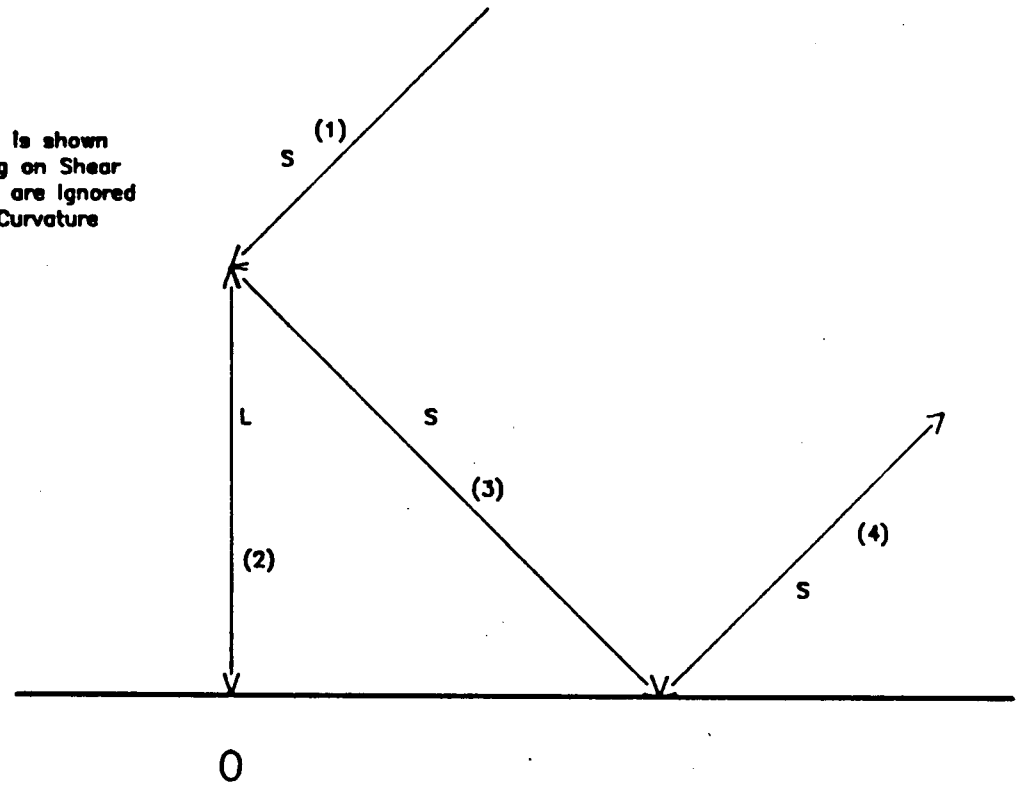
Note:
1.) Only One Direction Is shown
2.) Effects of Cladding on Shear Wave Beam Angle are Ignored
3.) Effects of Vessel Curvature are Ignored



45°S MULTI–PATH ANALYSIS

GROUP	PATH	DEPTH
A	(1–1) S–S	7.5
B	(1–2–2–1) S–L–L–S	8.25
C	(1–3–4 & 4–3–1) S–S–S	9.0
D	(4–3–3–4) S–S–S–S	10.5

Figure 4: 45°Shear Wave Multi–Path Analysis

APPENDIX A

COMPUTER AIDED MAPPING
PLOTS OF INDICATIONS #10, #11 AND #16

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Table A—1: CAMP Data, Indication 10

NEW YORK POWER AUTHORITY

INDIAN POINT UNIT NO. 3

REACTOR VESSEL INSERVICE EXAMINATION

JUNE 1987

WELD NO. 10 INDICATION COORDINATES

INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
10	86.50	-67.01	228.35	59.94	95.10	-59.00	228.35
10.1	86.50	-67.54	226.92	59.94	95.10	-59.53	226.92
10.2	86.50	-67.14	227.02	59.94	94.17	-59.86	227.02
10.2	86.50	-67.51	227.02	59.94	95.11	-59.49	227.02
10.2	86.50	-68.03	227.02	59.94	95.08	-59.33	227.02
10.3	86.50	-67.38	227.12	59.94	95.05	-59.41	227.12
10.3	86.50	-68.03	227.12	59.94	95.08	-59.33	227.12
10.4	86.50	-67.40	227.22	59.94	95.04	-59.43	227.22
10.4	86.50	-67.98	227.22	59.94	95.10	-59.30	227.22
10.5	86.50	-67.35	227.33	59.94	95.03	-59.39	227.33
10.5	86.50	-68.01	227.33	59.94	95.09	-59.32	227.33
10.7	86.50	-67.03	227.52	59.94	94.40	-59.56	227.52
10.7	86.50	-67.19	227.52	59.94	95.10	-59.18	227.52
10.7	86.50	-68.57	227.52	59.94	94.57	-59.47	227.52
10.8	86.50	-67.19	227.63	59.94	94.55	-59.60	227.63
10.8	86.50	-67.19	227.63	59.94	95.01	-59.25	227.63
10.8	86.50	-68.64	227.63	59.94	94.50	-59.49	227.63
10.9	86.50	-67.18	227.73	59.94	94.52	-59.62	227.73
10.9	86.50	-67.22	227.73	59.94	94.99	-59.29	227.73

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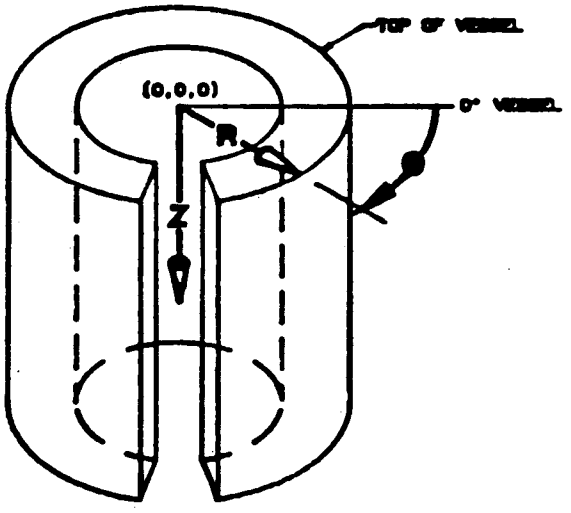
Table A—1: CAMP Data, Indication 10 (continued)

INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
10.9	86.50	-68.50	227.73	59.94	94.60	-59.43	227.73
10.10	86.50	-67.24	227.82	59.94	94.54	-59.66	227.82
10.10	86.50	-67.24	227.82	59.94	95.03	-59.28	227.82
10.10	86.50	-68.64	227.82	59.94	94.57	-59.54	227.82
10.11	86.50	-67.24	227.93	59.94	94.56	-59.65	227.93
10.11	86.50	-67.24	227.93	59.94	94.98	-59.32	227.93
10.11	86.50	-68.64	227.93	59.94	94.64	-59.60	227.93
10.12	86.50	-67.22	228.03	59.94	94.51	-59.67	228.03
10.12	86.50	-67.34	228.03	59.94	95.06	-59.36	228.03
10.12	86.50	-68.09	228.03	59.94	94.96	-59.30	228.03
10.13	86.50	-66.84	228.12	59.94	94.23	-59.51	228.12
10.13	86.50	-67.68	228.12	59.94	95.32	-59.50	228.12
10.13	86.50	-67.96	228.12	59.94	95.08	-59.27	228.12
10.14	86.50	-66.81	228.23	59.94	94.22	-59.49	228.23
10.14	86.50	-67.58	228.23	59.94	95.23	-59.47	228.23
10.14	86.50	-68.55	228.23	59.94	94.63	-59.50	228.23
10.15	86.50	-66.67	228.33	59.94	94.11	-59.44	228.33
10.15	86.50	-67.61	228.33	59.94	95.26	-59.48	228.33
10.15	86.50	-68.50	228.33	59.94	94.68	-59.49	228.33
10.16	86.50	-66.68	228.42	59.94	94.11	-59.44	228.42
10.16	86.50	-67.59	228.42	59.94	95.22	-59.49	228.42
10.16	86.50	-68.56	228.42	59.94	94.57	-59.46	228.42
10.17	86.50	-66.64	228.53	59.94	94.08	-59.43	228.53
10.17	86.50	-67.66	228.53	59.94	95.29	-59.50	228.53

Table A—1: CAMP Data, Indication 10 (continued)

INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
10.17	86.50	-67.97	228.53	59.94	95.08	-59.28	228.53
10.18	86.50	-66.50	228.63	59.94	93.96	-59.39	228.63
10.18	86.50	-67.66	228.63	59.94	95.29	-59.51	228.63
10.18	86.50	-68.48	228.63	59.94	94.70	-59.48	228.63
10.19	86.50	-66.78	228.72	59.94	94.16	-59.51	228.72
10.19	86.50	-66.94	228.72	59.94	94.74	-59.21	228.72
10.19	86.50	-68.14	228.72	59.94	94.93	-59.33	228.72
10.6A	86.50	-67.02	227.42	59.94	94.37	-59.58	227.42
10.6A	86.50	-67.43	227.42	59.94	95.13	-59.40	227.42
10.6A	86.50	-68.16	227.42	59.94	95.09	-59.47	227.42



