1985

INDIAN POINT 3

NUCLEAR POWER PLANT

STEAM GENERATOR

GIRTH WELD

(NO. 6)

INSPECTION

REPORT

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Section 1

Executive Summary

1985 Girth Weld Inspection

Ultrasonic inspection (UT) of the designated sample area, which was base-lined in 1983 subsequent to the weld repairs , yielded three (3) recordable indications not found during the 1983 baseline inspection. Approximately 15% of the indications located during the baseline inspection exhibited increases in parametric values of indication length and/or depth.

The results of the 1985 UT examinations of this same (baseline) area are summarized below:

Initial Sample Plan

	S/G 31	S/G 32	S/G 33	S/G 34
No. Reportable UT Indication	0	2	0	12
No. Rejectable UT Indications (ASME XI, Table IWB-3511.1)	0	1	0	6

In order to fully determine the condition of the welds, the Authority expanded the program to include UT examination of an additional area equal in size to the initial sample plan as specified by ASME Section XI. It was further decided to expand the program to those areas that were found to be the most severely degraded and extensively repaired during the 1982/1983 outage.

The results of this expanded UT inspection program are summarized below:

Expanded UT Program

	S/G 31	S/G 32	S/G 33	S/G 34
No. Reportable UT Indications	1	0	0	4
No. Rejectable UT Indications (ASME XI, Table IWB-3511.1)	1	0	0	2

This data indicated that the then apparent problem was limited to steam generator No. 34 (the single rejectable indication located in No. 31 was determined to be mid-wall and clearly is not related to the ID initiated problem discovered in 1982). Therefore, the Authority expanded the inspection to include the entire girth weld (100%) of No. 34; the results, including the data of the two (2) partial inspections, are summarized as follows:

100% UT Program (S/G 34)

No. Reportable UT Indications	23
No. Rejectable UT Indications	11

In order to completely evaluate and resolve the UT findings, the Authority established access to the secondary side of steam generator No. 34. Subsequent visual and magnetic particle inspection of a nine (9) foot section of the weld's inside surface, containing 16 of the 23 reportable (and 8 of the 11 rejectable) UT indications, resulted in the following observations: (1) numerous surface irregularities, (resulting from the 1982/1983 repair) were located in the area of interest; and (2) the magnetic particle inspection was satisfactory; there were no indications.

In view of the inside surface condition, a supplemental UT examination was performed. Of seven (7) indications examined, all of which were rejectable, all were conclusively demonstrated to be related to the geometry (irregularities) of the inside surface. Although this supplemental technique was not valid for the remaining indications within the nine (9) foot area of interest, it is postulated that these too are geometry related for the following reasons: (1) all are located with areas of surface irregularities; and (2) magnetic particle examination failed to locate these indications even though the UT data suggested that they were within 0.1 and 0.2 inches of the inside surface. Beyond these considerations regarding inside surface irregularities, these indications are acceptable within ASME Section XI (Appendix A) guidelines.

The remaining three (3) rejectable indications in steam generator No. 34 and the two (2) rejectable indications in No.'s 31 and 32 have been evaluated in accordance with ASME Section XI provisions (Appendix A). All five (5) indications are acceptable for continued vessel operation using the Appendix A evaluation criteria.

Conclusions

The condition of the Indian Point 3 steam generator girth welds has been determined to be unchanged from the 1983 baseline and acceptable for continued plant operation for the following reasons:

(1) The few and small changes from the UT baseline inspection are not indicative of a failure mechanism and have been attributed to UT variability (personnel and technique);

(2) The surface examinations performed in steam generator No. 34 were satisfactory, no surface indications were found (the failure mechanism discovered in 1982 was ID surface initiated);

(3) Surface irregularities (geometry) have been demonstrated to be responsible for a significant population of UT indications utilizing a supplemental UT technique; and

(4) The remaining indications (which are located within areas of surface irregularities are similarly postulated to be related to surface irregularities) have been evaluated in accordance with ASME Section XI and are acceptable for continued operation without repair.

Section 2

1985 Steam Generator Girth Weld No. 6 Inspection

The Indian Point 3 Technical Specification, Section 4.2, Table 4.2-1 requires that an augmented steam generator girth weld inspection be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code 1974 edition, Summer 1975 addenda, during the 1985 refueling Outage. Inspection requirements consist of an ultrasonic examination (UT), using the 45 degree shear wave method, of one hundred and seventy five (175) linear inches of weld in the manner listed in Table 2-1.

In order to more accurately determine indication locations and also allow for comparison with 1983 inspection results, the ultrasonic examination was performed with 0 degree and 60 degree transducers, in addition to the required 45 degree transducer. The ultrasonic inspection program was performed in accordance with NYPA Quality Assurance Procedure NDEP 9.4-9 (reference Appendix C). The results of the baseline (first sample) examination are indicated in Table 5-1, along with values from the 1983 and 1984 inspections, further described in Section 3.

In accordance with Section IWB-2430 of the ASME XI Code, detection of a rejectable indication in a weld sample requires expanding the inspection to another equally sized area. Thus, a second inspection was required in steam generators 32 and 34. To gather additional information, it was decided to expand the inspection in all generators to the areas illustrated in Figures 2-1 through 2-4, which were the areas that contained the greatest density of pre-repair UT indications and thus were thought to be the worst condition.

Table 5-2 summarizes the results of the second sample UT inspection. Of the generators requiring an expanded inspection, additional rejectable indications were found in steam generator 34. Section IWB-2430 to ASME XI then requires the inspection of the remainder of the weld surface (approximately 73%).

The remaining 382 linear inches of steam generator 34 girth weld were therefore UT inspected and the results are tabulated in Table 5-3.

Table 5-4 summarizes the results of the entire ultrasonic inspection performed on the steam generator girth welds.

Each of the detected reportable indications (greater than 50% DAC signal) are characterized by size and location in Table 5-5. It is evident from this data that the majority of reportable indications (78%) in steam generator 34 are concentrated in an area of the weld that is centered about the FW nozzle, defined as Quardrant I in Figure 5-1.

Since two (2) indications from the ultrasonic examination reported in Table 5-4 were rejectable to Appendix A criteria of the ASME XI Code, (reference Appendix E), further indication evaluation became necessary. In accordance with Section IWB-3200 of the ASME XI Code - Supplemental Examinations, a magnetic particle (MT) examination was performed in the area of the two referenced rejectable indications - on the ID surface of steam generator 34 girth weld in Quadrant I. An MT examination was selected over a liquid penetrant examination (PT) because of its ability to detect near-surface, as well as surface, indications, which is characteristic of the majority of the UT reportable indications listed in Table 5-5. The MT inspection was performed in accordance with NYPA Quality Assurance Procedure NDEP 9.2-2 (reference Appendix C). The inspection, witnessed by the NRC Resident Inspector, consisted of the use of two yokes each with 100% overlap on both AC and DC settings.

As is indicated on the MT Quality Control Inspection Report - Figure 5-2 - no indications were noted. However, a visual inspection of the same MT area revealed a significant number of blended repair grooves on the ID surface, which could act as signal reflectors for the surface and near-surface UT indications previously reported.

In order to either confirm or deny the above hypothesis, Section IWB-3200 of the ASME XI Code was again invoked as well as Section T-451 of the ASME V Code, in order to perform a supplemental nondestructive examination of the area in question.

A UT thru-transmission, signal damping technique was employed for this purpose and is described in NDEP 9.4-11 and QAI 4.0 (reference Appendix C). Employing this technique, the operators were able to successfully damp all of the reported UT indications to which the technique applies. This technique is limited to those indications that are detected on a direct signal, and for those detected on a reflected signal for which the indication position is at least 1/4" from the reflection point.

TABLE 2-1

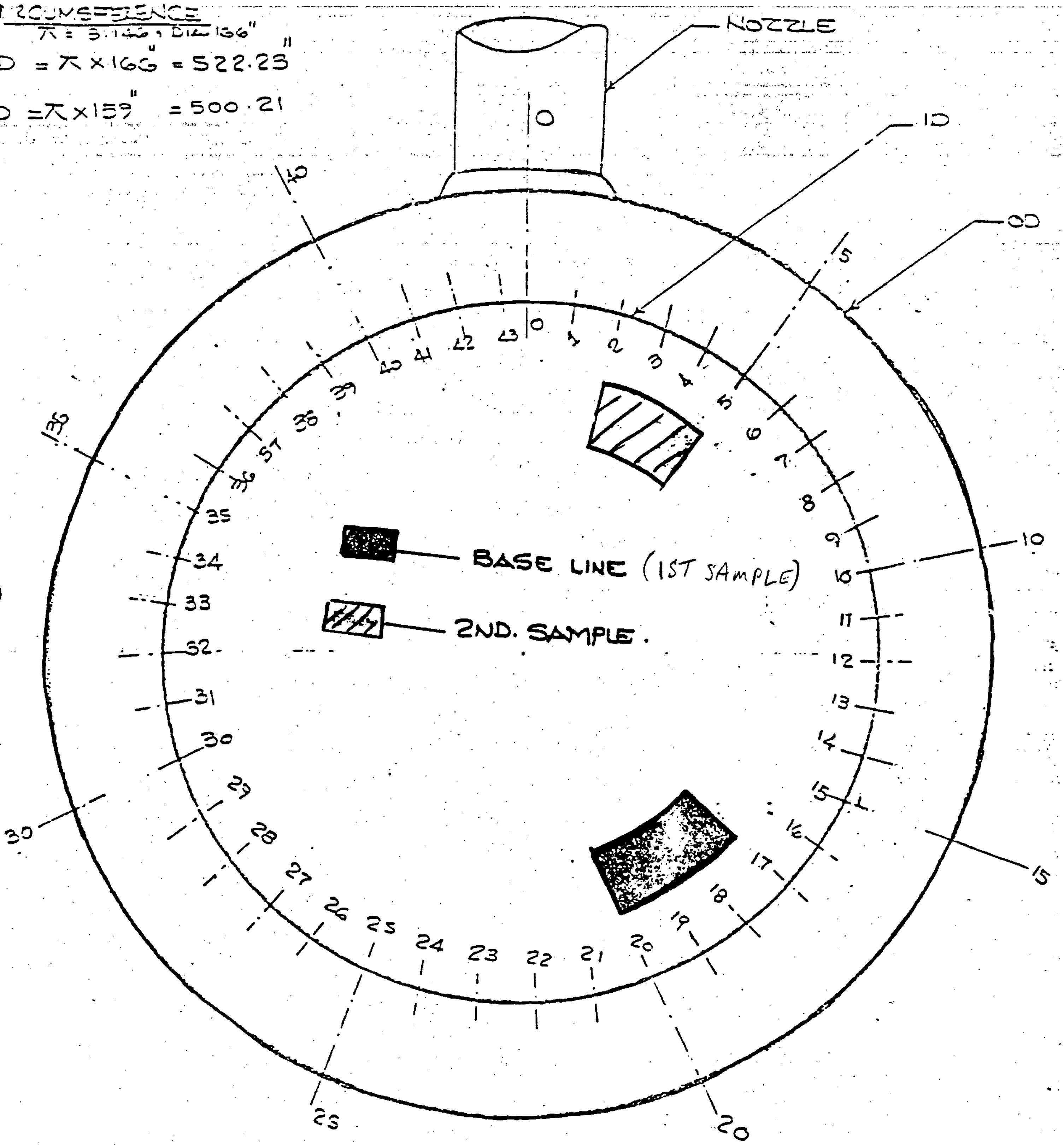
Steam Generator	Location on Circumference	Segment Location
31	204° clockwise to 239° from 0 Reference	17-20
32	316° clockwise to 334° from 0 Reference	25-28
	348° clockwise to 365° from 0 Reference	29-31
33	360° clockwise to 395° from 0 Reference	30-33
34	0 Reference clockwise to 18°	0-2
	505° clockwise to 522° from 0 Reference	42-0
	168° clockwise to 203° from 0 Reference	14-17

FIG. 2-1
TYP. STEAM GENERATORS.

CIRCUMFERENCE
π = 3.146, DIA 166"

OD = π × 166" = 522.23"

ID = π × 159" = 500.21



S/G. No 31.

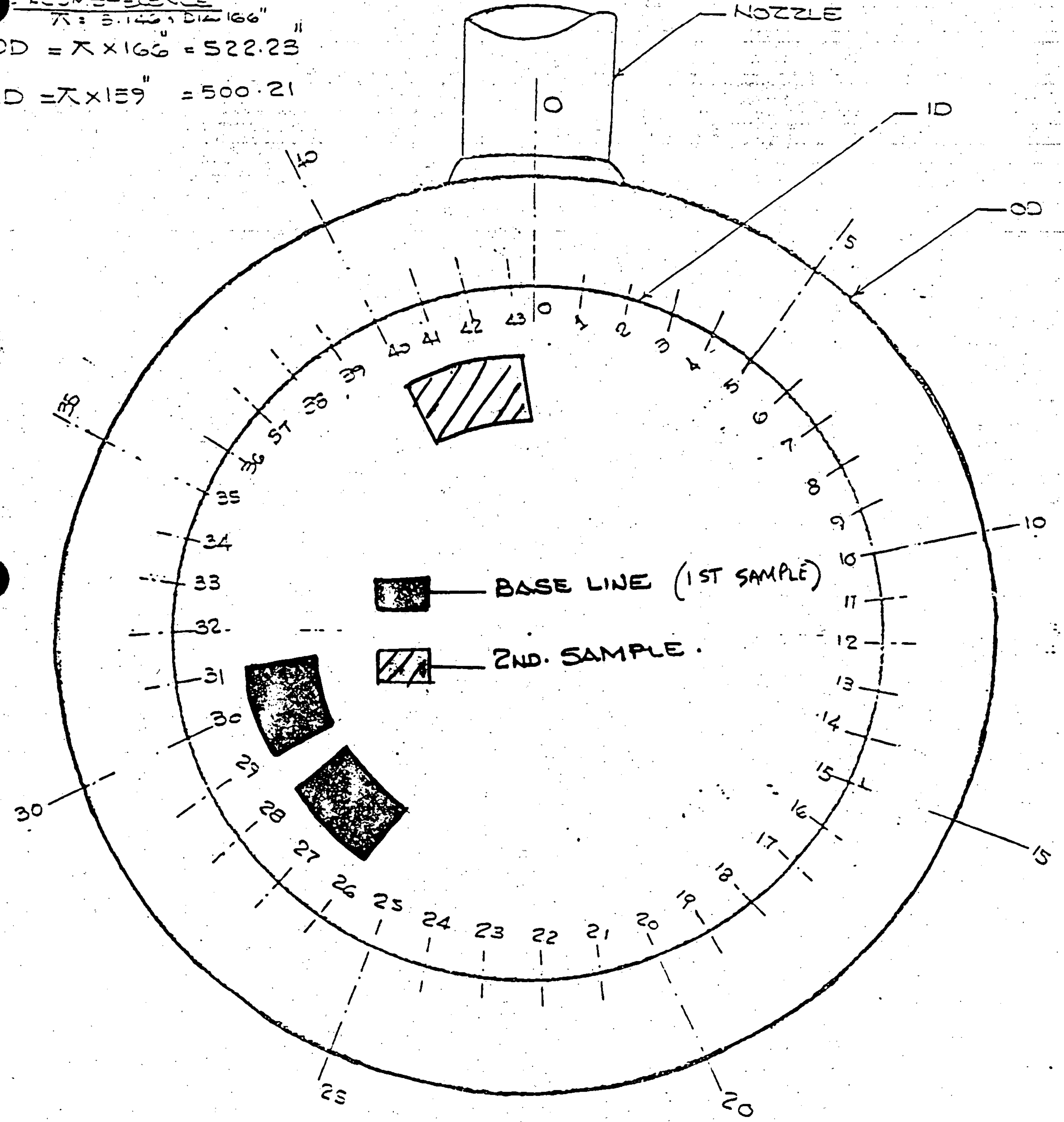
FIG. 2-2

TYP. STEAM GENERATORS.