REACTOR VESSEL SHELL WELD
C·A·M·P COORDINATE SYSTEM

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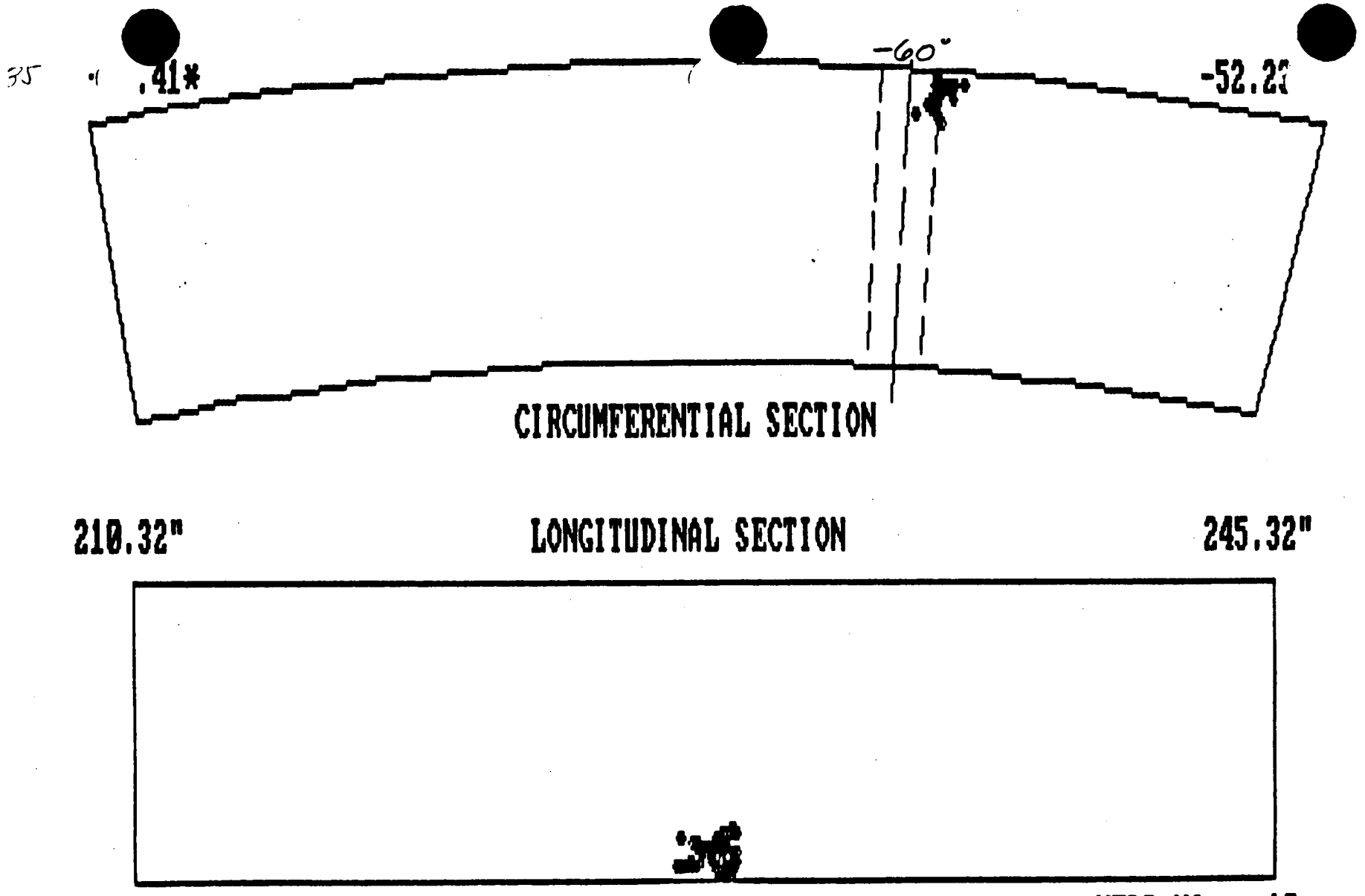
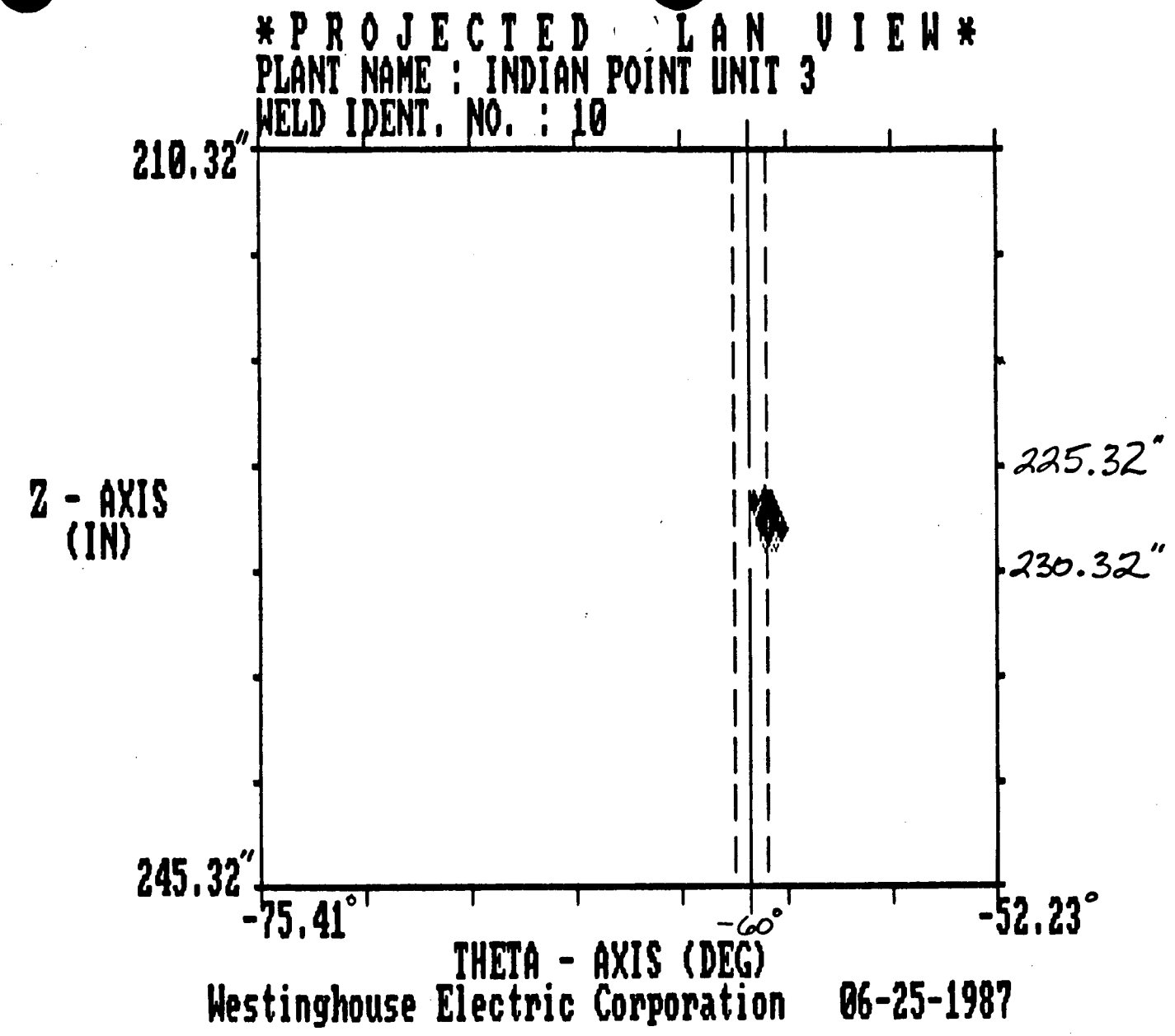


PLANT NAME: INDIAN POINT UNIT 3 WELD NO. : 10
Westinghouse Electric Corporation 06-25-1987

INDICATION NO. 10
TRANSDUCER NO. 25 (60°s)

Figure A—1: CAMP Plot, All Indication #10 Data

36

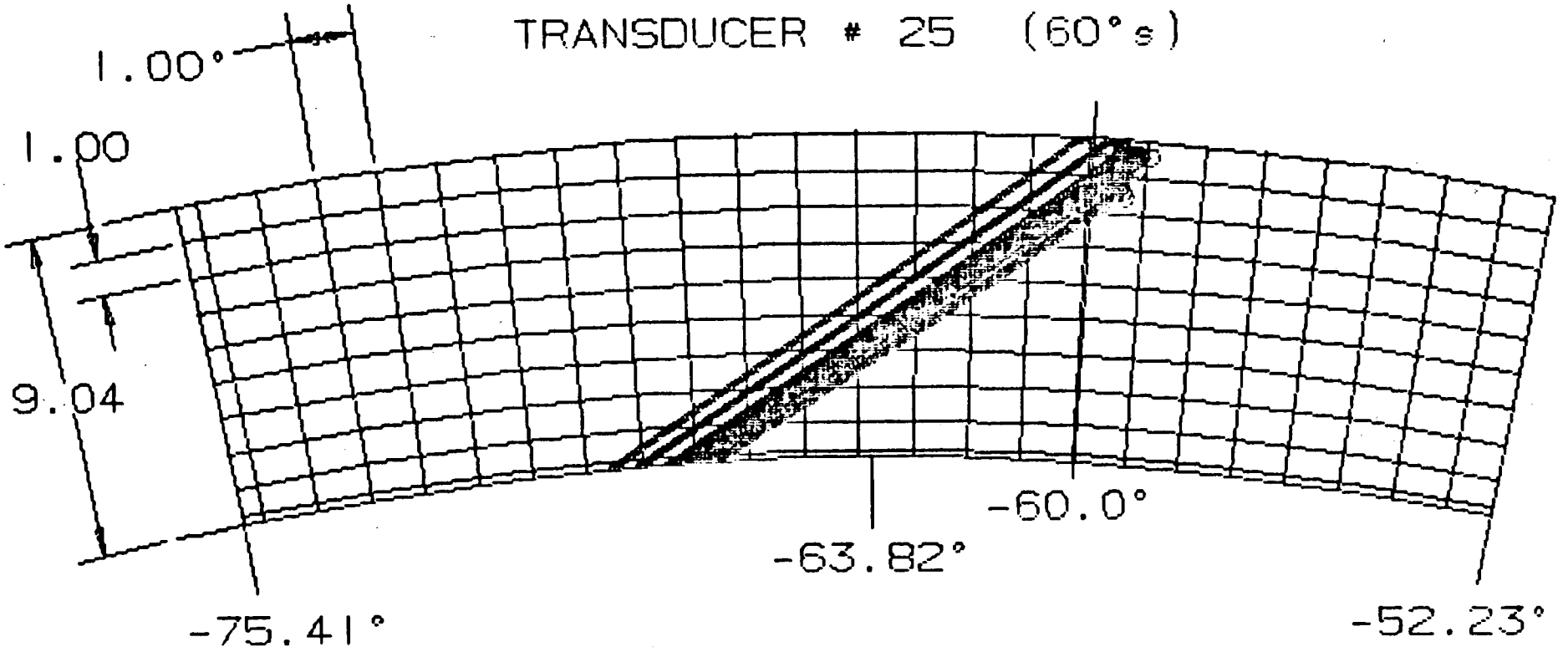


INDICATION NO. 10
TRANSDUCER NO. 25 (60°s)

Figure A—2: CAMP Plan View, All Indication #10 Data

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI

WELD # 10 INDICATION # 10
TRANSDUCER # 25 (60°s)

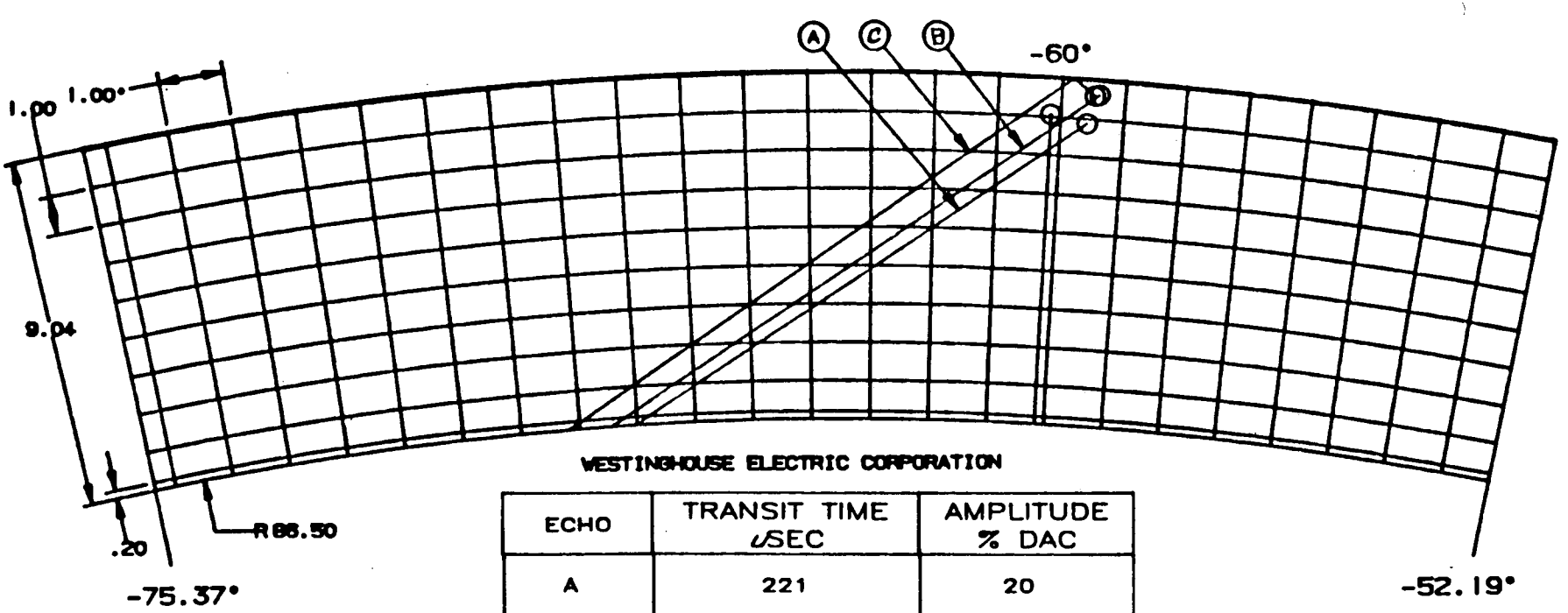


WESTINGHOUSE ELECTRIC CORPORATION

Figure A–3: Indian Point Unit 3, Indication #10, All Indication #10
Ray Trace Data

INDICATION 10 (60°e)
SLICE 10.6 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



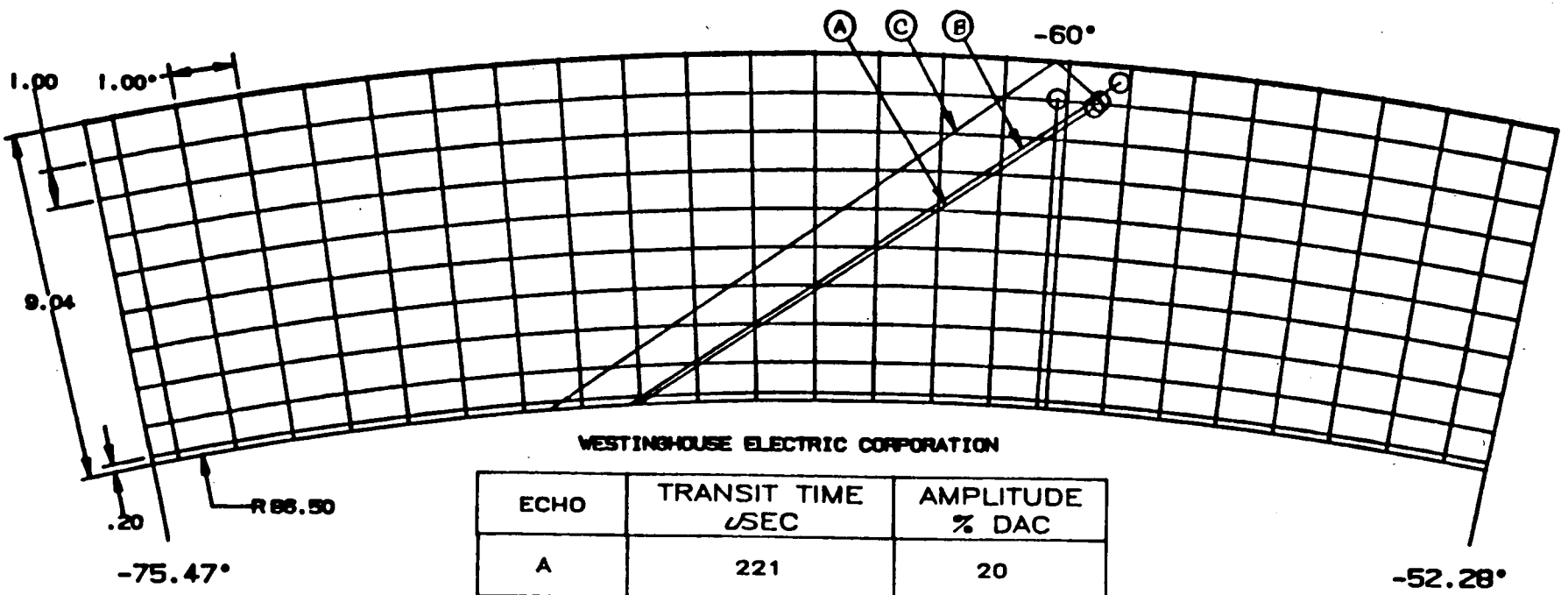
WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	221	20
B	240	52
C	262	45

Figure A—4: Indian Point Unit 3, Indication #10, Ray Trace Slice at 227.4"

INDICATION 10 (60°e)
SLICE 10.7 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



WESTINGHOUSE ELECTRIC CORPORATION

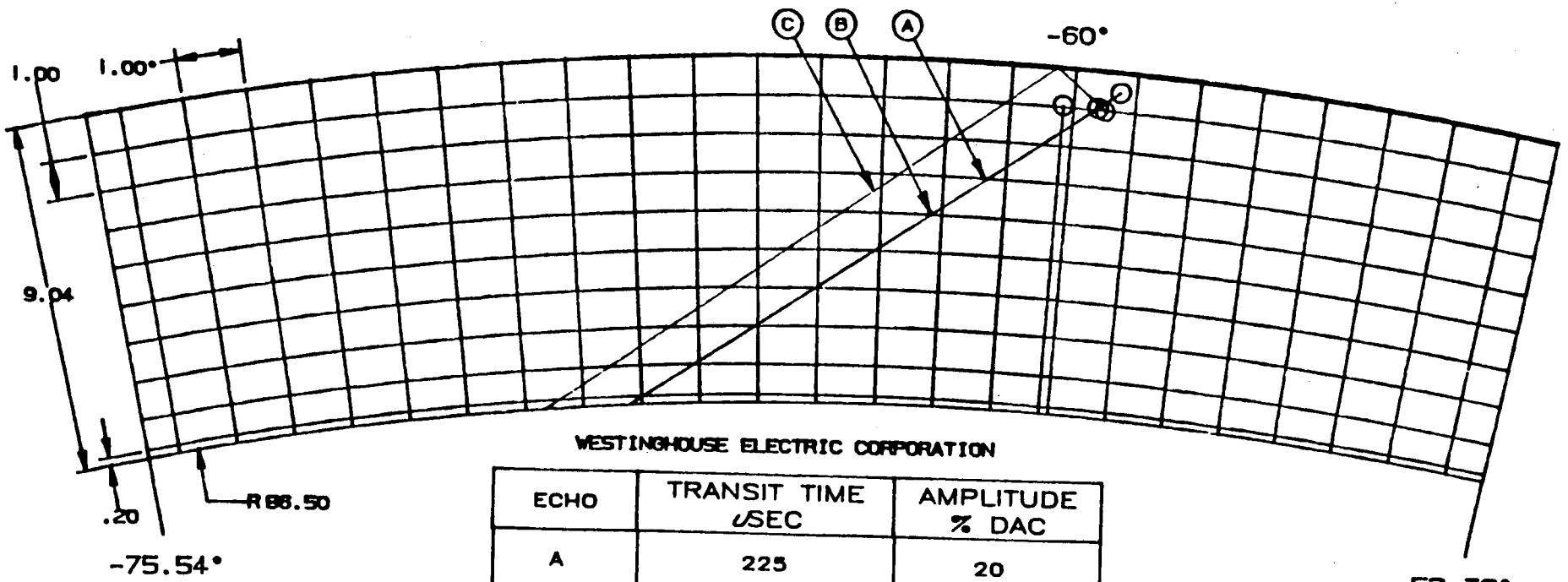
ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	221	20
B	239	48
C	275	50