CIRCUMFERENCE
π = 3.146, DIA 166"

OD = $\pi \times 166''$ = 522.23"

ID = $\pi \times 159''$ = 500.21

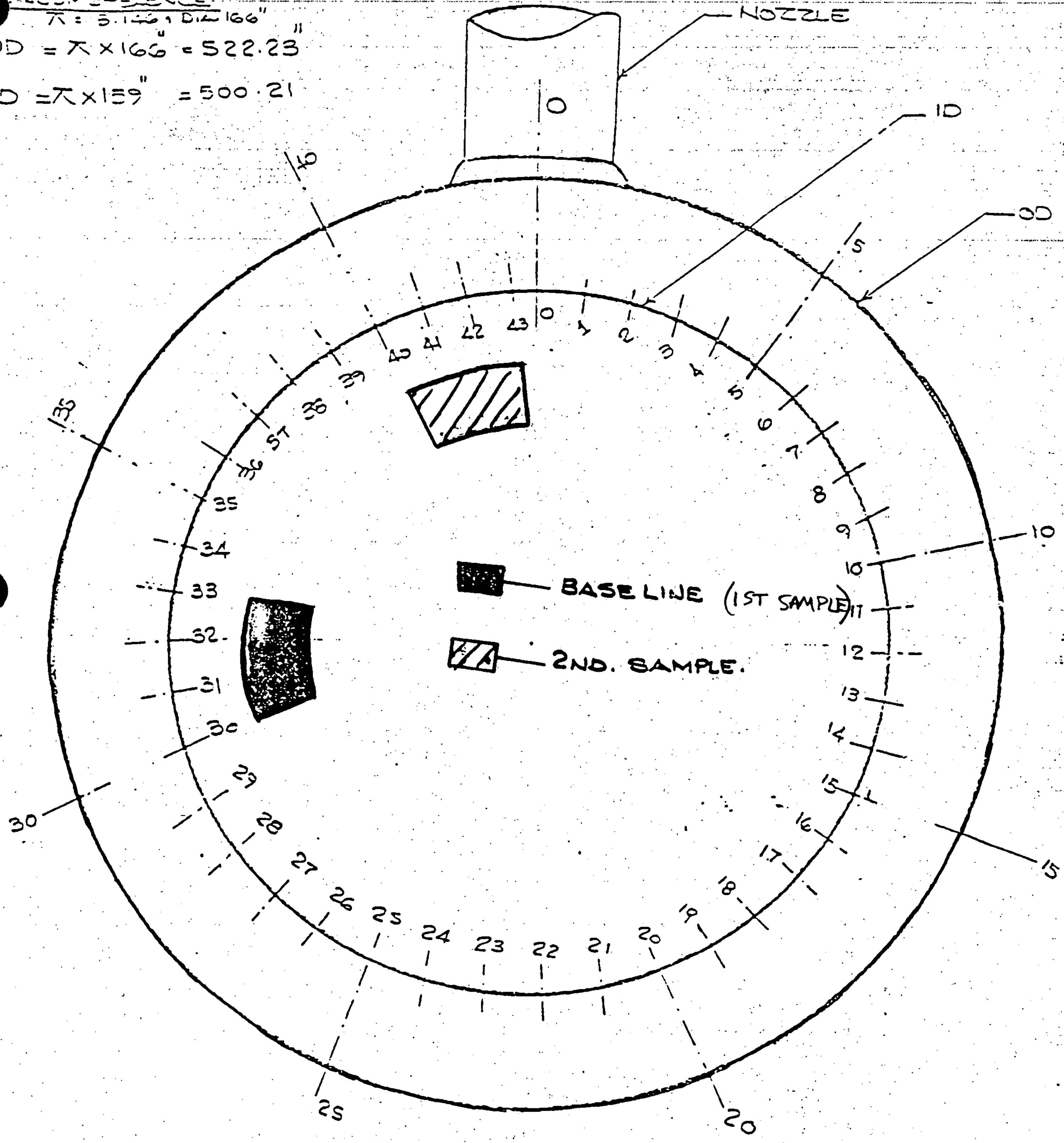


S/G. No 32

FIG 2-3
TYP. STEAM GENERATORS.

CIRCUMFERENCE
π = 3.1416, DIA 166"
OD = π x 166" = 522.23"

ID = π x 159" = 500.21



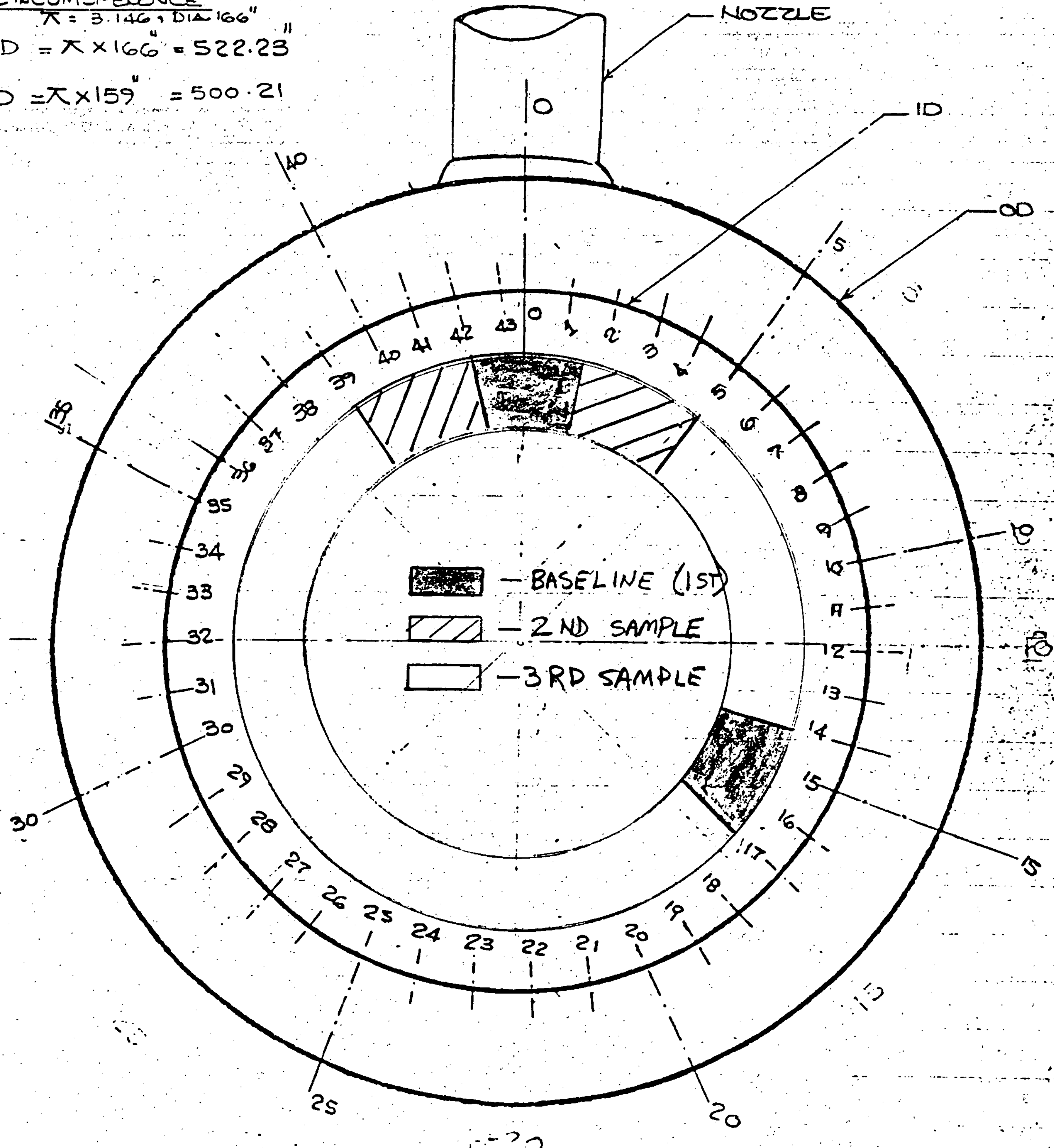
S/G. No 33

FIG. 2-4

TYP. STEAM GENERATORS

CIRCUMSFERENCE
π = 3.146, DIA 166"
OD = π × 166" = 522.23"

ID = π × 159" = 500.21



S/G No 34

Section 3

1983 Girth Weld Inspection

Following the 1982-83 steam generator girth weld repair and stress relieving operation, a baseline ultrasonic examination (UT) of the augmented inspection area (reference Table 2-1) was performed (Appendix F - Reference 1). The examination was conducted in accordance with NYPA Quality Assurance Procedure NDEP 9.4-9 (reference Appendix C) utilizing 0 degree, 45 degree, and 60 degree beam transducers.

The results of this examination are tabulated in Table 3-1. All of the detected indications met the acceptance criteria of the ASME Section XI Code, Article IWB, Table IWB-3511-1, for "Allowable Planar Indications".

1984 Girth Weld Inspection

During the 1984 mid-cycle outage, the steam generator girth welds were reinspected in the same areas (Table 2-1) as required by the IP-3 Technical Specification, Section 4.2, Table 4.2-1 (Item 3.8). The examination was limited to the technical specification requirements of using 45 degree beam in the vertical plane only (Appendix F - Reference 2). Otherwise, the examination was again conducted in accordance with NYPA Quality Assurance Procedure NDEP 9.4-9.

The results of the examination are tabulated in Table 3-2. All of the detected indications met the acceptance criteria of the ASME Section XI Code, Article IWB, Table IWB-3511-1.

A comparison of the inspection data between 1983 and 1984 revealed minor changes in indication parameters. Only three (3) of twenty (20) recordable indications detected during both inspections changed in length (max. increase of 1/2"), and only a single indication increased in signal amplitude (by 30% DAC).

It is likely that the small number and extent of changes from baseline can be attributed to operator and/or equipment variability.

TABLE 3-1
1983 UT INSPECTION RESULTS

INDICATIONS	S/G 31		S/G 32		S/G 33		S/G 34		TOTAL	
	45°	60°	45°	60°	45°	60°	45°	60°	45°	60°
RECORDABLE (≥ 20% DAC)	2	2	5	1	0	1	15	12	22	16
REPORTABLE (> 50% DAC)	0	0	1	0	0	0	4	3	5	3
REJECTABLE (ASME XI, T.3511.1)	0	0	0	0	0	0	0	0	0	0
REJECTABLE (ASME XI, APP. A)	0	0	0	0	0	0	0	0	0	0

TABLE 3-2

1984 UT INSPECTION RESULTS

INDICATIONS	S/G 31 45°	S/G 31 60°	S/G 32 45°	S/G 32 60°	S/G 33 45°	S/G 33 60°	S/G 34 45°	S/G 34 60°	TOTAL 45°	TOTAL 60°
RECORDABLE (≥ 20% DAC)	2	–	4	–	1	–	14	–	21	–
REPORTABLE (> 50% DAC)	0	–	0	–	0	–	5	–	5	–
REJECTABLE ([illegible]E XI, T.3511.1)	0	–	0	–	0	–	0	–	0	–
REJECTABLE (ASME XI, APP. A)	0	–	0	–	0	–	0	–	0	–

Section 4

Inspection Evaluation Records

As indicated earlier, Quality Assurance Procedure NDEP 9.4-9 requires code evaluation of all UT indications reporting an amplitude signal of greater that 50% during the inspection. The following evaluation sheets represent a listing of these reportable indications, categorized by generator and sample inspection area. Indication parameters of length, depth and distance from inside surface are tabulated on these sheets. From these values key ratios are calculated and compared against the allowable values in Table IWB-3511.1 of the ASME XI Code, a copy of which is included on the evaluation sheet. Indications are then classified as either acceptable or rejectable to this particular table.

The ASME XI Code also allows evaluation against the broader linear elastic, fracture mechanics criteria described in Appendix A of this code. A pre-analysis, utilizing Appendix A criteria and documented in WCAP 10863 (included in Appendix E of this report), was performed by Westinghouse for the IP-3 steam generator girth weld. The results of this analysis are summarized in graphic form on Figures 4-1, 4-2, and 4-3 in this section. Each of the reportable indications, listed and numbered on the evaluation sheets, is plotted on these figures to ascertain their acceptability to ASME XI - Appendix A criteria.

To summarize, twenty-six (26) UT indications were classified as reportable requiring evaluation, half of these (13) were rejectable to Table IWB-3511.1 of the ASME XI Code, however, only two (2) of this number failed to meet the criteria of Appendix A to the ASME XI Code.

FIRST SAMPLE INSPECTION AREA

(REFERENCE FIG. 2-1 TO FIG. 2-4)

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a)	Sub-Surface (2a)	Beam		Base Metal Thick.	Weld Thick. (t)	REF FIG 4-1,2,3
	From	To	Length (l)	Div.	Inches	Div.	Inches		(✓)	(✓)	∡	Dir.			
32-6	321.50	324.38	2.88	6.0	3.48	7.0	4.06 (3.24)	.24	NA	.12	45	5	3.65	3.80	2:
32-6	348.0	348.5	0.5	5.8	3.36	6.4	3.71 (3.49)	.13	NA	.065	45	2	3.60	3.60	2(

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

1)

l = 2.88   t = 3.80
a = .12
a/l = .04

S = distance to nearest surface.

S = .17

a/t,% = a/t x 100 = 3.16

For max. allowable a/t,% interpolate from Table IWB-3511-1

2.78

'74....Accept....(Reject)

2)

l = .50   t = 3.60
a = .065
a/l = .13

S = distance to nearest surface.

S = .11

a/t,% = a/t x 100 = 1.81

For max. allowable a/t,% interpolate from Table IWB-3511-1

3.08

'74..(Accept)....Reject

3)

l = ____   t = ____
a = ____
a/l = ____

S = distance to nearest surface.

S = ____

a/t,% = a/t x 100 = ____

For max. allowable a/t,% interpolate from Table IWB-3511-1

____

'74....Accept.....Reject

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a) (✓)	Sub-Surface (2a) (✓)	Beam		Base Metal Thick.	Weld Thick. (t)	REF
	From	To	Length (l)	Div.	Inches	Div.	Inches				∡	Dir.			
34-6	11.50	12.38	.88	6.0	3.48	6.4	3.71 (3.61)	.13	NA	.065	45	5	3.66	3.80	1
34-6	14.38	15.25	.87	6.0	3.48	6.8	3.74 (3.40)	.08	NA	.04	45	5	3.67	3.80	2
34-6	506.66	507.50	.84	6.2	3.60	6.8	3.94 (3.42)	.18	NA	.09	45	5	3.68	3.75	3

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = .88 t = 3.80
a = .065
a/l = .07
S = distance to nearest surface.
S = .05
a/t,% = a/t x 100 = 1.7
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.83
'74...(Accept)....Reject

(2)
l = .87 t = 3.80
a = .04
a/l = .05
S = distance to nearest surface.
S = .19
a/t,% = a/t x 100 = 1.1
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.80
'74...(Accept)....Reject

(3)
l = .84 t = 3.75
a = .09
a/l = .11
S = distance to nearest surface.
S = .08
a/t,% = a/t x 100 = 2.40
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.96
'74...(Accept)....Reject

Weld Number	Indication Length From	Indication Length To	Length (l)	Minimum Depth Div.	Minimum Depth Inches	Maximum Depth Div.	Maximum Depth Inches	Ind. Depth	Surface (a) (✓)	Sub-Surface (2a) (✓)	Beam ∡	Beam Dir.	Base Metal Thick.	Weld Thick. (t)	REF.
34-6	510.0	510.5	0.50	6.0	3.48	6.5	3.77 (3.29)	.19	NA	.095	45	2	3.53	3.80	4
34-6	511.0	511.75	0.75	5.4	3.13	6.0	3.48	.35	.35	NA	45	2	3.55	3.80	5
34-6	512.38	512.88	0.50	6.2	3.59	6.8	3.94 (3.40)	.19	NA	.095	45	5	3.67	3.76	6

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = .50 t = 3.80
a = .095
a/l = .19
S = distance to nearest surface.
S = .05
a/t,% = a/t x 100 = 2.50
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.52
'74...Accept (circled)....Reject

(2)
l = .75 t = 3.80
a = .35
a/l = .47
S = distance to nearest surface.
S = .07
a/t,% = a/t x 100 = 9.21
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.70
'74....Accept....Reject (circled)

(3)
l = .50 t = 3.76
a = .095
a/l = .19
S = distance to nearest surface.
S = .08
a/t,% = a/t x 100 = 2.52
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.52
'74...Accept (circled)....Reject

Weld Number	Indication Length			Minimum Depth		um Depth		Indic. Depth	Surface (2)	Sub-Surface (2a)	Beam		Ba Metal Thick.	Weld Thick. (t)	REF
	From	To	Length (1)	Div.	Inches	Div.	Inches		(✓)	(✓)	∡	Dir.			
34-6	511.68	512.50	.82	5.2	3.01	5.8	3.36	.35	NA	.175	45	2	3.53	3.80	7
34-6	522.0	522.0	2a (.14)	5.8	3.36	6.2	3.60 (3.50)	.14	NA	.07	45	2	3.55	3.72	8
34-6	520.5	0.5	2.00	5.5	3.19	6.0	3.48	.29	NA	.145	45	2	3.57	3.72	9

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

(1) l = .82 t = 3.80
a = .175
a/l = .21
S = distance to nearest surface.
S = .17
a/t,% = a/t x 100 = 4.61
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.70
'74....Accept....(Reject)

(2) l = .14 t = 3.72
a = .07
a/l = .50
S = distance to nearest surface.
S = .05
a/t,% = a/t x 100 = 1.88
For max. allowable a/t,% interpolate from Table IWB-3511-1
7.20
'74...(Accept)....Reject

(3) l = 2.00 t = 3.72
a = .145
a/l = .07
S = distance to nearest surface.
S = .09
a/t,% = a/t x 100 = 3.90
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.84
'74....Accept....(Reject)

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a)	Sub-Surface (2a)	Beam		Base Metal Thick.	Weld Thick. (t)	REF
	From	To	Length (l)	Div.	Inches	Div.	Inches		(✓)	(✓)	∠	Dir.			
34-6	503.0	514.0	11.0	4.8	2.76	6.0	3.48	.70	.70	NA	60	2	3.55	3.80	10
34-6	507.0	515.0	8.0	5.2	3.02	6.4	3.71	.69	.69	NA	60	5	3.71	3.80	11
34-6	511.5	513.0	1.5	6.6	3.83 (3.57)	7.6	4.41 (2.79)	.58	NA	.29	60	5	3.70	3.81	12

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
(1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
(2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
(3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = 11.0 t = 3.80
a = .70
a/l = .06
S = distance to nearest surface.
S = .07
a/t,% = a/t x 100 = 18.42
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.14
'74....Accept....Reject (circled)

(2)
l = 8.0 t = 3.80
a = .69
a/l = .09
S = distance to nearest surface.
S = 0.00
a/t,% = a/t x 100 = 18.16
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.26
'74....Accept....Reject (circled)

(3)
l = 1.50 t = 3.81
a = .29
a/l = .19
S = distance to nearest surface.
S = .13
a/t,% = a/t x 100 = 7.61
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.60
'74....Accept....Reject (circled)

SECOND

SAMPLE

INSPECTION

AREA

(REFERENCE

FIG. 2-1 TO

FIG. 2-4)

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a) (✓)	Sub-Surface (2a) (✓)	Beam		Base Metal Thick.	(CONF) Weld Thick. (t)	REF #
	From	To	Length (1)	Div.	Inches	Div.	Inches				∠	Dir.			
31-6	30 5/8	31 5/8	1.0"	8.6	5.02 (2.02)	9.8	5.72 (1.32)	0.7	NA	✓	60°	2	3.52	3.65	20

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

OTES:
) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = 1.0" t = 3.65
a = .35"
a/l = .35

S = distance to nearest surface.