Figure A–5: Indian Point Unit 3, Indication #10, Ray Trace Slice at 227.5"

4c

INDICATION 10 (60°)
SLICE 10.8 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



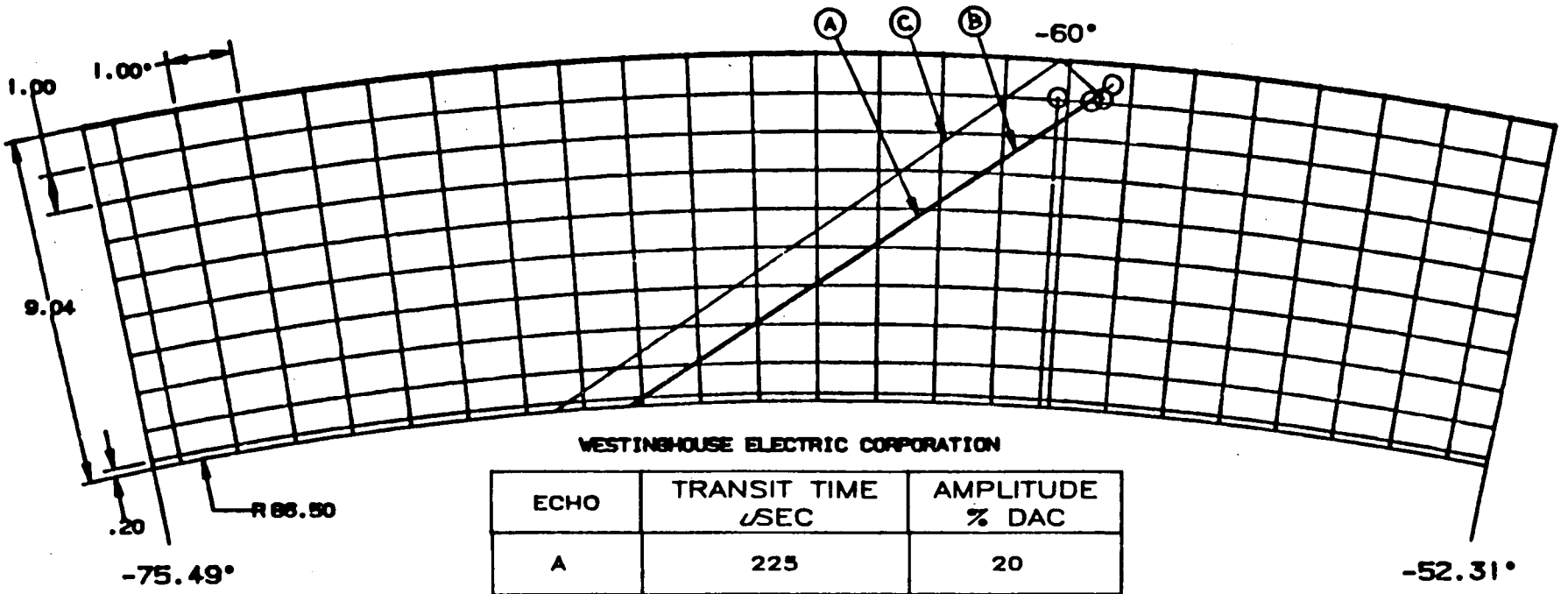
WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	225	20
B	237	50
C	277	48

Figure A–6: Indian Point Unit 3, Indication #10, Ray Trace Slice at 227.6"

INDICATION 10 (60°e)
SLICE 10.9 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	225	20
B	237	65
C	274	50

Figure A–7: Indian Point Unit 3, Indication #10, Ray Trace Slice at 227.7"

Table A-2: CAMP Data, Indication 11

NEW YORK POWER AUTHORITY

INDIAN POINT UNIT NO. 3

REACTOR VESSEL INSERVICE EXAMINATION

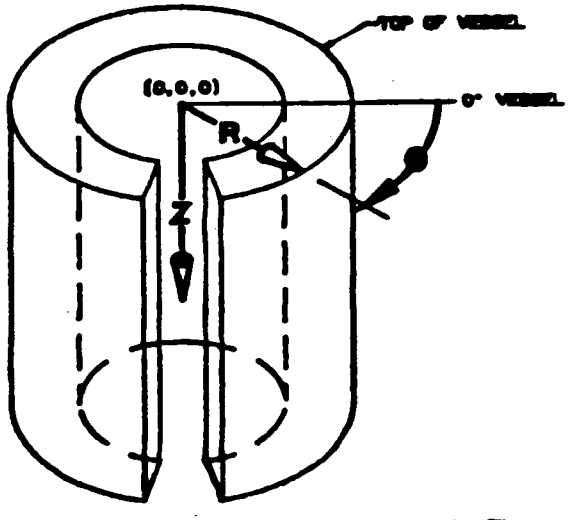
JUNE 1987

WELD NO. 10 INDICATION COORDINATES

INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
11	86.50	-54.48	228.75	-44.98	95.31	-59.79	228.75
11.1	86.50	-55.86	227.73	-44.98	94.31	-60.43	227.73
11.1	86.50	-55.16	227.73	-44.98	95.51	-60.34	227.73
11.2	86.50	-55.77	227.82	-44.98	94.35	-60.36	227.82
11.2	86.50	-55.11	227.82	-44.98	95.53	-60.31	227.82
11.3	86.50	-55.88	227.93	-44.98	94.25	-60.42	227.93
11.3	86.50	-55.88	227.93	-44.98	94.67	-60.63	227.93
11.3	86.50	-55.16	227.93	-44.98	95.47	-60.32	227.93
11.4	86.50	-55.99	228.03	-44.98	94.17	-60.49	228.03
11.4	86.50	-55.14	228.03	-44.98	95.48	-60.31	228.03
11.4	86.50	-54.90	228.03	-44.98	94.70	-60.52	228.03
11.5	86.50	-55.11	228.12	-44.98	95.50	-60.28	228.12
11.6	86.50	-55.90	228.23	-44.98	94.15	-60.39	228.23
11.6	86.50	-54.98	228.23	-44.98	95.48	-60.21	228.23
11.7	86.50	-54.66	228.33	-44.98	95.22	-60.02	228.33
11.8	86.50	-54.70	228.42	-44.98	95.24	-60.04	228.42
11.9	86.50	-54.91	228.57	-44.98	94.50	-59.58	228.57
11.9	86.50	-54.76	228.57	-44.98	95.25	-60.10	228.57
11.9	86.50	-54.69	228.57	-44.98	94.94	-60.19	228.57

Table A—2: CAMP Data, Indication 11 (continued)

INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
11.10	86.50	-55.80	228.63	-44.98	94.52	-60.48	228.63
11.10	86.50	-54.77	228.63	-44.98	95.29	-60.09	228.63
11.11	86.50	-55.74	228.72	-44.98	94.54	-60.43	228.72
11.11	86.50	-54.84	228.72	-44.98	95.33	-60.14	228.72
11.12	86.50	-55.79	228.83	-44.98	94.47	-60.44	228.83
11.12	86.50	-54.90	228.83	-44.98	95.38	-60.17	228.83
11.13	86.50	-55.65	228.93	-44.98	94.56	-60.35	228.93
11.13	86.50	-54.83	228.93	-44.98	95.33	-60.13	228.93
11.14	86.50	-55.77	229.02	-44.98	94.55	-60.46	229.02
11.14	86.50	-54.95	229.02	-44.98	95.41	-60.21	229.02
11.15	86.50	-55.20	229.13	-44.98	95.45	-60.35	229.13
11.16	86.50	-55.11	229.23	-44.98	95.53	-60.30	229.23
11.17	86.50	-55.11	229.32	-44.98	95.51	-60.32	229.32