S = 1.5"

a/t,% = a/t x 100 = 9.5%

For max. allowable a/t,% interpolate from Table IWB-3511-1

5.2%

'74....Accept....Reject (circled)

(2)
l = ____ t = ____
a = ____
a/l = ____

S = distance to nearest surface.

S = ____

a/t,% = a/t x 100 = ____

For max. allowable a/t,% interpolate from Table IWB-3511-1

'74....Accept.....Reject

(3)
l = ____ t = ____
a = ____
a/l = ____

S = distance to nearest surface.

S = ____

a/t,% = a/t x 100 = ____

For max. allowable a/t,% interpolate from Table IWB-3511-1

'74....Accept.....Reject

Weld Number	Indication Length From	To	Length (l)	Minimum Depth Div.	Inches	M[illegible]um Depth Div.	Inches	Indic. Depth	Surface (a) (✓)	Sub-Surface (2a) (✓)	Beam ∡	Dir.	Bas[illegible] Metal Thick.	Weld Thick. (t)	REF FIG
34-6	46-	47½	1.5"	7.0	4.08 (3.36)	6.0	3.50	0.14"	NA	✓	45	2 (5 SIDE)	3.72	3.72	13
34-6	53 1/8	54 1/8	1.0"	5.2	3.03	6.0	3.50	0.47"	NA	✓	60	5	3.68	3.50	14
34-6	482-	483 1/8	1.1"	6.0	3.50	6.6	3.85 (3.67)	0.17"	NA	✓	45	2 (5 SIDE)	3.76	3.76	15

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = 1.5" t = 3.72
a = .07"
a/l = .05
S = distance to nearest surface.
S = 0.22"
a/t,% = a/t x 100 = 1.9%
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.8%
'74....Accept....Reject (Accept circled)

(2)
l = 1.0" t = 3.50
a = .24"
a/l = .24
S = distance to nearest surface.
S = 0.18"
a/t,% = a/t x 100 = 6.9%
For max. allowable a/t,% interpolate from Table IWB-3511-1
4.0%
'74....Accept....Reject (Reject circled)

(3)
l = 1.1" t = 3.76
a = .09"
a/l = .08
S = distance to nearest surface.
S = 0.09"
a/t,% = a/t x 100 = 2.4%
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.86%
'74....Accept....Reject (Accept circled)

Weld Number	Indication Length			Minimum Depth		...ium Depth		Indic. Depth	Surface (a)	Sub-Surface (2a)	Beam		Ba... Metal Thick.	Weld Thick. (t)	REF
	From	To	Length (l)	Div.	Inches	Div.	Inches		(✓)	(✓)	∡	Dir.			
34-6	486 1/4	487 1/4	1.0"	8.8	5.13 (2.29)	9.9	5.78 (1.64)	0.65	NA	✓	60°	5	3.71	3.97	16

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
(1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
(2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
(3) The total depth of an allowable subsurface indication is twice the listed value.

(1)

l = 1.0 t = 3.97

a = 0.33

a/l = 0.33

S = distance to nearest surface.

S = 1.42"

a/t,% = a/t x 100 = 8.3%

For max. allowable a/t,% interpolate from Table IWB-3511-1

5.0%

'74....Accept....Reject (circled)

(2)

l = ____ t = ____

a = ____

a/l = ____

S = distance to nearest surface.

S = ____

a/t,% = a/t x 100 = ____

For max. allowable a/t,% interpolate from Table IWB-3511-1

'74....Accept.....Reject

(3)

l = ____ t = ____

a = ____

a/l = ____

S = distance to nearest surface.

S = ____

a/t,% = a/t x 100 = ____

For max. allowable a/t,% interpolate from Table IWB-3511-1

'74....Accept.....Reject

THIRD

SAMPLE

INSPECTION

AREA

(REFERENCE

FIG. 2-1 TO

FIG. 2-4)

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a)	Sub-surface (2a)	Beam		Base Metal Thick.	Weld Thick. (t)	REF. FIG. #1,2,3
	From	To	Length (l)	Div.	Inches	Div.	Inches		(✓)	(✓)	∡	Dir.			
34-6	402 1/2	403 1/2	1.0"	8.8	5.13 (2.23)	10.0	5.83 (1.53)	0.70"	NA	✓	60°	5	3.68	3.56 (SHELL)	17
34-6	406-	407 3/4	1.75"	8.8	5.13 (2.23)	SAY 10.0	5.83 (1.53)	0.70"	NA	✓	60°	5	3.68	3.56 (SHELL)	18
34-6	445 1/4	446 3/4	1.5"	6.0	3.50	6.8	3.96 (3.44)	.06"	NA	✓	60°	5	(NOM) 3.70	(NOM) 3.80 (WELD)	19

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
(1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
(2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
(3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = 1.0" t = 3.56
a = .35"
a/l = .35
S = distance to nearest surface.
S = 1.45"
a/t,% = a/t x 100 = 9.8%
For max. allowable a/t,% interpolate from Table IWB-3511-1
5.2%
'74....Accept....Reject (circled: Reject)

(2)
l = 1.75" t = 3.56
a = .35"
a/l = .20
S = distance to nearest surface.
S = 1.45"
a/t,% = a/t x 100 = 9.8%
For max. allowable a/t,% interpolate from Table IWB-3511-1
3.6%
'74....Accept....Reject (circled: Reject)

(3)
l = 1.5" t = 3.80
a = .03"
a/l = .02
S = distance to nearest surface.
S = .20"
a/t,% = a/t x 100 = 0.8%
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.6%
'74....Accept....Reject (circled: Accept)

Weld Number	Indication Length			Minimum Depth		Maximum Depth		Indic. Depth	Surface (a)	Sub-Surface (2a)	Beam		Base Metal Thick.	Weld Thick. (t)	REF.
	From	To	Length (1)	Div.	Inches	Div.	Inches		(✓)	(✓)	∡	Dir.			
34-6	74 3/4	75 3/4	1.0"	8.8	5.13 (1.67)	SAY 10.0	5.83 (0.97)	0.70	NA	✓	60°	2	3.40	3.68 (CONE)	2[illegible]
34-6	73 1/4	74 1/2	1.25"	5.9	3.44	6.7	3.91 (3.45)	0-	NA	✓	45°	5	3.68	3.68 (CONE)	2[illegible]

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

NOTES:
(1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
(2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
(3) The total depth of an allowable subsurface indication is twice the listed value.

(1)
l = 1.0"   t = 3.68
a = .35"
a/l = .35
S = distance to nearest surface.
S = 1.73"
a/t,% = a/t x 100 = 9.5%
For max. allowable a/t,% interpolate from Table IWB-3511-1
5.2%
'74....Accept....(Reject)

(2)
l = 1.25"   t = 3.68
a = 0-
a/l = 0-
S = distance to nearest surface.
S = .23"
a/t,% = a/t x 100 = 0%
For max. allowable a/t,% interpolate from Table IWB-3511-1
2.6%
'74...(Accept)....Reject

(3)
l = ____   t = ____
a = ____
a/l = ____
S = distance to nearest surface.
S = ____
a/t,% = a/t x 100 = ____
For max. allowable a/t,% interpolate from Table IWB-3511-1
'74....Accept.....Reject

Weld Number	Indication Length From	Indication Length To	Length (1)	Minimum Depth Div.	Minimum Depth Inches	Maximum Depth Div.	Maximum Depth Inches	Indic. Depth	Surface (a) (✓)	Sub-Surface (2a) (✓)	Beam ∡	Beam Dir.	Base Metal Thick. (Nom.)	Weld Thick. (t) (Nom.)	REF. FIG.
34-6	456 1/4	456 3/4	0.5"	3.6	2.10	3.6	2.10	0 —	NA	✓	0°	5 SIDE	3.7	3.7	23
34-6	468 —	468 —	SPOT	2.8	1.63	2.8	1.63	0 —	NA	✓	0°	5 SIDE	3.7	3.7	24

TABLE IWB-3511.1
ALLOWABLE PLANAR INDICATIONS

Material: Ferritic steels that meet the requirements of NB-2331 and have specified minimum yield strength of 50 ksi or less at room temperature
Thickness Range: 4 in. and greater

Aspect Ratio, a/ℓ[1]	Surface Indications, a/t,%[2]	Subsurface Indications, a/t,%[2,3]
0.	2.0	2.6
0.05	2.1	2.8
0.10	2.3	2.9
0.15	2.6	3.2
0.20	2.9	3.6
0.25	3.2	4.1
0.30	3.7	4.6
0.35	3.7	5.2
0.40	3.7	5.8
0.45	3.7	6.5
0.50	3.7	7.2

OTES:
1) Dimensions a and ℓ are defined in the figures referenced in IWB-3511.1. For intermediate flaw-aspect ratios, a/ℓ, linear interpolation is permissible.
2) Component thickness t is measured normal to the pressure-retaining surface of the component. Where the section thickness varies, the average thickness over the length of the planar indication is the component thickness.
3) The total depth of an allowable subsurface indication is twice the listed value.

(1)

l = 0.5" t = 3.7"

a = 0

a/l = 0

S = distance to nearest surface.

S = 1.60"

a/t,% = a/t x 100 = 0%

For max. allowable a/t,% interpolate from Table IWB-3511-1

2.6%

'74...Accept.....Reject (Accept circled)

(2)

l = 2a t = 3.7"

a = 0

a/l = —

S = distance to nearest surface.

S = 2.07"

a/t,% = a/t x 100 = 0%

For max. allowable a/t,% interpolate from Table IWB-3511-1

2.6%

'74...Accept.....Reject (Accept circled)

(3) (crossed out)

l = ___ t = ___

a = ___

a/l = ___

S = distance to nearest surface.

S = ___

a/t,% = a/t x 100 = ___

For max. allowable a/t,% interpolate from Table IWB-3511-1

'74...Accept.....Reject

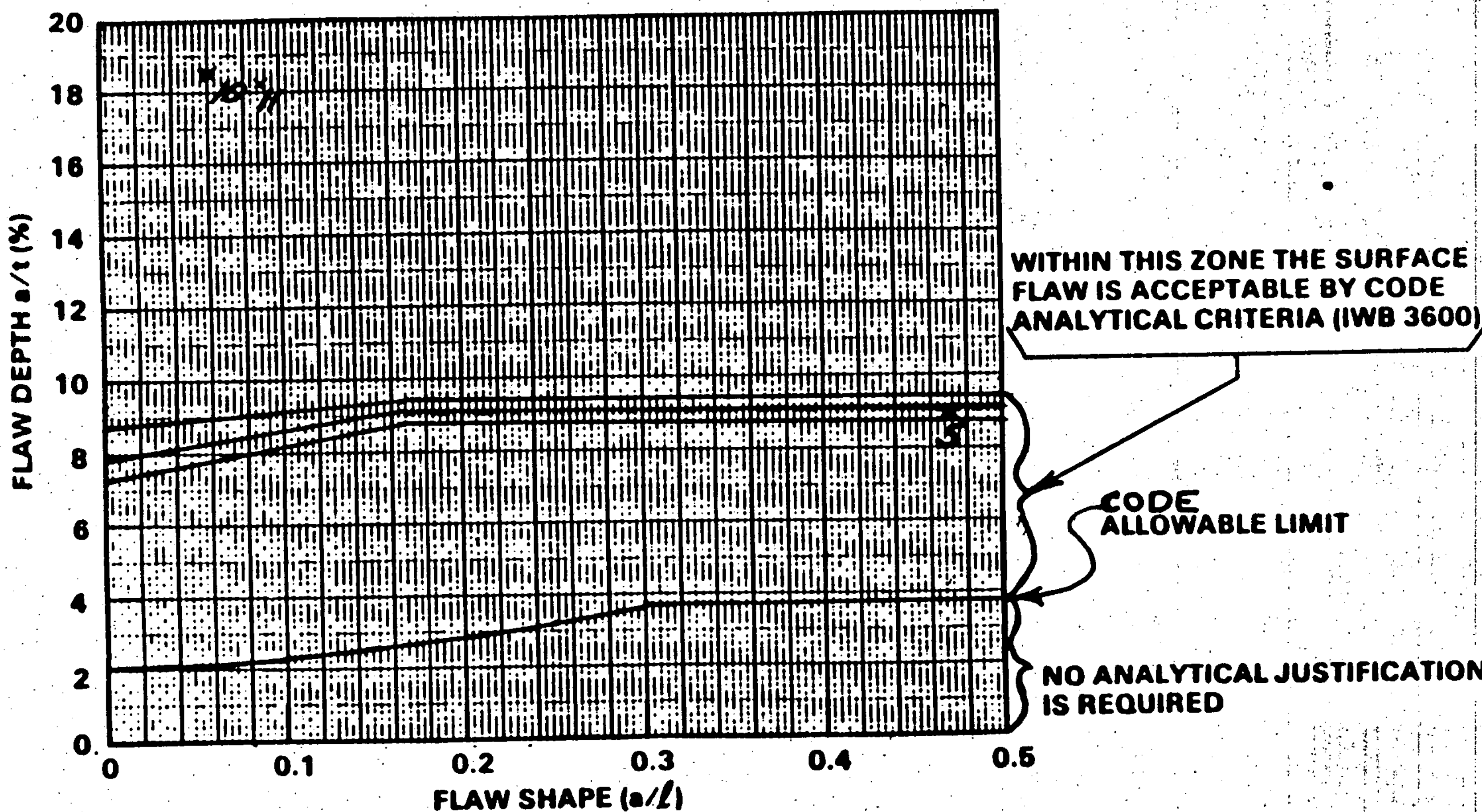


FIGURE 4-1 FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INSIDE SURFACE FLAWS IN THE UPPER SHELL TO CONE REGION

REFERENCE: WCAP 10863 - HANDBOOK ON FLAW EVALUATION

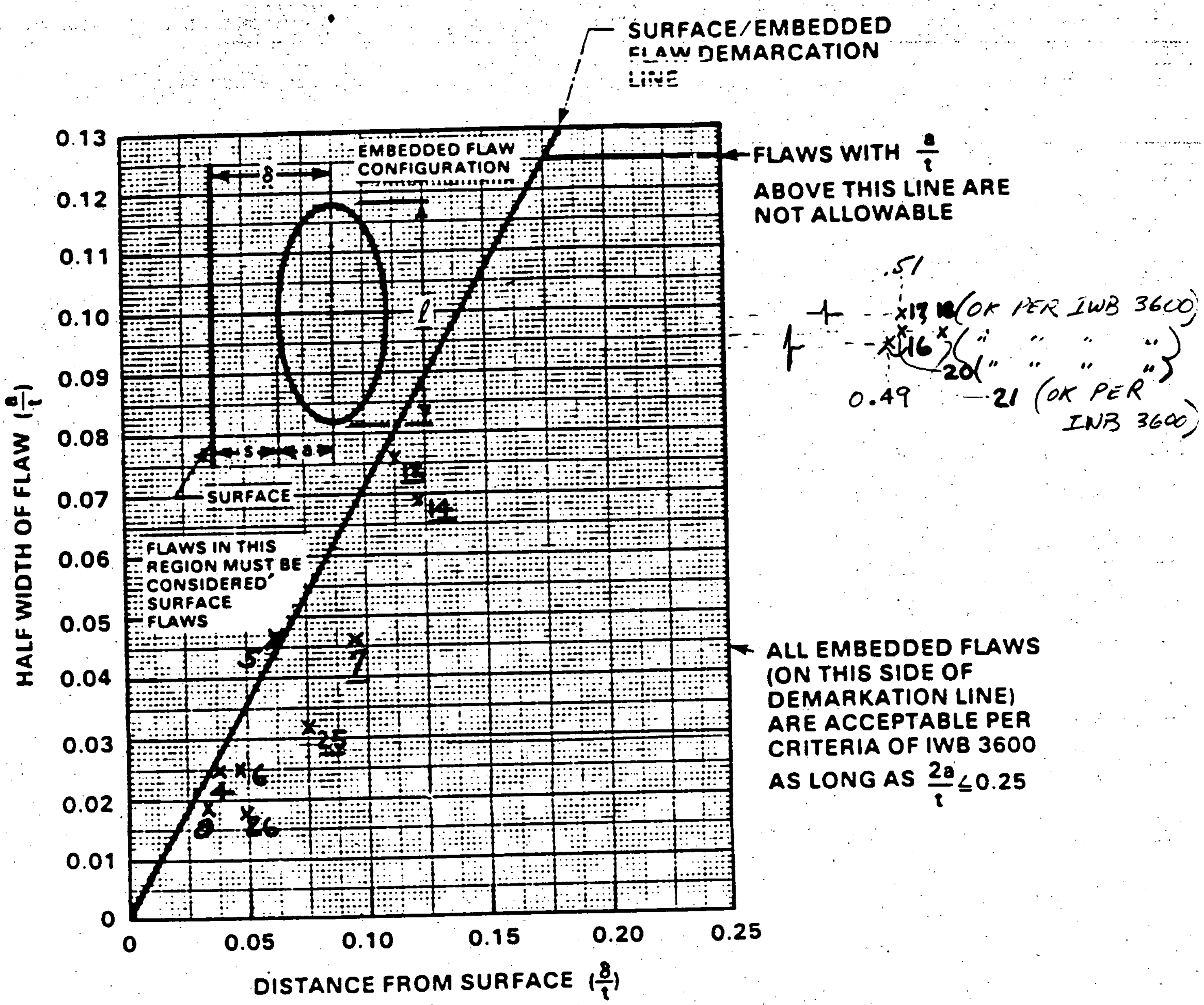


FIGURE 4-2 EMBEDDED FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INDICATIONS IN THE UPPER SHELL TO CONE

REFERENCE: WCAP 10863

[See Figure 6-4 for application to Steam Generator Unit 34, for a/ℓ < 0.1667]

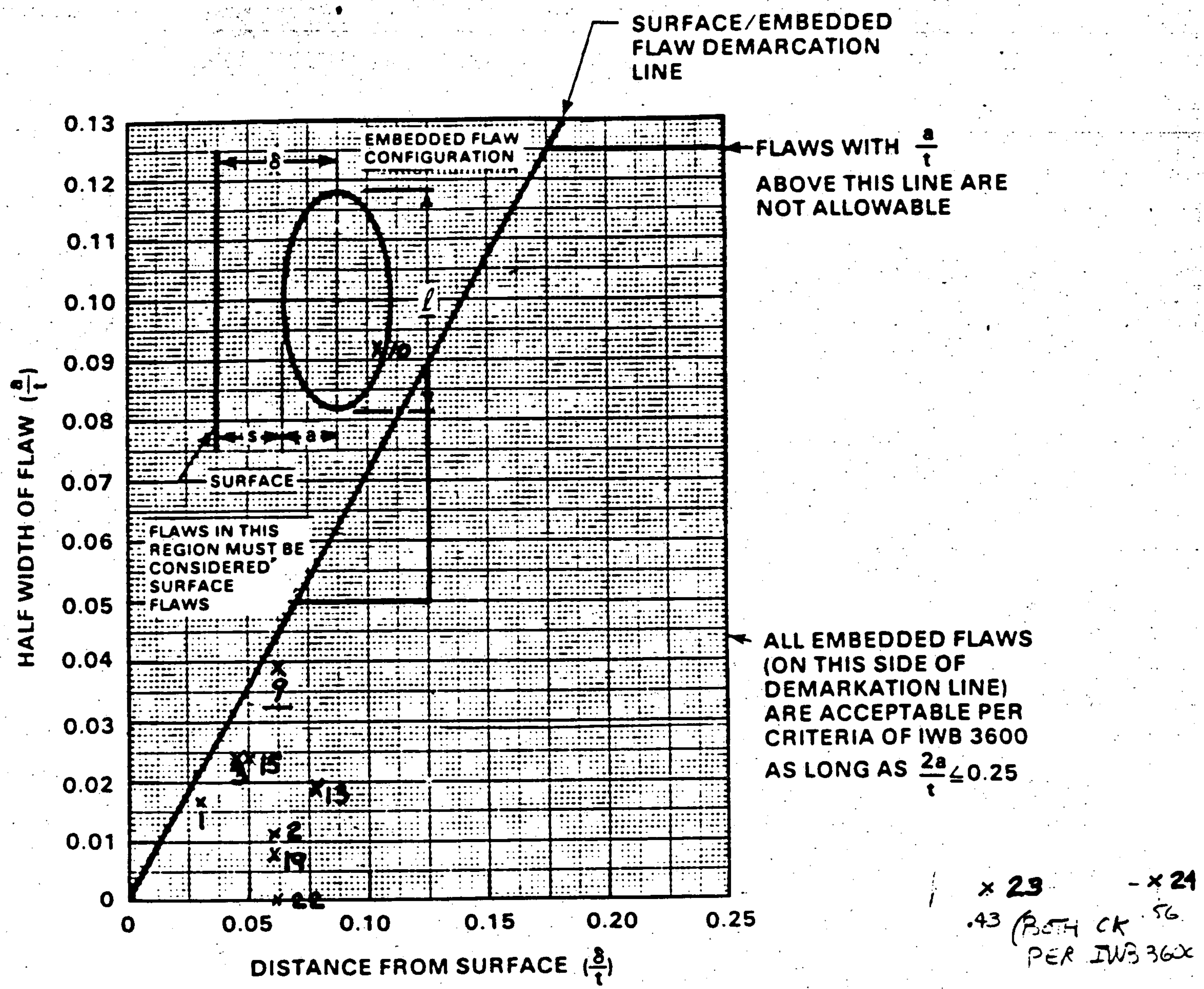


FIGURE 4-3 EMBEDDED FLAW EVALUATION CHARTS FOR CIRCUMFERENTIAL FLAWS IN STEAM GENERATOR 34 WITH a/ℓ LESS THAN 0.1667

REFERENCE: WCAP 10863

Section 5

1985 Steam Generator Girth Weld No. 6 Inspection Conclusions

Conclusions to the 1985 Steam Generator Girth Weld Inspection Program can be separately addressed in the following four areas:

A. Changes in UT indication Number and Parameters from Baseline Inspection.

B. Evaluation of UT Indications against ASME XI Acceptance Criteria.

C. Evaluation of ID Surface Examination.

D. Affect of Internal Surface Geometry.

Each of these areas is sequentially commented on in the following paragraphs, and conclusions are drawn.

A. Changes in UT Indication Number and Parameters From Baseline Inspection

With regard to the number of UT indications detected during the 1985 inspection of the initial area versus the 1983 baseline inspection, only 3 additional indications, out of a total of 41 recordable indications, were observed as indicated in Table 5-1.

In terms of a comparison of changes in indication parameters from the 1983 to the 1985 inspection, again only minor differences existed. Measurable changes in length were reported for six (6) indications, four (4) indications were detected with different depth values (two of which being smaller), and five (5) indications were greater DAC signals.

These minor changes in indication number and size can be explained by the following factors, some of which is further explained later in this section.

- operator/equipment variability allowances
- allowances for area gridding and indication positioning

B. Evaluation of UT Indications Against ASME XI Acceptance Criteria

Table 5-4 indicates that a total of twenty-six (26) reportable indications were detected during the ultrasonic examination of the girth welds. Each of these reportable indications was evaluated to ASME XI acceptance criteria and is documented in Section 4 of this report.

Thirteen (13) of the indications were rejectable to Table IWB-3511.1 of the ASME XI Code, however, all but two (2) of these indications were acceptable to the more encompassing linear elastic fracture mechanics acceptance standards of Appendix A to ASME XI (reference handbook in Appendix E to this report). Figures 4-1 through 4-3 illustrate the status of each of the reportable indications with regard to the criteria of ASME XI, Appendix A.

The condition of the two (2) Appendix A - rejectable indications is further evaluated in the following paragraphs.

C. Evaluation of ID Surface Examination

As explained in Section 2 of this report, the inspection program was expanded from the ultrasonic OD examinations to an ID magnetic particle examination of a sample containing the two (2) Appendix A-rejectable indications.

The two indications in question are No's. 14 and 16 in steam generator 34 as listed in Table 5-5. The table clearly shows these two indications to be near the ID surface (approximately 0.1" below). Thirteen (13) other reportable indications in this same area and also listed in TAble 5-5 were reported to be within 0.2" of the ID surface. However, the MT examination of the area did not reveal any indications (Figure 5-2). As mentioned earlier, a visual inspection of this same inside surface noted numerous blended repair grooves which created the erroneous UT signals. This is more clearly described in the following sub-section.

D. Affect of Internal Surface Geometry

In order to confirm the fact that the UT indications were just erroneous signals generated by an irregular grooved ID surface, a UT thru-transmission, signal damping inspection was performed on the applicable UT indications in this area in accordance with NDEP 9.4-11 and QAI 4.0. Figure 5-7 and its accompanying data sheet in Appendix D reveal that this method did in fact confirm that the signals were simply the result of internal surface grooves for seven (7) rejectable indications. The other reportable UT indications outside the MT inspection area were also plotted on blended groove maps generated from earlier radiographic examination film. These are included as Figures 5-3 through 5-6. As is shown from the figures, all of the indications are located in blended groove areas, thereby concluding that these indications were probably the result of irregular surface geometry also. Internal surface examinations were not performed in these other areas for ALARA considerations, however, it is postulated that these indications are also geometry related in view of the surface irregularities which are known to exist.

In Summary, the condition of the Indian Point 3 steam generator girth welds has been determined to be unchanged from the 1983 baseline and acceptable for continued plant operation for the following reasons:

(1) The few and small changes from the UT baseline inspection are not indicative of a failure mechanism and have been attributed to UT variability (personnel and technique);

(2) The surface examinations performed in steam generator No. 34 were satisfactory, no surface indications were found (the failure mechanism discovered in 1982 was ID surface initiated);

(3) Surface irregularities (geometry) have been demonstrated to be responsible for a significant population of UT indications utilizing a supplemental UT technique; and

(4) The remaining indications (which are located within areas of surface irregularities are similarly postulated to be related to surface irregularities) have been evaluated in accordance with ASME Section XI and are acceptable for continued operation without repair.

TABLE 5-1 1ST SAMPLE AREA

GIRTH WELD INSPECTION SUMMARY

	S/G 31			S/G 32			S/G 33			S/G 34		
	83	84	85	83	84	85	83	84	85	83	84	85
RECORDABLE INDICATIONS	4	2	4	6	4	6	1	0	1	27	14	30
REPORTABLE INDICATIONS	0	0	0	1	1	2	0	0	0	7	5	12
RESECTABLE INDICATIONS	0	0	0	0	0	1	0	0	0	0	0	6
REJECTABLE INDICATIONS - App. A	0	0	0	0	0	0	0	0	0	0	0	2

NOTE

(1) RECORDABLE INDICATIONS ≥ 20% DAC

(2) REPORTABLE INDICATIONS > 50% DAC

(3) RESECTABLE INDICATIONS PER ASME XI, TABLE IWB 3511.1

(4) 1983 & 1985 INSPECTIONS INCLUDE 60° WEDGE DATA

6/26/85

TABLE 5-2 2ND SAMPLE AREA
1985 SG GIRTH WELD UT INSPECTION

		SG 31	SG 32	SG 33	SG 34	TOTAL
		35"	35"	35"	70"	175" (≈8%)
1	RECORDABLE INDICATIONS	7	2	4	14	27
2	REPORTABLE INDICATIONS	1	0	0	4	5
3	REJECTABLE INDS. - TABLE IWB-3511.1	1	0	0	2	3
4	REJECTABLE INDS. - APP. A	0	0	0	0	0

DATA REPRESENTS 0°, 45°, & 60° BEAM UT INSPECTIONS

1 - ≥ 20% DAC

2 - > 50% DAC

TABLE 5-3 3RD INSPECTION 6/30/85

SG 34 UT INSPECTION RESULTS

REMAINING 73% OF WELD (~382")

SCAN	RECORDABLE	REPORTABLE	REJECTABLE*
60°	18	4	3
45°	9	1	0
0°	2	2	0
TOTAL	29	7	3

* REJECTABLE TO ASME XI, TABLE IWB 3511.1 ONLY, ACCEPTABLE TO ASME XI, APPENDIX A CRITERIA.

7/5/85

TABLE 5-4

SG GIRTH WELD UT INSPECTION STATUS

SUMMARY

	SG 31	SG 32	SG 33	SG 34	TOTAL
INSPECTION LENGTH / %	70" / 13%	70" / 13%	70" / 13%	522" / 100%	
RECORDABLE IND	11	8	5	73	97
REPORTABLE IND	1	2	0	23	26
REJECTABLE - T. 3511.1	1	1	0	11	13
REJECTABLE - APP. A	0	0	0	2	2