REACTOR VESSEL SHELL WELD
C·A·M·P COORDINATE SYSTEM

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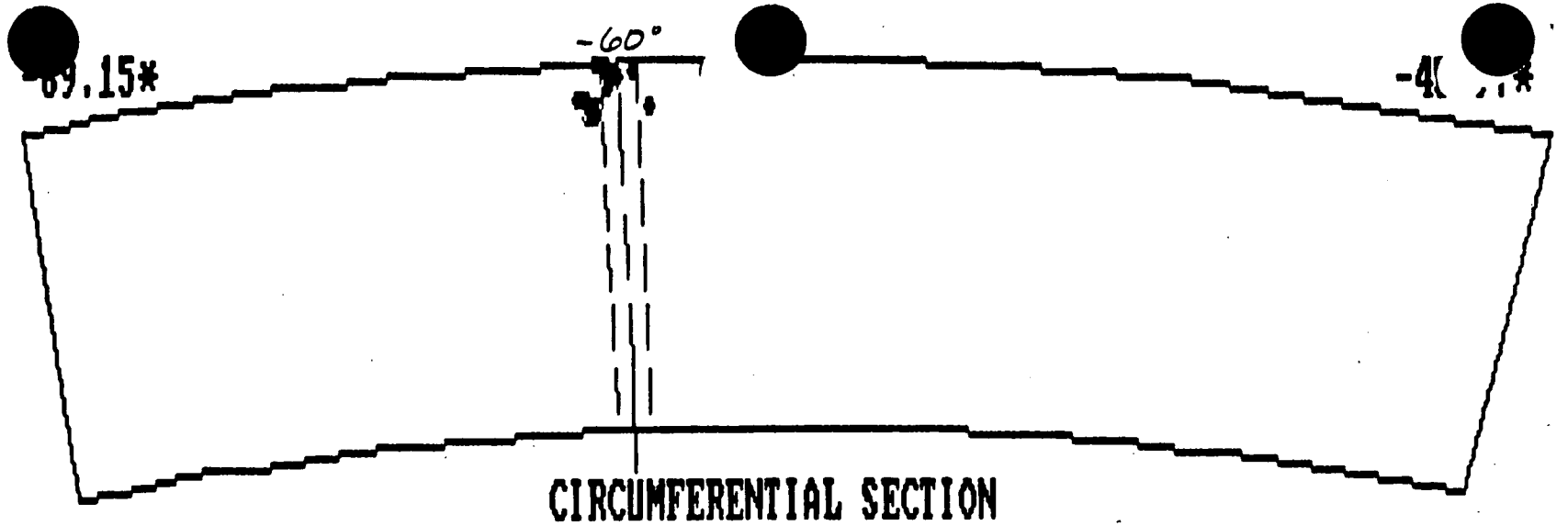
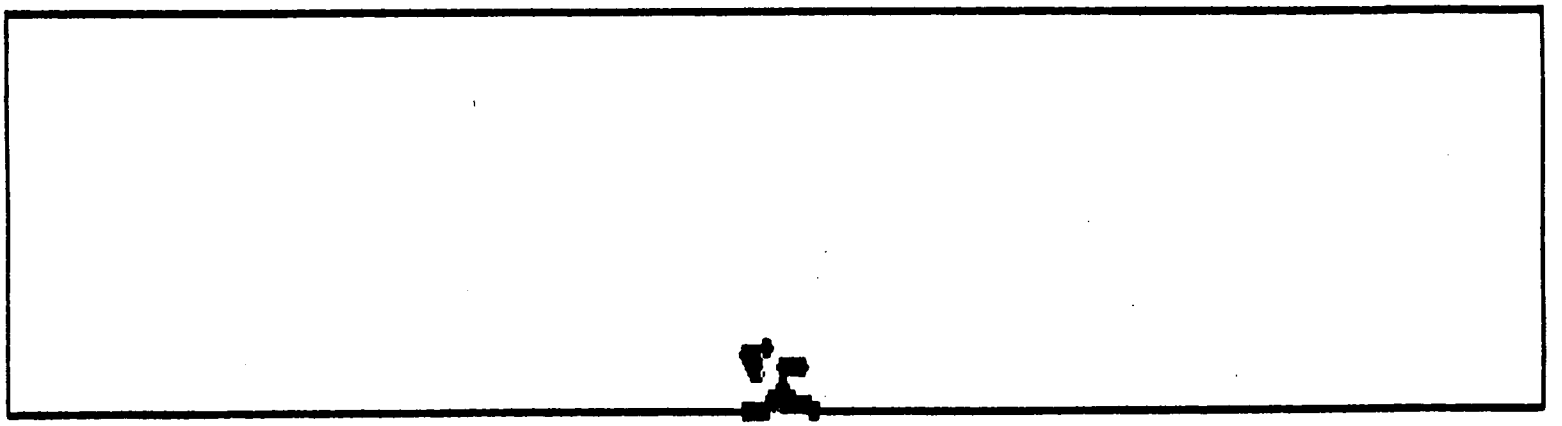


211.03" LONGITUDINAL SECTION 246.03"

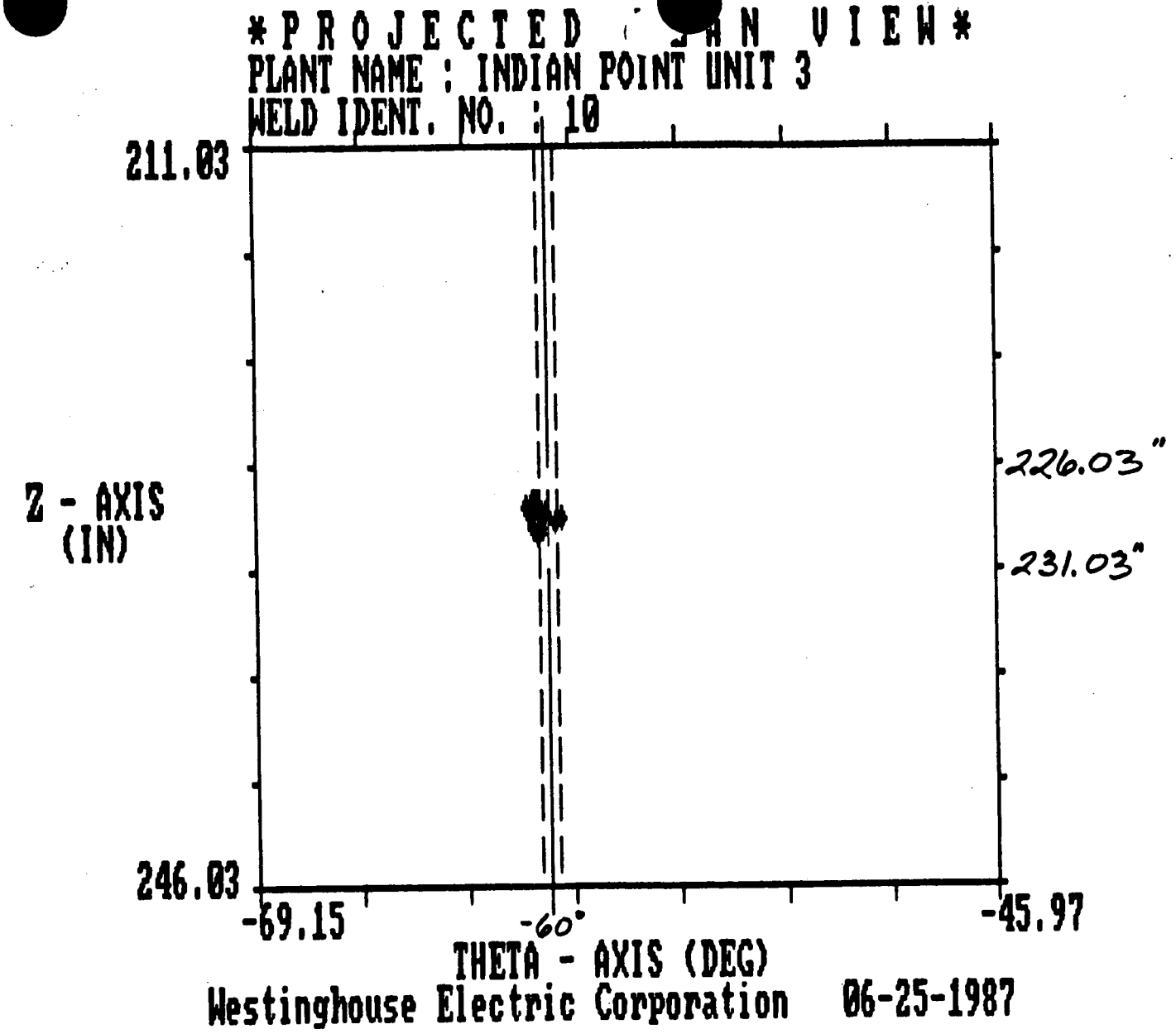


PLANT NAME: INDIAN POINT UNIT 3 WELD NO. : 10
Westinghouse Electric Corporation 06-25-1987

INDICATION NO. 11
TRANSDUCER NO. 22 (45°s)

Figure A–8: CAMP Plot, All Indication #11 Data

45

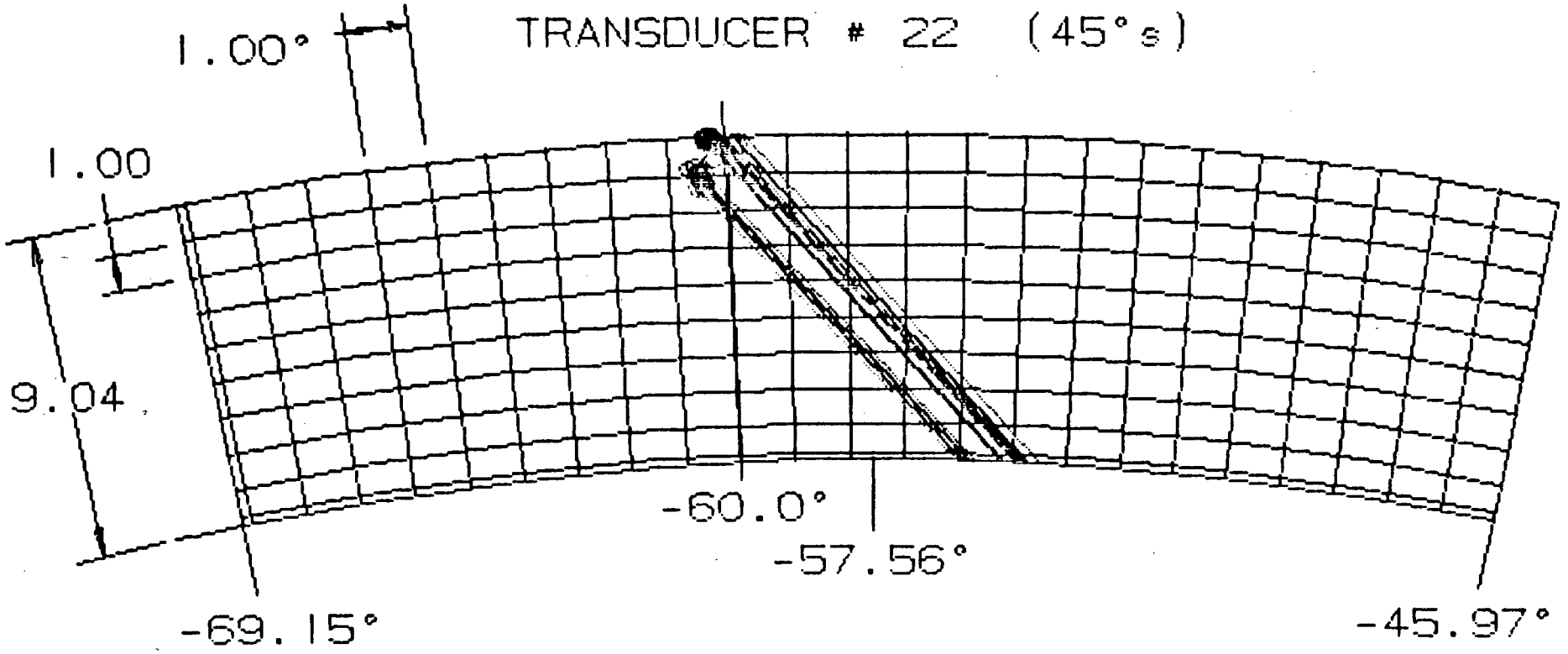


INDICATION NO. 11
TRANSDUCER NO. 22 (45°s)