NewYorkPower
Authority

TABLE 5-5

Project

Subject

Page 1 of 1

Date 7/9/1985

Computed by PEP

1985 S/G GIRTH WELD UT INSPECTION STATUS

REPORTABLE INDICATION PARAMETERS

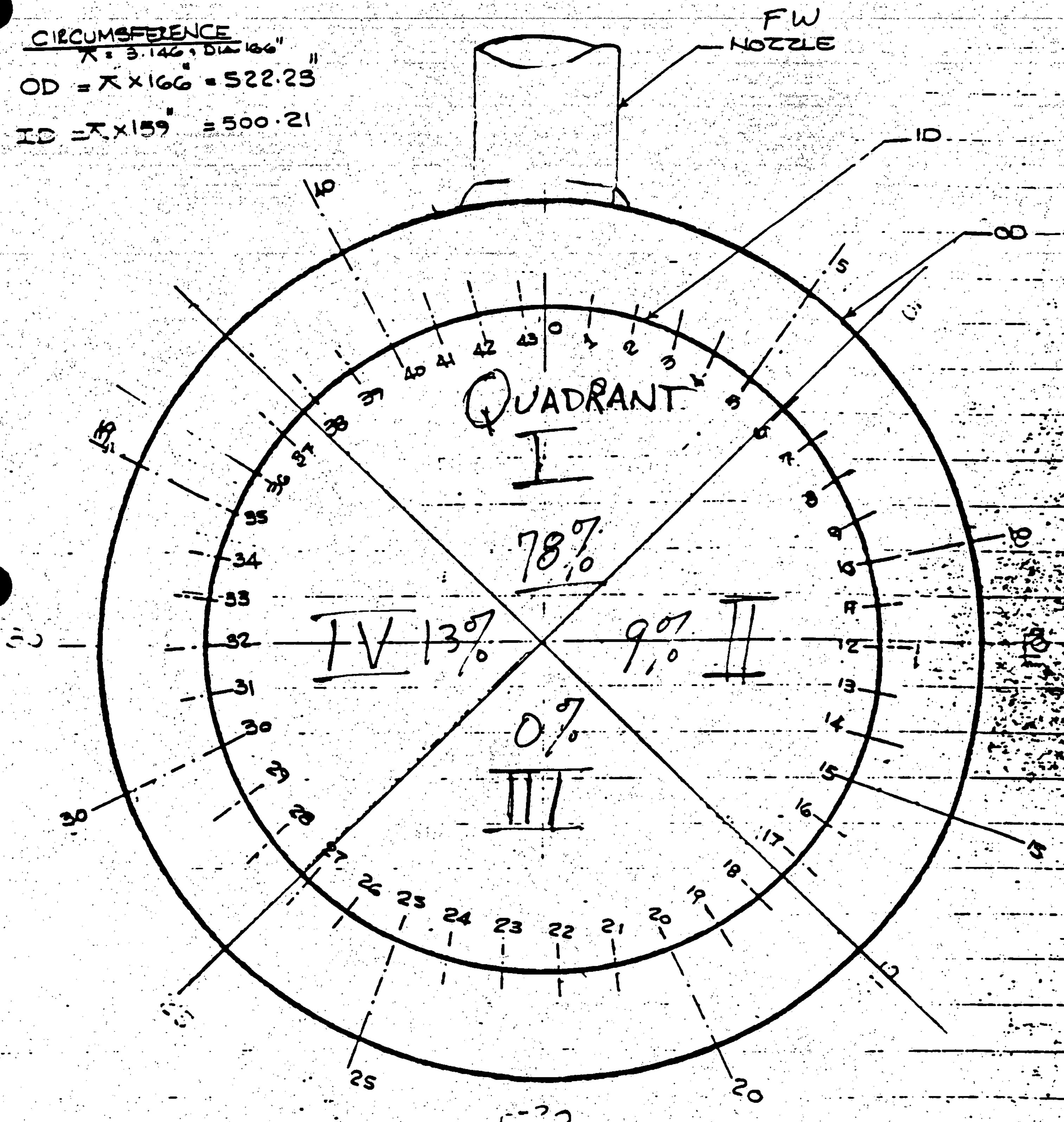
IND. NO.	S/G	INDICATION LOCATION: QUADRANT (SEE MAP)	INDICATION LOCATION: FROM	INDICATION LOCATION: TO	LENGTH, IN.	DEPTH, IN.	IND. POSITION: SURFACE	IND. POSITION: SUB-SURFACE	SUB-SURFACE: FROM I.D. IN.	REJECT. ASME XI T.3511.1	REMARK
1	31	I	30 5/8	31 5/8	1-	.7		✓	1.5	YES	
1	32	III	321 1/2	324 3/8	2 7/8	.2		✓	.2	YES	NEAR SUR
2		IV	348	348 1/2	1/2	.1		✓	.1	NO	↓
	33	(NONE)									
1	34	I	11 1/2	12 3/8	7/8	.1		✓	.1	NO	NEAR SUR
2		↓	14 3/8	15 1/4	7/8	.1		✓	.2	NO	↓
3		↓	46-	47 1/2	1 1/2	.1		✓	.2	NO	↓
4		↓	53 1/8	54 1/8	1-	.5		✓	.2	YES	↓
5		II	73 1/4	74 1/2	1 1/4	0-		✓	.2	NO	↓
6		↓	74 3/4	75 3/4	1-	.7		✓	1.7	YES	
7		IV	402 1/2	403 1/2	1-	.7		✓	1.5	YES	
8		↓	406-	407 3/4	1 3/4	.7		✓	1.5	YES	
9		↓	445 1/4	446 3/4	1 1/2	.1		✓	.2	NO	NEAR SUR
10		I	456 1/4	456 3/4	1/2	0-		✓	1.6	NO	
11		↓	468-	468-	SPOT	0-		✓	2.1	NO	
12		↓	482-	483 1/8	1 1/8	.2		✓	.1	NO	NEAR SUR
13		↓	486 1/4	487 1/4	1-	.6		✓	1.4	YES	
14		↓	503-	514-	11-	.7		✓	.1	YES	NEAR SUR
15		↓	506 2/3	507 1/2	5/6	.2		✓	.1	NO	↓
16		↓	507-	515-	8-	.7	✓			YES	SAME AS #
17		↓	510-	510 1/2	1/2	.2		✓	.1	NO	NEAR SUR
18		↓	511-	511 3/4	3/4	.4		✓	.1	YES	↓
19		↓	511 1/2	513-	1 1/2	.6		✓	.1	YES	↓
20		↓	511 5/8	512 1/2	7/8	.4		✓	.2	YES	↓
21		↓	512 3/8	512 7/8	1/2	.2		✓	.1	NO	↓
22		↓	520 1/2	1/2	2-	.3		✓	.1	YES	↓
23		↓	522-	522-	SPOT	.1		✓	.1	NO	↓

FIGURE 5-1
TYP. STEAM GENERATORS.

CIRCUMFERENCE
$\pi = 3.146$, DIA 166"

OD = $\pi \times 166" = 522.23"$

ID = $\pi \times 159" = 500.21$



S/G. No 34

New York Power Authority

INDIAN POINT NO. 3 NUCLEAR POWER PLANT

FIG. 5-2 QUALITY CONTROL INSPECTION REPORT

	QCIR NO.
Site Location: Indian Point 3 Nuclear Power Plant	Work Request No.: N/A
System Name: STEAM GENERATOR	QA Category: CAT I
Component Name: #34 S/G	Material Replacement Required: Yes ___ No ✓
Responsible Dept./Group: Q.C.	Material Certification Required: Yes ___ No ✓
Activity Location: 95' VC. INSIDE S/G.	Material CERT NUMBER(S): N/A

Procedure Title/No.: NDEP 9.2-2 M.T. YOKE DRY CONTINUOUS METHOD

Prerequisites Accomplished: Yes ✓ No ___ (if no, explain in remarks)

Reason for Activity: M.T. ID OF GIRTWELD #34-6 PER ATTACHED

Work Description (Include material and components used)

M.T. PER ATTACHED

Tests Performed

PER ATTACHED

Test Data

" "

Remarks

NO INDICATIONS NOTED.

Signature of QC Inspector [signature] Date 7/12/85

STEAM GENERATOR NO. 31
LOCATION ON CIR. 24"-36"
SEG 2-3.

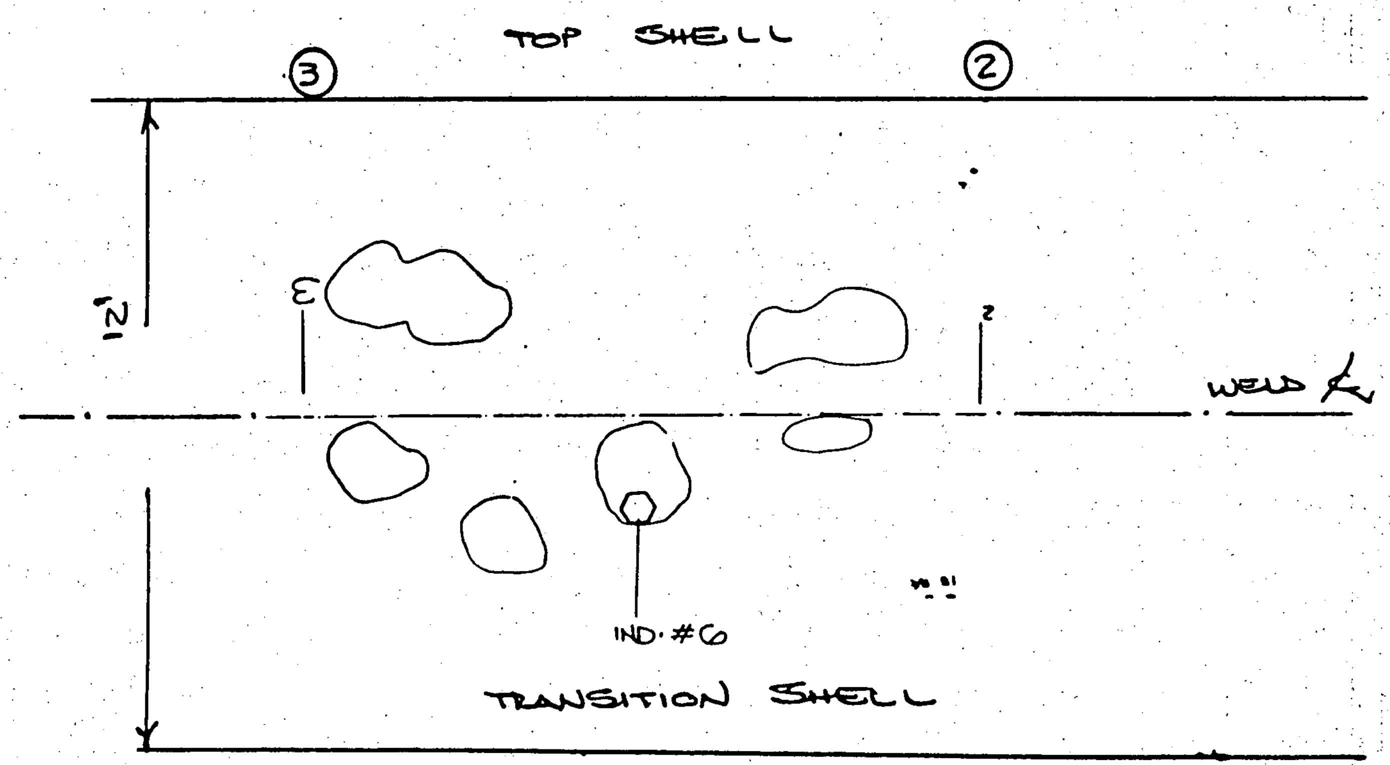


FIGURE 5-3

[signature] 7/27/85

INDICATION NUMBERS CORRESPOND TO THOSE ON UT DATA SHEETS.

STEAM GENERATOR NO. 32
LOCATION ON CIR.
SEG 26-30

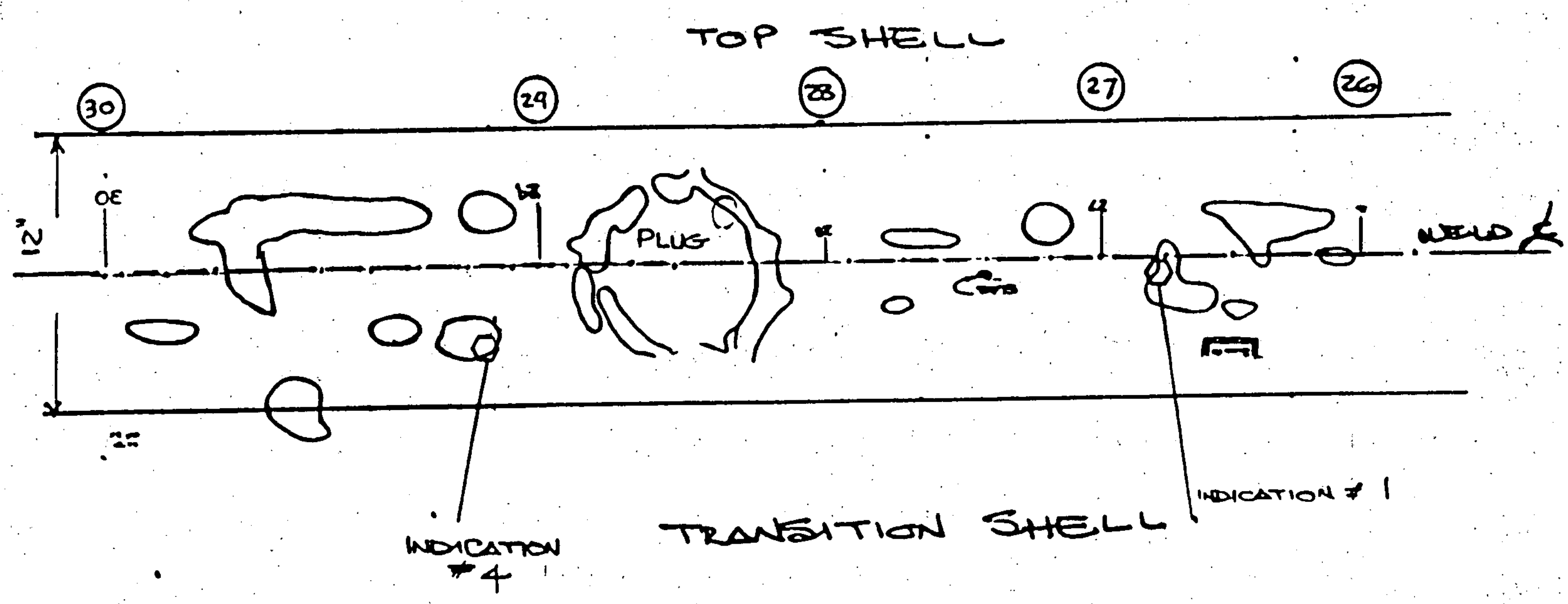


FIGURE 5-4

7/27/85

INDICATION NUMBERS CORRESPOND TO THOSE ON UT DATA SHEETS.

STEAM GENERATOR NO. 34
LOCATION ON CIR. 396" - 468"
SEG. 33 - 39

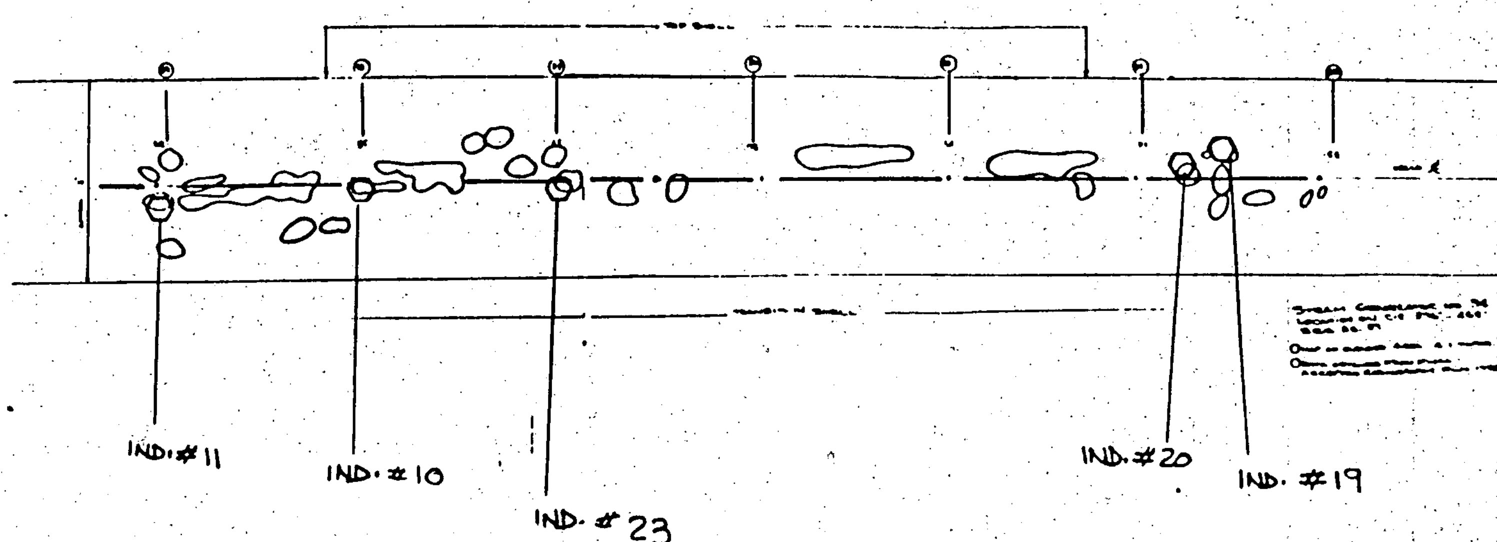


FIGURE 5-5

7/27/85

INDICATION NUMBERS
CORRESPOND TO THOSE
ON UT DATA SHEETS

STEAM GENERATOR NO. 34
LOCATION ON CIR. 72"
SEG. 6-7.

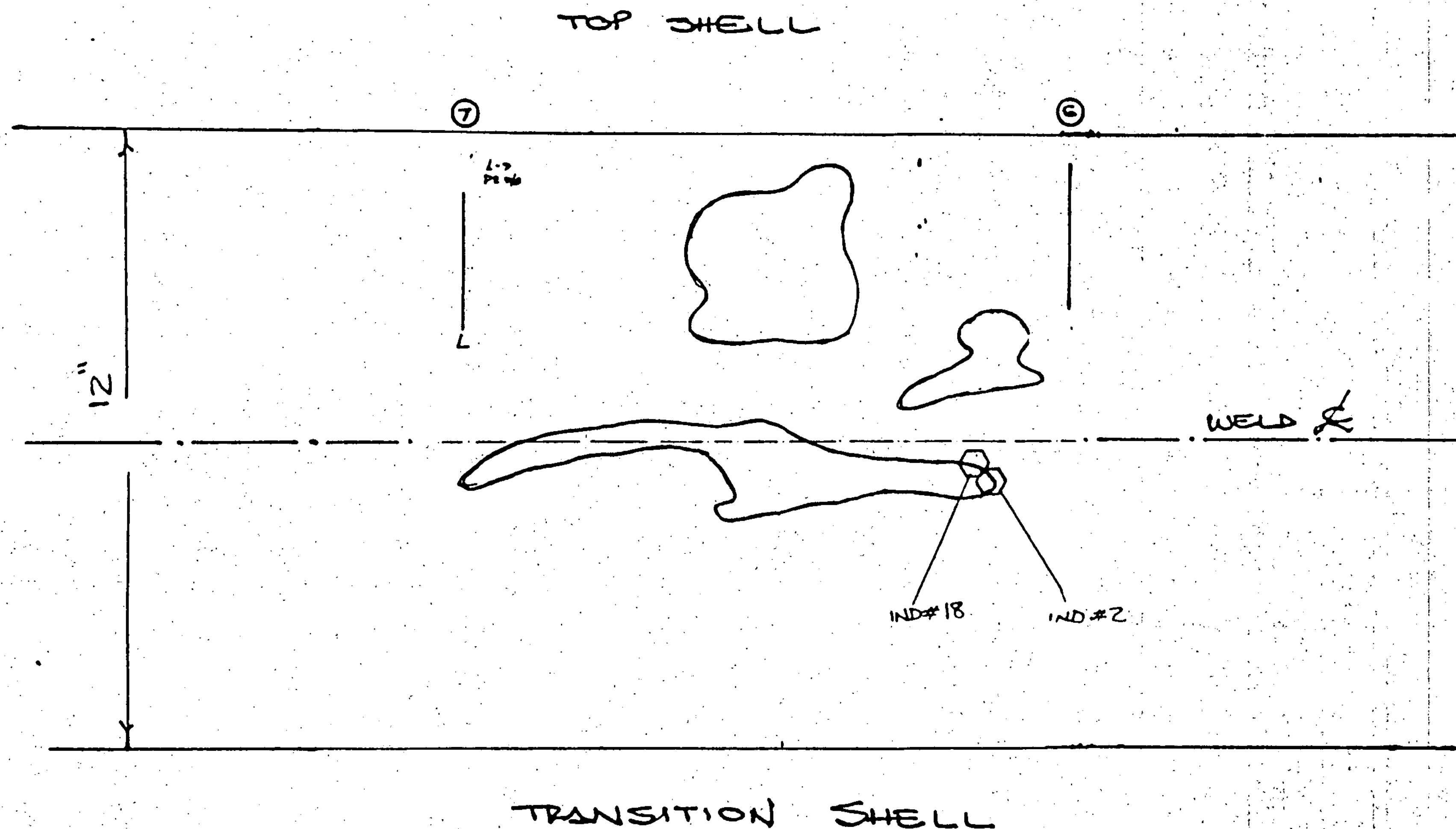


FIGURE 5-6

7/27/85

INDICATION NUMBERS CORRESPOND TO THOSE ON UT DATA SHEETS.