Figure A–9: CAMP Plan View, All Indication #11 Data

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI

WELD # 10 INDICATION # 11
TRANSDUCER # 22 (45°s)



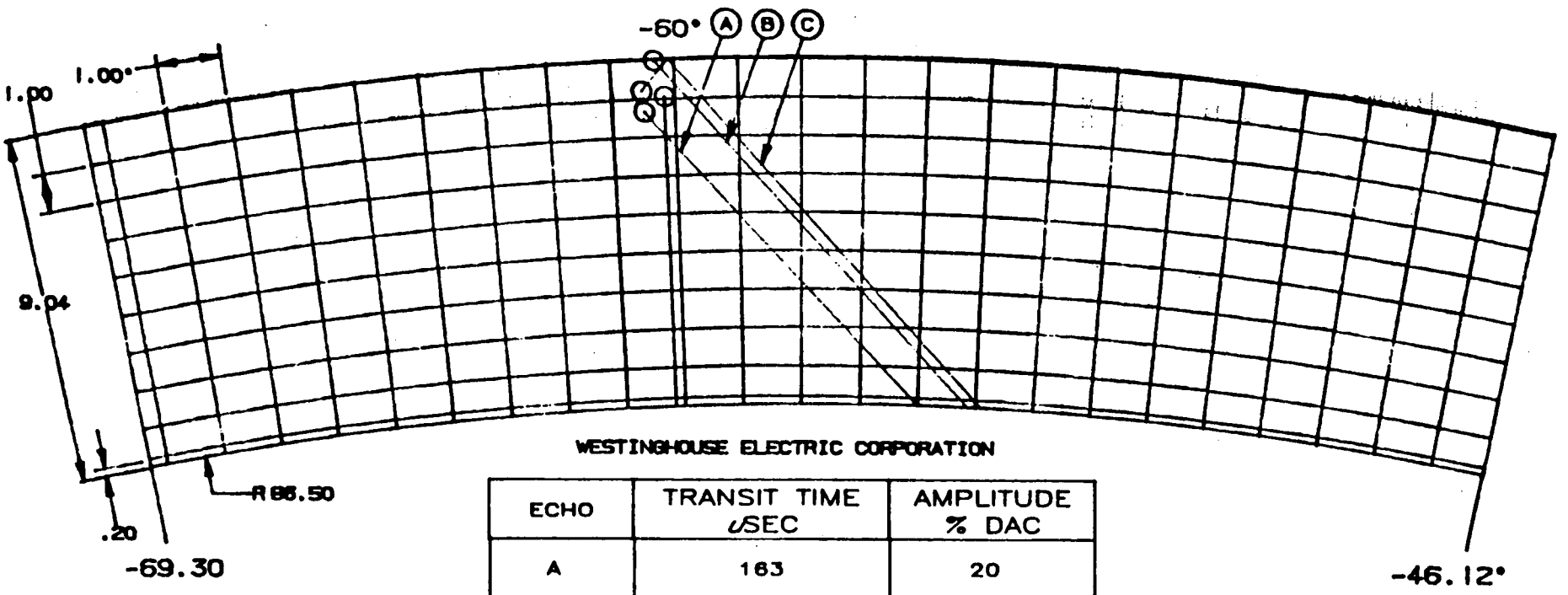
WESTINGHOUSE ELECTRIC CORPORATION

Figure A–10: Indian Point Unit 3, Indication #11, All Indication #11 Ray Trace Data

47

INDICATION 11 (45°s)
SLICE 11.4 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	163	20
B	190	85
C	208	18

Figure A–11: Indian Point Unit 3, Indication #11, Ray Trace Slice at 228.0"

Table A—3: CAMP Data, Indication 16

NEW YORK POWER AUTHORITY

INDIAN POINT UNIT NO. 3

REACTOR VESSEL INSERVICE EXAMINATION

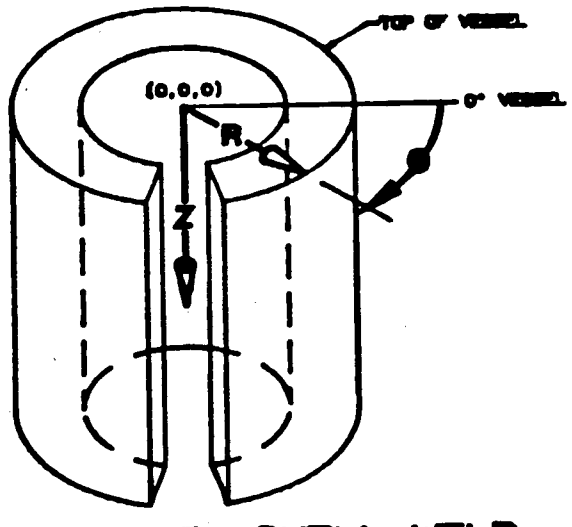
JUNE 1987

WELD NO. 10 INDICATION COORDINATES

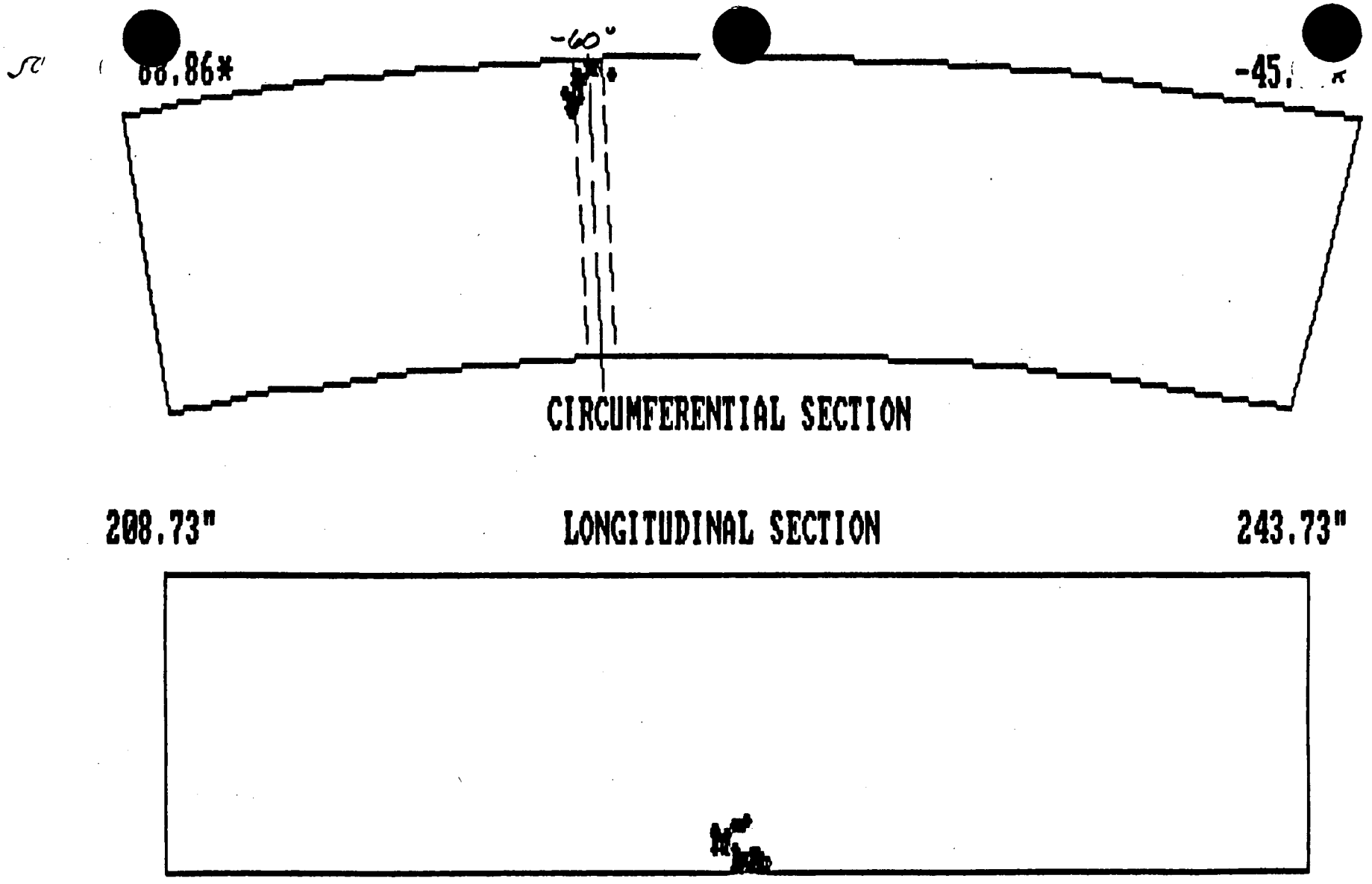
INDICATION	POINT OF SOUND ENTRY			DETECTION ANGLE	REFLECTOR COORDINATE		
IDENT.	R	θ	Z	AR	R	θ	Z
(-)	(IN)	(DEG)	(IN)	(DEG)	(IN)	(DEG)	(IN)
16	86.50	-54.10	226.67	-44.98	94.99	-59.57	226.67
16.1	86.50	-54.72	225.72	-44.98	94.87	-60.25	225.72
16.1	86.50	-54.72	225.72	-44.98	94.52	-60.43	225.72
16.2	86.50	-54.56	225.82	-44.98	94.78	-60.14	225.82
16.2	86.50	-54.56	225.82	-44.98	94.41	-60.33	225.82
16.3	86.50	-54.60	225.44	-44.98	94.81	-60.16	225.44
16.3	86.50	-54.60	225.44	-44.98	94.41	-60.37	225.44
16.3	86.50	-55.60	225.44	-44.98	94.31	-60.17	225.44
16.4	86.50	-54.65	226.02	-44.98	95.33	-59.95	226.02
16.4	86.50	-54.54	226.02	-44.98	94.89	-60.06	226.02
16.4	86.50	-55.84	226.02	-44.98	94.08	-60.29	226.02
16.5	86.50	-54.67	226.13	-44.98	95.33	-59.97	226.13
16.5	86.50	-54.82	226.13	-44.98	95.10	-60.24	226.13
16.5	86.50	-55.92	226.13	-44.98	94.06	-60.36	226.13
16.6	86.50	-54.69	226.23	-44.98	95.36	-59.98	226.23
16.6	86.50	-54.86	226.23	-44.98	95.14	-60.26	226.23
16.6	86.50	-55.94	226.23	-44.98	94.05	-60.37	226.23
16.7	86.50	-54.70	226.32	-44.98	95.36	-59.99	226.32
16.7	86.50	-54.83	226.32	-44.98	95.10	-60.25	226.32

Table A-3: CAMP Data, Indication 16 (continued)

INDICATION IDENT. (-)	POINT OF SOUND ENTRY R (IN)	θ (DEG)	Z (IN)	DETECTION ANGLE AR (DEG)	REFLECTOR COORDINATE R (IN)	θ (DEG)	Z (IN)
16.7	86.50	-55.87	226.32	-44.98	94.11	-60.34	226.32
16.8	86.50	-54.66	226.43	-44.98	95.33	-59.96	226.43
16.8	86.50	-54.85	226.43	-44.98	95.14	-60.24	226.43
16.8	86.50	-55.94	226.43	-44.98	94.01	-60.35	226.43
16.9	86.50	-54.65	226.53	-44.98	95.33	-59.95	226.53
16.9	86.50	-54.75	226.53	-44.98	95.05	-60.19	226.53
16.10	86.50	-54.70	226.62	-44.98	95.35	-59.99	226.62
16.10	86.50	-54.72	226.62	-44.98	95.03	-60.17	226.62
16.11	86.50	-54.56	226.73	-44.98	95.30	-59.87	226.73
16.11	86.50	-54.65	226.73	-44.98	94.98	-60.13	226.73
16.12	86.50	-54.47	226.83	-44.98	95.16	-59.86	226.83
16.12	86.50	-54.80	226.83	-44.98	95.06	-60.24	226.83
16.13	86.50	-54.61	226.92	-44.98	95.23	-59.96	226.92
16.14	86.50	-54.63	227.03	-44.98	95.29	-59.95	227.03



REACTOR VESSEL SHELL WELD
C·A·M·P COORDINATE SYSTEM



PLANT NAME: INDIAN POINT UNIT 3 WELD NO. : 10
Westinghouse Electric Corporation 06-26-1987

INDICATION NO. 16
TRANSDUCER NO. 22 (45°s)

Figure A—12: CAMP Plot, All Indication #16 Data

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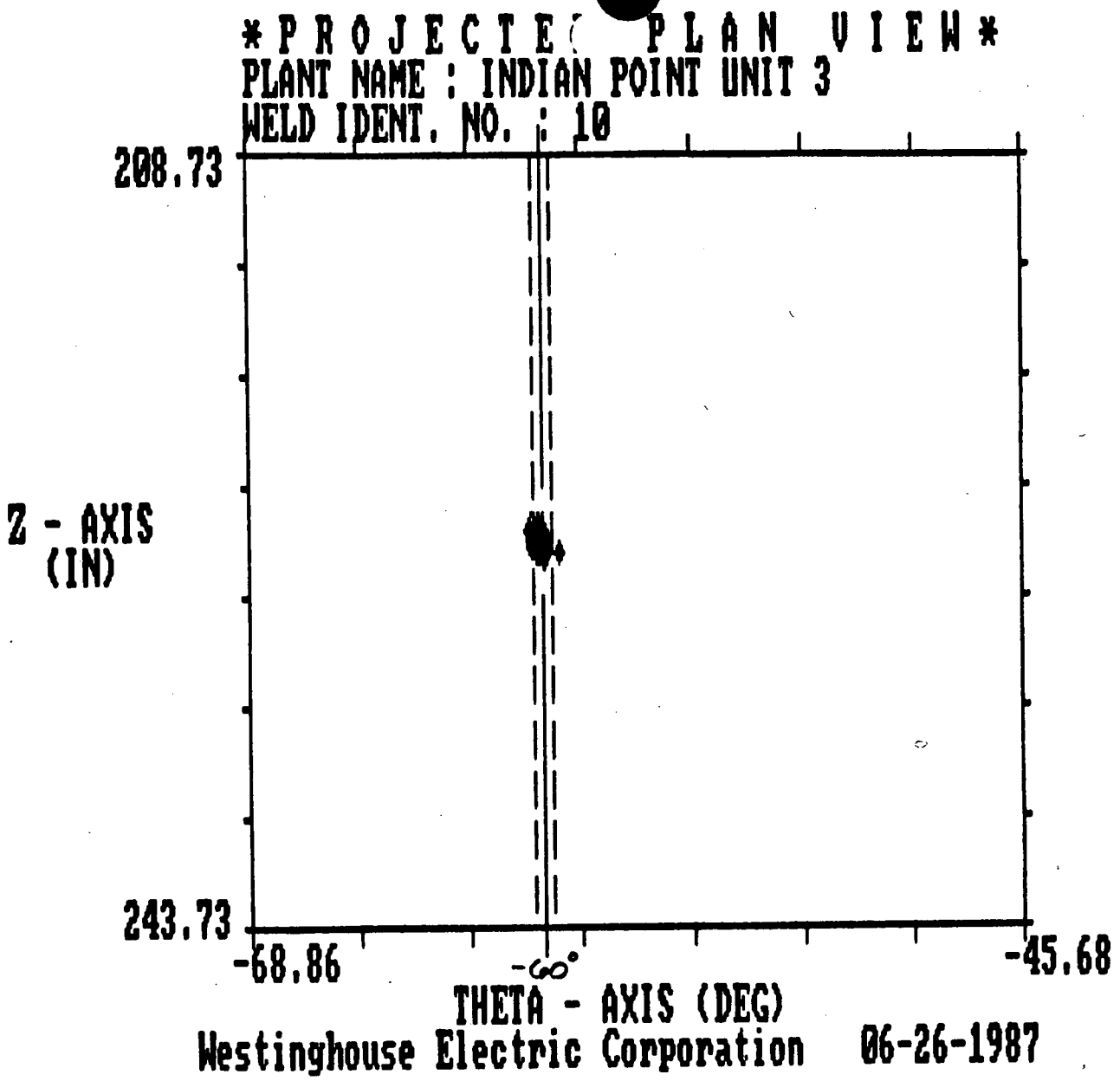
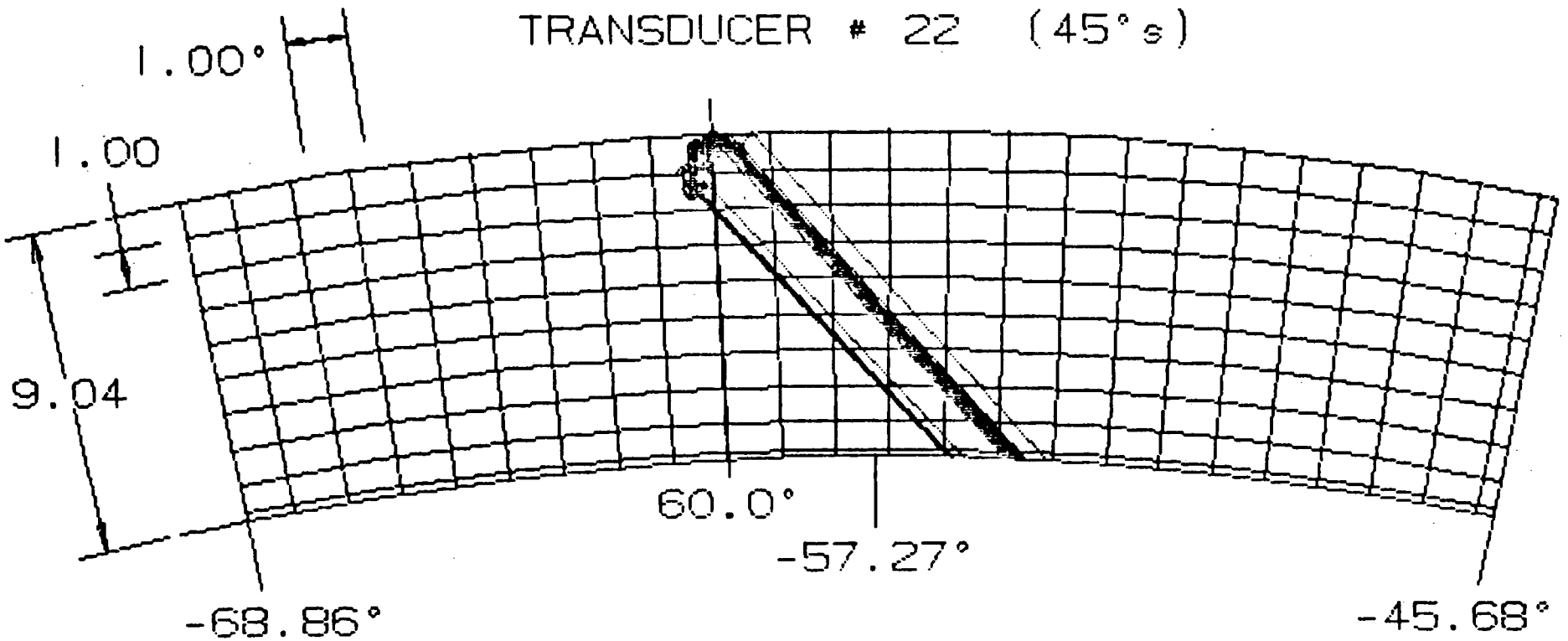


INDICATION NO. 16
TRANSDUCER NO. 22 (45°s)

Figure A–13: CAMP Plan View, All Indication #16 Data

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI

WELD # 10 INDICATION # 16
TRANSDUCER # 22 (45°s)