FIG. 6-7

TEAM GENERATOR NO. 34

IRTH SEAM 34-6

MAP OF BLENDED AREAS - 4:1 TAPER

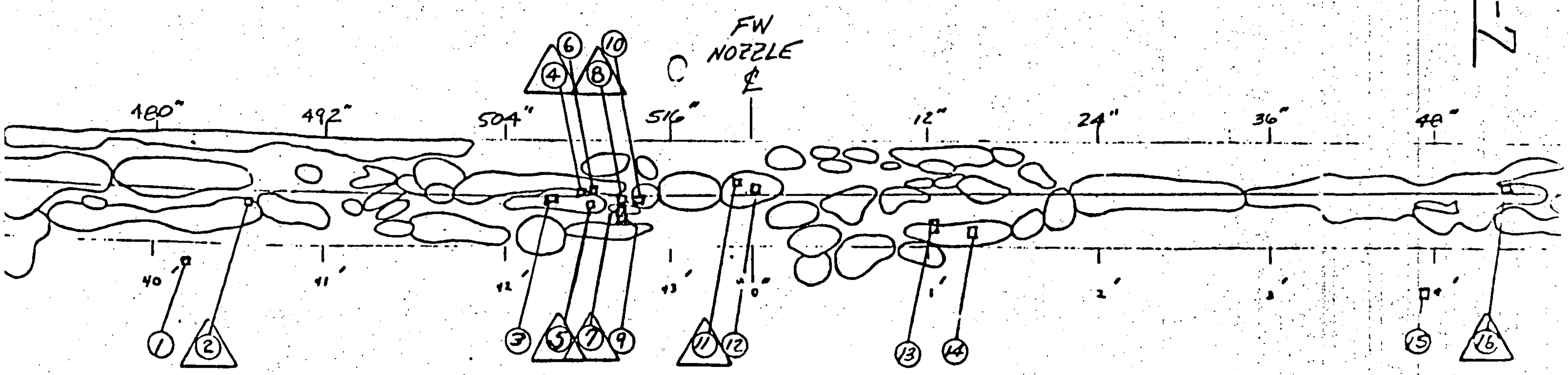
LOCATION(S) 39' TO "0" & "0" TO 5' SEGMENTS ("0" IS CENTERLINE OF FEEDWATER N

DATA OBTAINED FROM FINAL ACCEPTED RADIOGRAPHIC FILM - 1983

REPORTABLE INDICATIONS (16)

LOCATIONS

FIGURE 5-7



REDUCED - NOT TO SCAL.

△ - REPORTABLE INDICATION NUMBERS, APPLICABLE TO QAI 4.0.

○ - REPORTABLE INDICATION NUMBERS.

POWER AUTHORITY OF THE STATE OF NEW YORK

QUALITY ASSURANCE

NONDESTRUCTIVE EXAMINATION PROCEDURE

TITLE MAGNETIC PARTICLE EXAMINATION PROCEDURE YOKE TYPE CONTINUOUS DRY METHOD	NDEP: 9.2-2
APPLICABILITY NUCLEAR POWER PLANTS	REVISION: 1
APPROVAL NDE - LEVEL III	DATE 3/25/82
CONCURRENCE VICE PRESIDENT - QUALITY ASSURANCE	DATE 3/25/82
SUPERCEDES REV. 0, 1/17/78	

MAGNETIC PARTICLE EXAMINATION PROCEDURE YOKE TYPE
CONTINUOUS DRY METHOD

1.0 PURPOSE

This procedure describes the requirements for examination of welded ferromagnetic materials for detecting surface defects using yoke type, dry method magnetic particle examination.

2.0 APPLICABILITY

This procedure shall be applicable to the examination of ferromagnetic materials only where magnetic particle examination is required by specifications, codes, for nuclear power plants.

3.0 REFERENCES

3.1 ASME Boiler and Pressure Vessel Code 1968, 1974, 1977 edision, Section I, III, V, VIII, XI, plus addendas.

3.2 ANSI B31.1, Standard Code for Pressure Piping. 1

3.2 NDEP 1.1, NDE Personnel Qualification and Certification. 1

3.3 ASTM-E-109-63, Standard Method for Dry Powder Magnetic Particle Inspection. 1

3.4 NDEP 9.2, General Requirements for Magnetic Particle Examination. 1

4.0 ATTACHMENTS

9.2.2-1 Nondestructive Examination Procedure Qualification.

9.2.2-2 Magnetic Particle Inspection Report.

5.0 GENERAL

5.1 Definitions

5.1.1 Procedure Qualification - Capability as verified by comparison to an established or defined standard of performance.

5.1.2 Discontinuity - An interruption in the physical structure of configuration of a part which may or may not affect the usefulness of the part.

5.1.3 Defect - A discontinuity which interfers with the usefulness of part detrimental to its serviceability.

5.1.4 Indication - Any magnetically held particle pattern on a surface of a part being tested.

5.1.5 Non-relevent Indications - They are true indications produced by leakage fields, however, the conditions causing them are present by design, manufacturing or other features of the part having no relation to the damaging flaws being sought. Such an indication has no relation to discontinuities that may constitute defects.

5.1.6 False Indication - An indication that may be interpreted erroneously as a discontinuity such as mechanically held magnetic particles.

5.2 Responsibility

5.2.1 All personnel performing the magnetic particle testing in accordance with this procedure shall be qualified and certified to at least Level I tester.

5.2.2 Magnetic Particle Level I Tester shall not perform any testing except under guidance and supervision of a certified Level II Tester or Level III Examiner.

5.2.3 All personnel assigned to interpret and evaluate test results shall be certified to at least Magnetic Particle Level II Tester.

5.3 General Requirements

5.3.1 All magnetic particle materials shall meet the requirements of ASTM E-109.

5.3.2 Examinations in accordance with this procedure shall not be done on the surface of parts whose temperature exceeds 600°F.

5.3.3 Examination records shall be maintained as part of quality records.

6.0 PROCEDURE

6.1 Surface Preparation

6.1.1 The surface to be examined and all adjacent areas within at least 1" shall be dry and free of dirt, grease, lint, scale, oil, weld spatter, or other matter that would interfere with the examination.

6.1.2 Surface preparation such as grinding or machining may be necessary in cases where surface irregularities would mask an indication.

6.1.3 Cleaning may be accomplished by detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand or grit blasting and ultrasonic cleaning methods.

6.2 Description of Method

6.2.1 General - This method consists of magnetizing the area to be inspected to near saturation followed by applying particles of the ferromagnetic examination medium to the surface. The particles will be retained on the surface at cracks and other discontinuities due to leakage in the magnetic field. The patterns will be characteristic of the type of discontinuity present.

6.2.2 Examination of Medium

A. The examination medium shall be finely divided ferromagnetic particles of high permeability and low retentivity.

B. The color of the particles shall be such as to provide adequate contrast with the background of the surface being examined. Recommended particle colors, red, grey, magnaflux #8A and #1.

C. Particles shall be applied by dusting. Distance between applicator and test surface shall be at least 2 inches. Particles shall not be re-used.

D. Excess particles may be removed using a gentle air stream.

6.3 Magnetization

6.3.1 Aternating or direct current electromagnetic yokes or permanent magnetic yokes shall be used. Recommended yoke type machines: Magnaflux Y-6.

6.3.2 Pole spacing shall not exceed a maximum of 5 inches and a minimum of 3 inches.

6.4 Magnetizing Current

6.4.1 Alternating current electromagnetic yokes may be used to magnetize, provided the yoke has a lifting power of at least 10 lbs. and a pole spacing of 3 to 6 inches.

6.4.2 Direct current electromagnetic or permanent magnetic yokes may be used to magnetize, provided the yoke has a lifting power of at least 40 lgs. and pole spacing of 3 to 6 inches.

6.4.3 The magnetizing current shall remain on during the period the examination medium is being applied and while excess examination medium is being removed.

6.5 Direction of Magnetization

At least two separate examinations shall be carried out on each area being examined. The yoke shall be placed so that the lines of flux during one examination are approximately perpendicular to the lines of flux during the other.

6.6 Examination

6.6.1 Examination shall be conducted with sufficient overlap to assure 100% coverage at the established test sensitivity.

6.6.2 The maximum test sensitivity will be obtained when the lines of flux of the magnetic field are perpendicular to a linear discontinuity.

6.6.3 Adequate illumination is required at the area to be examined.

6.7 Evaluation of Indications

Any indication which is belived to be non-relevant shall be considered unacceptable until the indication is either eliminated by additional surface conditioning or proved to be nonrelevant. Nonrelevant indications which could mask unacceptable discontinuities shall be treated as unacceptable discontinuities.

6.8 Acceptance Standard

The following indications will be considered unacceptable:

A. Any cracks or linear indications.
B. Any rounded indication that exceeds 3/16"
C. Four or more rounded indications in a line separated by at least 1/16" edge-to-edge.
D. Ten or more rounded indications in any six square inches.

Linear indications are those indications in which the length is more than three times the width. Rounded indications are those which are circular or elliptical with the length less than three times the width.

6.9 Demagnetization

Demagnetization is required when residual magnetism may interfere with subsequent process or usage.

6.10 Procedure Qualification

Procedure shall be qualified and proven by actual demonstration using a test piece with known defects. Procedure qualification results shall be recorded on the Attachments 9.2.2-1 and 9.2.2-2.

6.11 Calibration of Equipment

6.11.1 The magnetizing equipment shall be calibrated at least once a year, or after each time it has been subjected to major electrical repair, periodic overhaul, or damage.

6.11.2 The magnetizing force of yokes shall be calibrated by determining their minimum lifting power.

6.11.3 The alternating current electromagnetic yoke shall have a lifting power of at least 10 lbs. at the maximum pole spacing at which it will be used.

6.11.4 The direct or permanent magnet yoke shall have a lifting power of at least 40 lbs. at the maximum pole spacing at which it will be used.

6.11.5 A sticker shall be attached to the yoke showing:

A. The date of performance of the lift test.
B. The name or initials of the person who performed such work.
C. The date the sticker expires.

POWER AUTHORITY OF THE STATE OF NEW YORK

NUCLEAR POWER PLANT ____________________

PROCEDURE Nº 9.2-2
REVISION Nº ______
DATE ______
ATTACHMENT 9.2.2-1

NONDESTRUCTIVE EXAMINATION PROCEDURE QUALFICATION RECORD

NO. ________

PROCEDURE NO. ____________ REV. ____________ DATE ____________

NDE METHOD ________________________________

INSPECTION REPORT NO. ____________ DATE ____________

METHOD ________________________________

PROCEDURE NO. ____________ REV. ____________ DATE ____________

METHOD ____________________ HAS BEEN SATISFACTORILY TESTED AND IS HEREBY QUALIFIED FOR USE.

TEST PERFORMED BY:	EVALUATION PERFORMED BY	
NAME ____________	NAME ____________	
SIGNATURE ________ LEVEL ____	SIGNATURE ________ LEVEL ____	
DATE ____________	DATE ____________	PAGE ______ OF ______

POWER AUTHORITY OF THE STATE OF NEW YORK

NUCLEAR POWER PLANT ________________

PROCEDURE Nº 9.2-2
REVISION Nº ______
DATE ______
ATTACHMENT 9.2.2-2

MAGNETIC PARTICLE EXAMINATION REPORT

REPORT Nº ____________ DATE: ____________

PURPOSE OF INSPECTION ________________ (PROCEDURE QUALIFICATION, ISI etc.)

COMPONENT:	Pole SPACING
IDENTIFICATION:	MAGNETIZATION METHOD
REPAIR WORK ☐ YES ☐ NO	MAGNETIZING CURRENT
SURFACE CONDITION	MAGNETIC PARTICLES DESCRIPTION
LENGTH INSPECTED	EQUIPMENT
MATERIAL	DEMAGNITIZATION

AREA OF EXAMINATION	DESCRIPTION OF INDICATION	ACCEPT	REJECT	REMARKS

SKETCH (If necesary)

TEST PERFORMED BY:	EVALUATION PERFORMED BY	
NAME: ________	NAME ________	
SIGNATURE ________ LEVEL ____	SIGNATURE ________ LEVEL ____	
DATE ________	DATE ________	PAGE ____ OF ____

New York Power Authority

Quality Assurance

Nondestructive Examination Procedure

TITLE: Manual Ultrasonic examination of circumferential and longitudinal butt welds in ferretic vessels of 2½" thick and greater	NDEP 9.4-9
APPROVAL: [signature] NDE - Level III	DATE 7/30/84
CONCURRENCE: [signature] Director - Quality Assurance	REVISION 1
APPLICABILITY: Nuclear Power Plants	SUPERSEDES: NDEP 9.4-9 Rev. 0

MANUAL ULTRASONIC EXAMINATION OF CIRCUMFERENTIAL AND LONGITUDINAL BUTT WELDS IN FERRITIC VESSELS OF 2 1/2" THICK AND GREATER

1.0 PURPOSE

The ultrasonic examination specified herein applies to the use of manual pulse/echo examination of circumferential and longitudinal full penetration welds in ferritic vessels.

2.0 APPLICABILITY

This procedure is applicable to, and describes requirements for manual ultrasonic examination of full penetration circumferential and longitudinal butt welds 2 1/2" thick and greater in ferritic vessels. This procedure complies with ASME Code, Section XI.

3.0 REFERENCES

3.1 NDEP 1.1 Procedure for Qualification and Certification of Nondestructive Examination Personnel.

4.0 ATTACHMENTS

4.1 APPENDIX A - Supplemental calibration parameters.

4.2 Fig. 1 - Typical calibration block.

4.3 Fig. 2 - Extent of metal examination.

4.4 Fig. 3 - Examination references.

4.5 APPENDIX B - Ultrasonic examination data.

4.6 APPENDIX C - Ultrasonic indication data sheet.

4.7 APPENDIX D - Ultrasonic transfer data sheet.

4.8 APPENDIX E - Instrument calibration data for welds 2 1/2" thick or greater in ferritic vessels.

5.0 GENERAL

5.1 TEST PERSONNEL

All personnel performing the nondestructive examinations in accordance with this procedure shall be qualified and certified to at least Level I in accordance with SNT-TC-1A and NDEP 1.1 Procedure for Qualification and Certification of Nondestructive Examination Personnel.

NOTE: At least one member of each examination crew shall have a minimum qualification of Level II. A Level II or III individual shall be responsible for witnessing the final interpretation on all ultrasonic examinations. He shall be responsible for the recording and acceptance of required data on ultrasonic examination reports.

5.2 TEST EQUIPMENT

5.2.1 Ultrasonic flaw detection instruments shall be of the pulse echo type with an A-Scan presentation.

5.2.2 Transducers used shall be a maximum of one (1) square inch in area and not less than 2.25 MHz nominal frequency. The transducers used for angle beam tests shall be affixed to suitable wedges designed to induce sound beams in the material under test at the required angles. The beam angles shall be within $\pm 2^{o}$ of nominal. Other frequencies and/or angles may be used if required to conduct the examinations or investigations.