WESTINGHOUSE ELECTRIC CORPORATION

Figure A—14: Indian Point Unit 3, Indication #16, All Indication #16 Ray Trace Data

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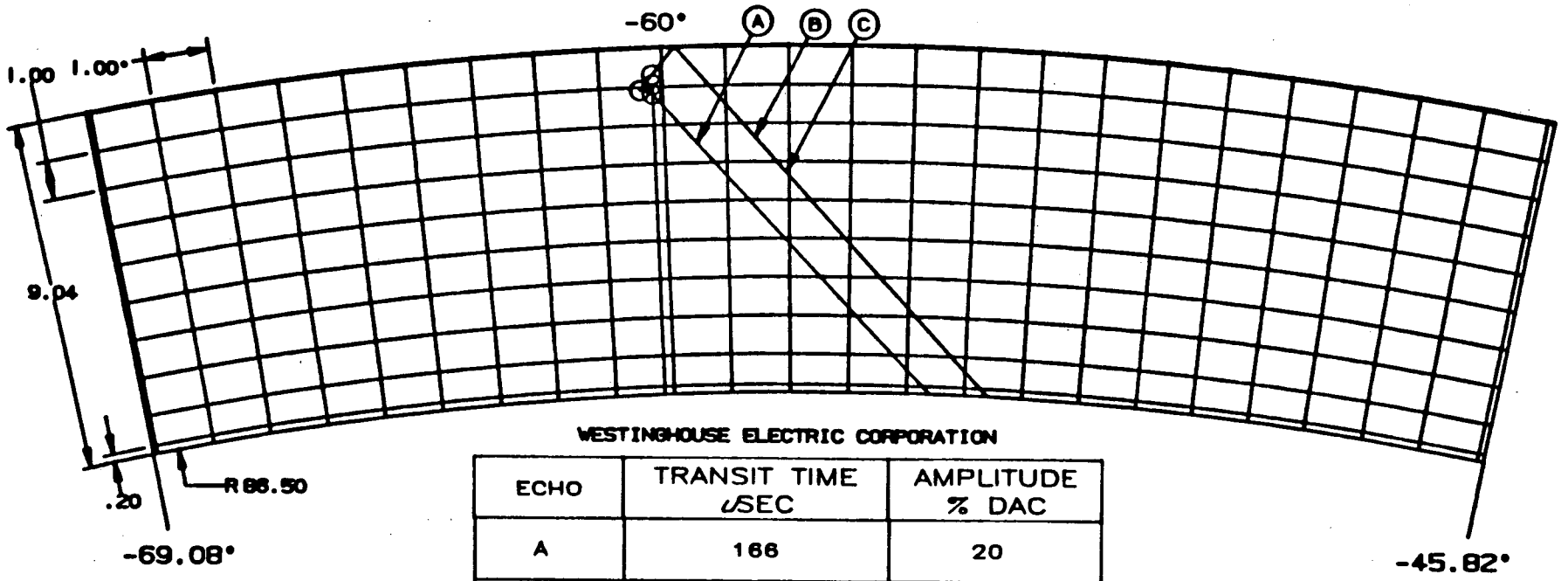
INDICATION 16
SLICE 16.3 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



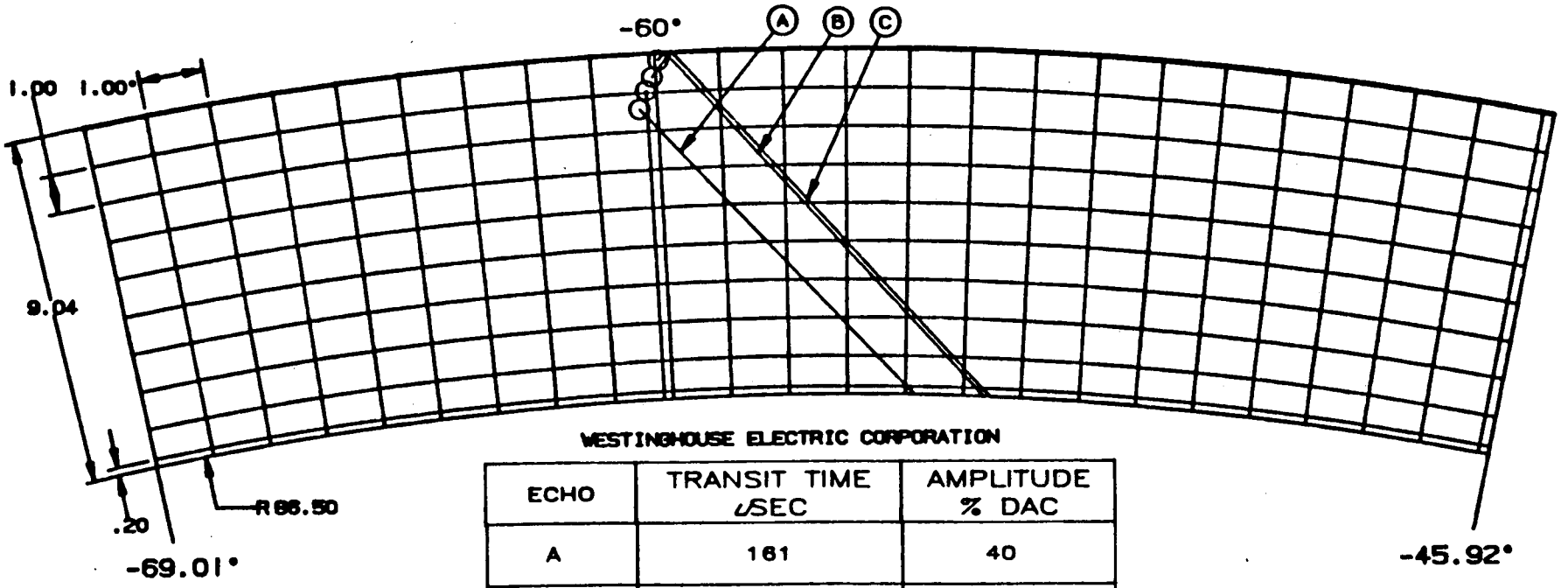
WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	166	20
B	206	100
C	214	20

Figure A—15: Indian Point Unit 3, Indication #16, Ray Trace Slice at 225.4"

INDICATION 16 (45°e)
SLICE 16.4 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



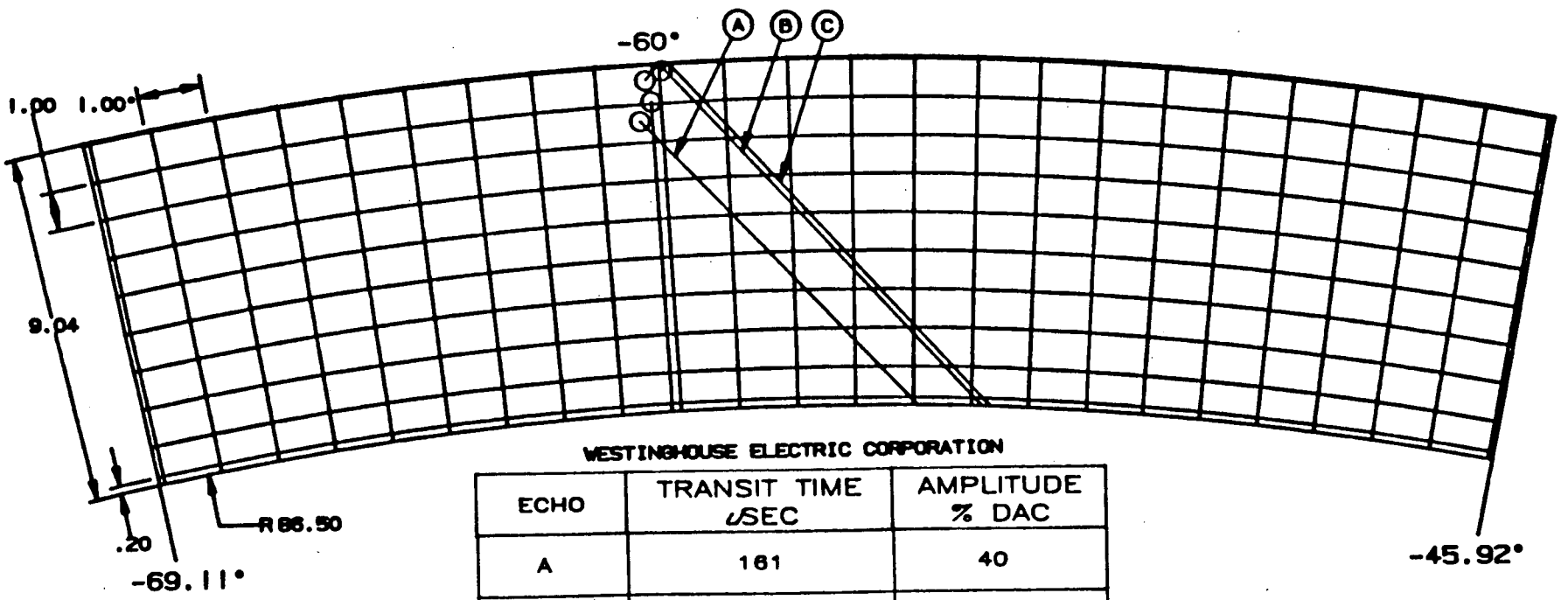
WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	161	40
B	195	125
C	204	40

Figure A—16: Indian Point Unit 3, Indication #16, Ray Trace Slice at 226.0"

INDICATION 16 (45°●)
SLICE 16.5 PEAK A,B & C
0° INDICATION MAPPED AT -60.16°

INDIAN POINT UNIT NO. 3
REACTOR VESSEL ISI 6-87
WELD 10 INDICATION PLOTS



WESTINGHOUSE ELECTRIC CORPORATION

ECHO	TRANSIT TIME µSEC	AMPLITUDE % DAC
A	161	40
B	195	150
C	210	40

Figure A-17: Indian Point Unit 3, Indication #16, Ray Trace Slice at 226.1"

APPENDIX B

OPERATING PROCEDURE - UDRPS