5.3 COUPLANT

A suitable liquid, semi-liquid, or paste couplant medium, such as water, oil, glycerin, or grease shall be applied to the test surface. Couplants used to ensure the transmission of ultrasonic beams shall contain not more than one percent (1%) by weight, of residual sulphur and halogens.

5.4 GENERAL REQUIREMENTS

5.4.1 Generally the examinations conducted in accordance with this procedure will be done from the O.D. surface. When examinations or evaluations are to be conducted from an

I.D. clad surface, calibration must be accomplished through the clad of the appropriate calibration block and noted on the report. For I.D. examinations the search unit size and configuration shall be such that coupling distance does not exceed .010". ◁1

5.4.2 The calibration standards used shall be made of ultrasonically sound material of the same specification, product form and heat treatment as one of the materials in the assembly to be examined.

5.4.3 Examined areas shall be dry wiped to remove excess couplant.

5.4.4 Unless otherwise specified the area to be examined shall include the weld and the adjacent base material for one wall thickness on either side.

5.4.5 The material shall be examined, where practical, from both sides of the weld by a straight beam and two angle beams of 45 and 60 degrees.

5.4.6 Prior to starting an examination, the areas to be examined and contacted by the search unit shall be cleaned to ensure that it is free of dirt, loose scale, machining or grinding particles, weld spatter or other loose foreign matter that would impair the free movement of the search unit or affect the inspection results. If such conditions are detected, they will be rectified prior to conducting the examination.

5.4.7 To assure complete coverage of the volume, the transducer shall be indexed with at least a 10% overlap with each pass. The scanning rate shall not exceed 6 inches per second.

6.0 PROCEDURE

6.1 BASE METAL STRAIGHT BEAM CALIBRATION AND EXAMINATION

6.1.1 Prior to performing angle beam examinations, the base material through which the angle beam will pass (Ref: Fig. 2) shall be completely scanned with a straight beam search unit to detect reflectors which might affect the interpretation of the results of the angle beam examination.

6.1.2 The sensitivity of the instrument shall be adjusted at a location free of indications so that the first back reflection from the far side of the plate will be 50 to 80 percent of full screen height. The sensitivity as adjusted above shall be continuously monitored during the examination and adjusted as necessary to maintain it within the stated amplitude.

6.1.3 For components having weld deposited cladding on the inside surface, the base metal straight beam examination shall be conducted concurrently and at the same sensitivity as the straight beam examination described in paragraph 6.5 below.

6.1.4 Areas containing indications (principally laminar) that will affect angle beam examinations shall be noted, considered during the examination, and reported on the data sheet.

6.2 INSTRUMENT CALIBRATION

Instrument calibration shall be verified at the beginning of each day of examination in accordance with the following requirements:

6.2.1 Amplitude Linearity Verification - Position an angle beam search unit on the calibration block so that indications can be observed from both the 1/2 and 3/4T holes. Adjust the search unit position to give a 2 to 1 ratio of amplitudes between the two indications, with the larger set at 80% of full screen height. Without moving the search unit, adjust sensitivity (gain) to successively set the larger indication from 100% to 20% of full screen height, in 10% increments (or 2 DB steps if a fine control is not available), and read the smaller indication at each setting. The reading must be within plus or minus 2 1/2% of 50% of the larger amplitude. The readings must be estimated to the nearest 1% of full screen.

6.2.2 Amplitude Control Linearity Verification - Position an angle beam search unit on a calibration block so that the indication from the 1/2 T hole is peaked on the screen. With the increases and decreases in attenuation shown in the following table, the indication must fall within the specified limits.

Indication set at % of full screen	DB Control Change	Indication limits, % of full screen
80%	- 6DB	36 - 42
80%	- 12DB	16 - 22
40%	+ 6DB	76 - 84
20%	+ 12DB	79 - 92

Note: Minus denotes decrease in amplitude; Plus denotes increase.

The readings must be estimated to the nearest 1% of full screen.

6.3 EXAMINATION SYSTEM CALIBRATION

Calibration shall include the complete ultrasonic examination system. Any change in search units, shoes, couplants, cables, ultrasonic instruments, or any other parts of the examination system shall be causes for recalibration.

6.3.1 Calibration shall be verified at the beginning of each day of examination, and at the end of each examination category or every four hours, whichever is less, and with any change of examination personnel. A DECREASE in sensitivity of more than 2 DB shall require recalibration and re-examination of all items examined since the previous acceptable calibration or check. An INCREASE in sensitivity of more than 2 DB shall require recalibration and re-examination and data correction of all indications reported since the previous acceptable calibration or check.

6.3.2 The instrument sweep range and a distance amplitude curve (DAC) shall be established utilizing the response from the applicable basic calibration holes in accordance with the following:

NOTE: When necessary, sweep position locations of the calibration reflectors may be altered to accomodate the examination area thickness within 90% of the sweep length.

6.4 ANGLE BEAM CALIBRATION

6.4.1 Sweep Range Calibration

A. Position the search unit for the maximum response from the 1/4 T side drilled hole. Adjust the left edge of this indication to line 2 on the screen with the delay control.

B. Position the search unit for the maximum response from the 3/4 T hole. Adjust the left edge of this indication to line 6 on the screen with the range control. 1

C. Repeat delay and range control adjustments until the 1/4 T and 3/4 T hole reflections start at sweep lines 2 and 6 respectively.

D. Position the search unit for maximum response from the square notch on the opposite surface. The indication will appear near sweep line 8.

E. Two divisions on the sweep equals 1/4 T.

6.4.2 Distance - Amplitude Correction

A. Position the search unit for maximum response from the hole which gives the highest amplitude.

B. Adjust the sensitivity control to provide an 80% of full screen indication from the hole. Mark the peak of the indication on the screen with a grease pencil or other suitable marker. 1

C. Decrease the peaked signal by 6DB and mark this amplitude on the screen to establish the 50% DAC point.

D. Re-establish the primary DAC response level by increasing the 50% amplitude by 6DB.

E. Position the search unit for maximum response from each of the remaining calibration holes.

F. Mark the peak of these indications on the screen.

G. Repeat step 3 and 4 for each of the remaining calibration holes.

I. Connect the screen marks from the side drilled holes to provide the primary DAC and the 50% Distance Amplitude Curve.

6.5 STRAIGHT BEAM CALIBRATION

6.5.1 Sweep Range Calibration

A. Position the search unit on the calibration block and obtain the maximum response from the 1/4T side drilled hole. Adjust the left edge of this indication to line 2 on the screen with the delay control.

B. Position the search unit for the maximum response from the 3/4 T hole. adjust the left edge of this indication to line 6 on the screen with the range control.

C. Repeat delay and range control adjustments until the 1/4T hole reflections start at sweep lines 2 and 6.

6.5.2 Distance Amplitude Correction

A. Position the search unit for maximum response from the 1/4 T hole.

B. Adjust the sensitivity control to provide an 80% of full screen indication from the hole. Mark the peak of the indication on the screen with a grease pencil of other suitable marker.

C. Position the search unit for maximum response from each of the remaining calibration holes.

D. Mark the peaks of these indications on the screen.

E. Connect the screen marks and extend through the thickness to provide the distance amplitude curve for the drilled holes.

6.6 WELD EXAMINATION

Examinations shall be performed for reflectors parallel and transverse to the weld utilizing the procedures outlined below. Scan sensitivity shall be a minimum 2X the reference sensitivity.

6.6.1 Reflectors Parallel to the Weld

The scan pattern shall start at one edge of the area to be examined with the ultrasonic search unit transmitting an angle beam perpendicular to the weld. The search unit shall be moved towards and away from the weld such that the calibrated beam passes through the whole area of the weld and base metal to be examined. Concurrent with this scan, the search unit shall be angled 15^{o} right and 15^{o} left and progressively indexed along the length of the weld such that the whole scan pattern follows a "saw-tooth" pattern. The "pitch" of the "saw-tooth" shall be such that on each pass the ultrasonic beam covers at least 10 per cent of the area covered by the previous adjacent pass. The weld and required amount of adjacent base metal is to be fully examined by this procedure. When practical, the examination shall be accomplished from both sides of the weld.

6.6.2 Reflectors Transverse to the Weld

A The search unit shall be placed on one edge (i.e., 1 weld thickness from the edge of the weld) of the inspection area directing the angle beam into the material parallel to the weld axis. From this position, the search unit shall be moved parallel to the weld and indexed toward the opposite side of the weld such that the next scan will cover at least 10 percent of the area covered by the previous adjacent scan. Parallel scans shall be repeated in this manner until the opposite side of the weld and base metal is reached and examined.

B. Welds having high or uneven reinforcement shall be ground flat for at least 90% of the weld width prior to performing the examination.

C. The examination in 6.6.1 and 6.6.2 shall be repeated with the transducer turned 180 degrees.

6.6.3 Extent of Examination

Volume and area subject to examination and extent of scan length shall be in accordance with Fig. 2.

6.7 CALIBRATED STRAIGHT BEAM EXAMINATION

6.7.1 A calibrated straight beam examination shall be performed on the weld and heat affected zone utilizing adjacent parallel scans with at least a 10 percent overlap.

6.7.2 Scanning shall be performed at a gain setting of 2 times the reference level (6DB increase in amplitude). Recording of indications shall be carried out with the gain control set at the reference level.

6.8 INVESTIGATION OF INDICATIONS

6.8.1 All indications exceeding 20% of the primary reference DAC (40% of scanning DAC) shall be investigated to determine maximum response, location and type of indication. Indications are generally categorized as flaw, geometric, or metallurgical.

6.8.2 All flaw indications which produce a response greater than 50 percent of the primary response reference level DAC curve will be investigated to the extent the examiner can characterize and report data relevant to the shape, orientation, location, and possible source of the indication producing area.

A. Prior to the performance of any investigations to further characterize flaw indications, the examination system shall be additionally calibrated in accordance with the requirements of Appendix A.

B. Reflector length shall be determined by positioning the search unit such that the sound beam is directed perpendicular to the long axis of the discontinuity and by moving the transducer parallel with this axis in each direction from the position of maximum signal amplitude. The extremities of the discontinuity shall be defined as the points where the signal amplitudes drop to 50% of the calibrated DAC line. The size and location of recordable indications shall be recorded and evaluated.

6.8.3 Indications which are positively determined to result from the geometric configuration of the component and that exceed the recording level for flaws shall be acknowledged by recording the length and location, i.e. at ID., from 175° to 270°.

6.8.4 Indications resulting from the metallurgical structure within the material shall be investigated and considered when assessing the effectiveness of th examinations. Restrictions or variations to the examination due to the metallurgical structure shall be recorded.

6.8.5 Investigation and recording of indications shall be performed at the reference frequency and sensitivity. Other frequencies or beam angles may be used as an aid in investigating or interpreting examination results.

6.9 EXAMINATION RESULTS AND DOCUMENTATION

All data relative to the examinations and the recordable indications shall be documented and evaluated.

6.9.1 Data Recording

The locations of all recordable indications noted during the performance of non-destructive examinations shall be recorded with reference to datum points established.

A. The length and location of all recordable indications parallel to the weld shall be recorded by the distance along the axis of the weld from the datum (or related reference) point, to each end of the indication (starting and finishing points defining the length). ◁1

B. The depth and width and location of all recordable indications parallel to the weld shall be recorded by the perpendicular distance from the centerline of the weld to each side of the indication (starting and finishing points defining the width).

C. The length and location of all recordable indications transverse to the weld shall be similarly recorded by the perpendicular distance from the centerline of the weld to each end of the indication.

D. The depth and width and location of all recordable indications transverse to the weld shall be similarly recorded by the distance along the axis of the weld from the datum or related reference point to each side of the indication.

E. All measurements between a datum point and a recordable indication circumferentially around a vessel or pipe weld shall be taken in a clockwise direction. (In the same direction as examination scan 7.)

F. The clockwise direction shall be established as viewed from the top of a vessel (viewed in the direction of examination scan 5).

G. The length and width (depths) of recordable ultrasonic indications shall be determined to the points where the signal amplitude response falls to a value of 50 percent of the calibration DAC level (DAC plus 6 db).

H. All measurements of recordable ultrasonic indications shall be referred to the point of sound entry of the search unit or the centerline of the search unit, whichever being applicable.

I. When a recordable indication located transverse to the weld is found to extend either side of the datum reference point, the distances from the datum to the ends shall be identified as to the direction of measurement. This shall be achieved by utilizing the scan direction reference identities applicable to the side of the weld in conjunction with the measurement. (i.e. 4" (2), 6 1/2" (5) etc.)

6.9.2 An indication is defined as any ultrasonic response where the amplitude visibly exceeds the ultrasonic noise level.

6.10 DATA REPORTING

All information with respect to the performance of non-destructive examinations shall be recorded on the data sheets similar to those attached in the Appendices of this document. 1

6.10.1 All information applicable to the calibration of ultrasonic equipment prior to the performance of examinations shall be recorded on the Ultrasonic Examination Report sheet in accordance with the requirements of Appendix A.

6.10.2 All information applicable to the examination of vessel or component welds shall be recorded on the Ultrasonic Examination Report sheet in accordance with the requirements of Appendix A.

6.10.3 All information applicable to the evaluation of indications to be recorded during the performance of ultrasonic examinations shall be recorded on the Ultrasonic Indication Data Sheet in accordance with the requirements of Appendix B.

6.10.4 During the performance of ultrasonic examination the information shall be recorded on the Ultrasonic Examination Data Sheet in accordance with the requirements of Appendix C.

6.10.5 The performance of instrument calibration as required prior to the examination of welds in accordance with this Procedure shall be recorded as required by Appendix E.

APPENDIX A

SUPPLEMENTAL CALIBRATION PARAMETERS

1.0 CALIBRATION CORRECTION FOR PERPENDICULAR PLANAR REFLECTORS

1.1 Position the search unit for maximum amplitude from the square notch on the opposite surface. "X" marks the peak of the indication on the screen near sweep line 8.

1.2 Couple the search unit to the square notch in the examination surface. Position for maximum amplitude from the square notch. "X" marks the peak of the indication on the screen near sweep line 0.

NOTE: The opposite surface square notch may give an indication 2 to 1 above DAC at 45° and 1/2 DAC at 60°. The square notch in the examination surface will give al low amplitude if detected. Therefore, the indication from the square notch must be considered when evaluating reflectoros at the top or bottom surface.

2.0 REFLECTOR POSITION DETERMINATION

2.1 Tabulate the flaw-to-search unit "setback" dimensions for each of the calibrated depths. These dimensions are obtained by measuring the distance between the sound exit point of the search unit and a point on the scanning surface normal to a selected calibration reflector, when the signal from the reflector is "peaked" on the CRT. This measurement shall be obtained for the calibration reference reflectors at 1/4T, 1/2T, 1 1/4T and the 1 T notch.

3.0 VERTICAL BEAM SPREAD DETERMINATION

3.1 Measurements of beam spread shall be made on side drilled holes.

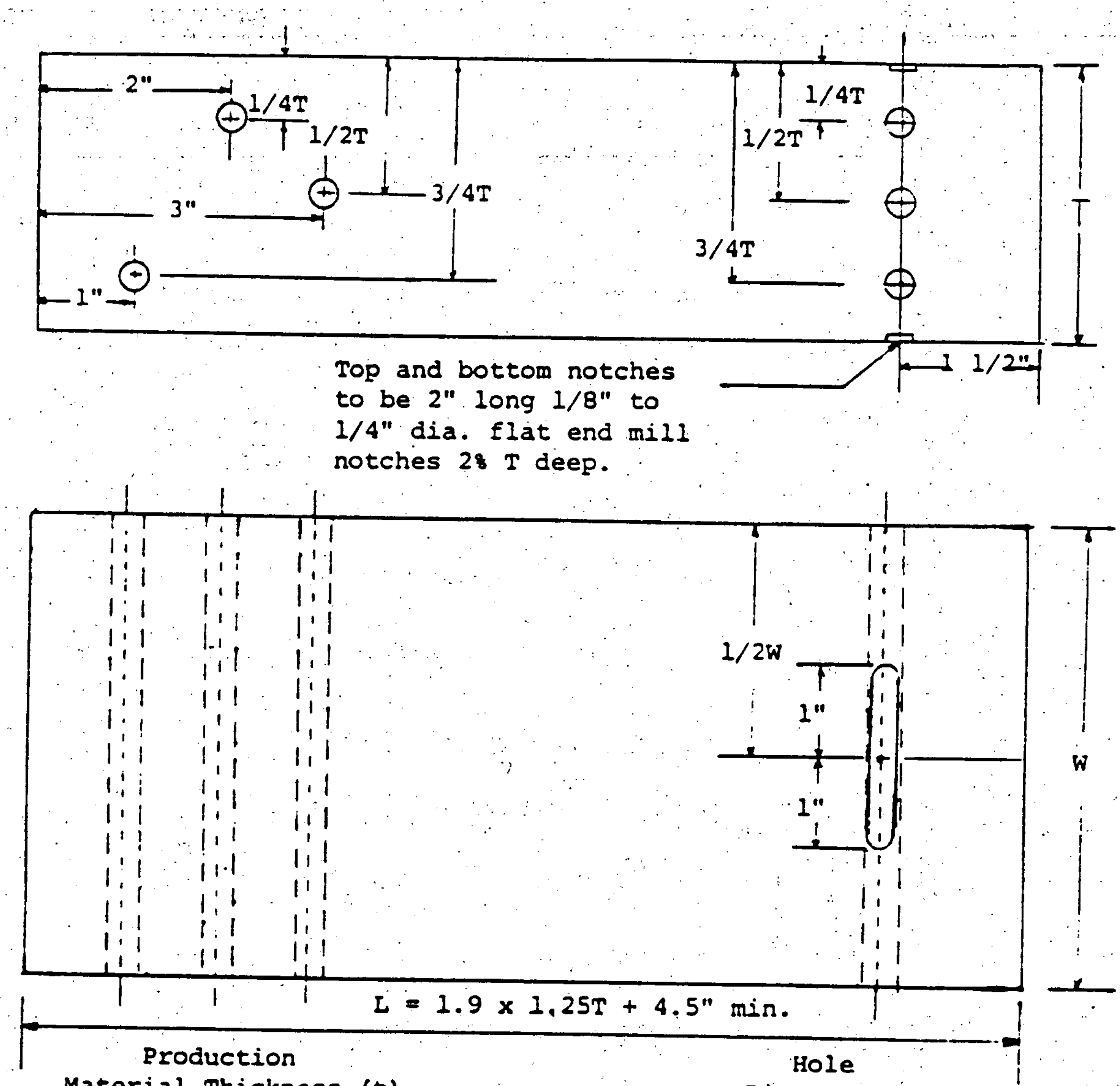
3.2 Position the search unit to obtain a maximum response from the 1/4 T hole. Move the search unit toward the hole until the signal amplitude equals the 50% DAC line.

3.3 Measure the distance from the sound exit point of the search unit to the hole as stated in 2.1 and record this measurement in the appropriate block on the calibration sheet.

3.4 Move the search unit away from the hole until the indication equals the 50% DAC line.

3.5 Measure the distance from the sound exit point of the search unit to the hole as stated in 2.1 and record this measurement in the appropriate block on the calibration sheet.

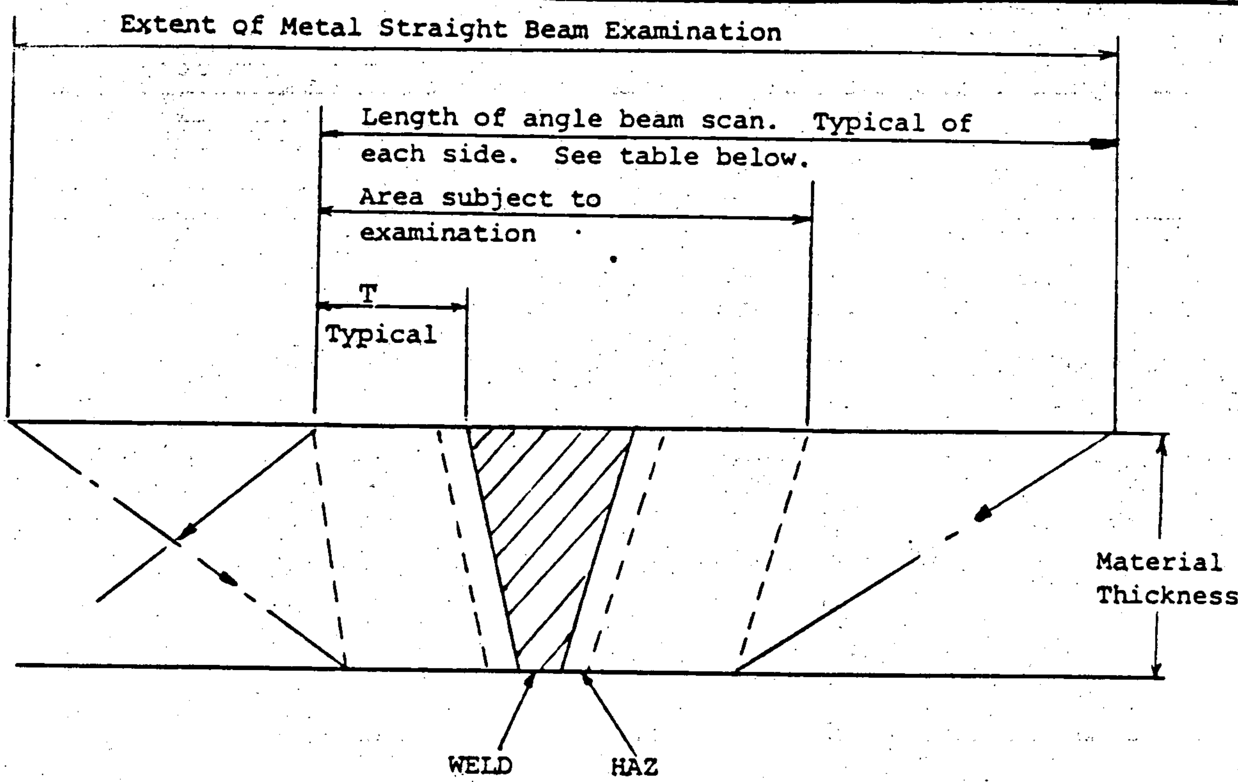
3.6 Repeat the above measurements on each of the remaining calibration holes.



Production Material Thickness (t)	Hole Diameter (d)
Over 2" thru 4"	3/16"
Over 4" thru 6"	1/4"
Over 6" thru 8"	5/16"
Over 8" thru 10"	3/8"
Over 10"	See Note 1

[1] For each increase in thickness of 2 inches or fraction thereof, the hole diameter shall increase 1/16 inch.

"ILLUSTRATIVE ONLY" TYPICAL CALIBRATION BLOCK FIGURE 1



For angle beam scan length, add the following from each side of the weld fusion line.

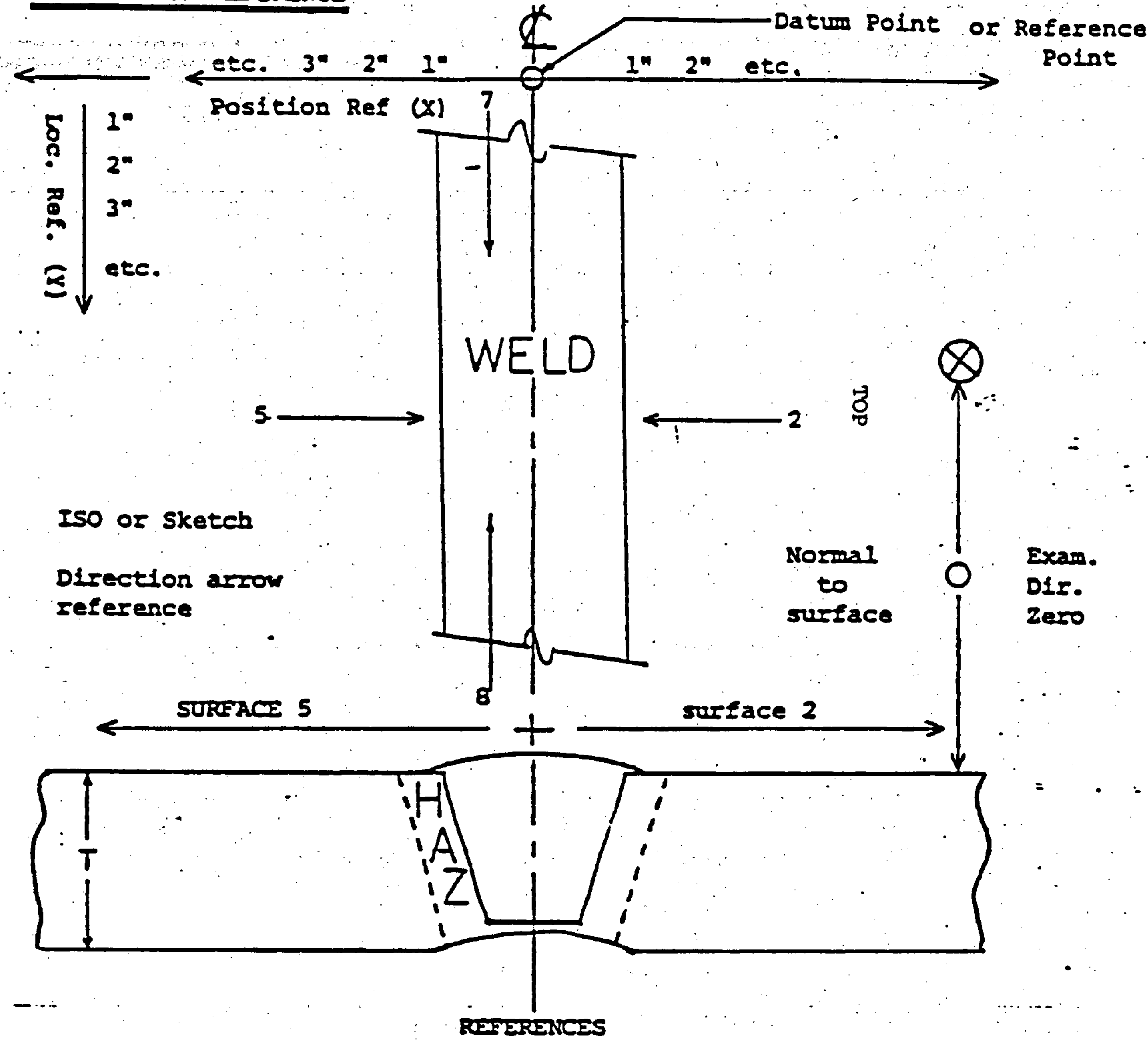
Material Thickness	45°	60°
2.5"	3.75	5.75
3"	4.5	6.75
3.5"	5.25	8.0
4"	6.0	9.0
4.5"	6.75	10.0
5"	7.5	11.0
5.5"	8.25	12.5
6"	9.0	13.5
6.5"	9.75	14.5
7" and greater	T + T/2	1.73T + T/2

Straight beam scan length shall be in accordance with the 60° angle beam scan length.

FIGURE 2

POWER AUTHORITY OF THE STATE OF NEW YORK QUALITY ASSURANCE NONDESTRUCTIVE EXAMINATION PROCEDURE	NDEP: 9.4-9 DATE: 7/30/84 REVISION: 1 Appendix A

EXAMINATION REFERENCE



Examination Reference Key

VESSELS - As viewed from "TOP"
Circumferential Welds - Direction 7, points clockwise
Vertical Welds - Direction 7, points down

PIPE - As viewed in direction of orientation arrow (toward face of clock)
Circumferential Welds - Direction 7, points clockwise
Vertical Welds - Direction 7, points in direction of arrow

FIGURE 3

APPENDIX B

ULTRASONIC EXAMINATION DATA

The ultrasonic examination report form shall be completed in accordance with the following requirements. (Refer to the attached sample form for block number references.)

Block No.	INFORMATION REQUIRED
1	Enter Plant Name
2	Enter Plant unit number
3	Enter Date of examination
4	Enter Examination procedure number
5	Enter Plant Technical Specification reference item number applicable to area being examined (to be entered by the data coordinator)
6	Enter Unit loop idnetity (if applicable)
7	Enter Identity of component or system
8	Enter Size of pipe, diameter and schedule
9	Enter Sketch or Iso number
10	Enter Weld type (i.e. circ. butt weld)
11	Enter Calibration Block Identification Number
12	Enter searach unit cable length
13	Make no entry if the examination is conducted from the O.D. surface of a pipe of components. Identify examination surface if other than these.
14	Enter search unit serial number
15	Enter search unit size
16	Enter search unit frequency
17	Enter search unit beam angle (i.e. o°, 45° or 60° etc.)
18	Enter calibration reference reflector (i.e. 1/4T, 1/2T, 3/4T, etc. or as node reference 1/8, 2/8, 3/8 etc.)
19, 21 & 25	Enter signal amplitude from reference relector as a percentage or full screen height
20, 22 & 26	Enter the location of the reference reflector signal along the horizontal axis of the CRT screen (i.e. sweep location)
23 & 27	Enter the distance form the search unit sound exit point to the point on the block surface, vertically above the location of the reference relector, when the search unit is positioned for the maximum reference response.

24 & 28 Enter the distance from the search unit sound exit point to the point on the block surface, vertically above the location of the reference reflector, when the search unit is positioned to obtain a response of 50 percent of that from the reference response.

NOTE: Information required for items 23, 24, 27 and 28 above is only to be recorded when specifically required by the Inspection Program Coordinator or his designate.

Block No.	Information Required
29	Enter ultrasonix instrument identity
30	Enter the U.T. instrument Rep. Rate setting when calibrated
31	Enter the U.T. instrument Reject Control setting when calibrated
32	Enter the U.T. Instrument Damping Control setting when calibrated
33	Enter the U.T. instrument Filter Switch setting when calibrated
34	Enter the time of initial calibration and subsequent calibration checks together with the ititials of the operator. Record calibration block and component temperatures.
35	Indicate if continuation sheet(s) have been utilized for recording weld examination data.
36	Indicate if examination transfer data sheets have been completed for welds covered by this data sheet.
37	Indicate if any field changes are applicable to the procedure utilized for the performance of the examination.
38	Operators signature certifying the examinations have been performed in accordance with the requirements of the referenced procedure and field changes.
39	Enter the gain control setting of the U.T. instrument after calibration
40	Enter the D.B. control settings of the U.T. instrument after calibration
41	Enter the identify (as given on the referenced sketch) of the weld being examined
42	If a transfer is found to be necessary, indicate by entering a 'Y' in this space. If not necessary indicate by entering a 'N'. Ensure that a transfer data sheet is completed and indicate its attachment in space 36

Block No.	INFORMATION REQUIRED
43	Indicate that the required straight beam examination of the area to be examined has been performed
44, 45 & 46	Indicate here that the required angle beam examinations have been performed
47	Indicate here if calibrated straight beam examination has been performed
48	Indicate in these spaces that the required examinations have been performed. Enter any limitations preventing the performance of the required examinations such as obstructions due to opip] supports, etc. Indicate approximate extent of limitation
49	Indicate condition of the base metal adjacent to the weld, i.e. as cast; hand ground, etc.
50	Indicate the condition of the weld surface; i.e. as welded; ground flat, etc.
51	Indicate the results of the ultrasonic examination by inserting the notation 'RI' if indications with an amplitude greater than 50 percent of the primary reference response are noted. Ensure that an ultrasonic indication data sheet is completed for each such indication. Should indications be found which are greater than 20 percent, but not exceeding 50% percent of the primary reference response this shall be indicated by inserting the notation 'NRI' in the space provided.
52	Indicate here if indications are noted as the result of performing an examination in accordance with the requirements of this Procedure. The results should be reported by inserting the notations 'RI' or 'NI' as appropriate.
53	Enter any information necessary to explain unusual examination problems. The presence of geometric reflectors, with an amplitude greater than the recording level, should be noted here with a brief indication of the approximate extent, i.e. Root reflector 50% max. for 360°.

Notes: Ultrasonic examination data continuation sheets shall, if utilized, also be completed in accordance with the above instructions as applicable to the twenty-two items of information required.

NI - NO INDICATION
NRI - NO RECORDABLE INDICATION (But examiner investigation required.)
RI - RECORDABLE INDICATION

QUALITY ASSURANCE NONDESTRUCTIVE EXAMINATION PROCEDURE

CALIBRATION AND WELD ULTRASONIC EXAMINATION DATA

PLANT	UNIT	DATE	PROCEDURE	TECH. SPEC.
(1)	(2)	(3)	(4)	(5)

LOOP	COMPONENT OR SYSTEM	PIPE SIZE	SECTION
(6)	(7)	(8)	(9

WELD TYPE	CALIBRATION BLOCK	SEARCH UNIT CABLE	INSTRUMENT	Block Temp ____ Comp. Temp ____
(10)	(11)	(12)	(29)	

EXAM. SURFACE (13)	STRAIGHT BEAM SCAN DIRECTION 0		AXIAL SCANS DIRECTIONS 2 & 5				CIRCUMFERENTIAL SCANS DIRECTIONS 7 & 8				
S. U. NO.	(14)										REP. RATE (30)
S. U. SIZE	(15)										REJECT (31)
S. U. FREQ.	(16)										DAMPING (32)
BEAM ANGLE	(17)										FILTER (33)
CALIBRATION REFLECTOR LOCATION	SIGNAL AMPLITUDE	SWEEP POSITION	SIGNAL AMPLITUDE	SWEEP POSITION	DISTANCE FROM SOUND ENTRY POINT TO: SCRIBE LINE	DISTANCE FROM SOUND ENTRY POINT TO: 50% DAC LOCATIONS	SIGNAL AMPLITUDE	SWEEP POSITION	DISTANCE FROM SOUND ENTRY POINT TO: SCRIBE LINE	DISTANCE FROM SOUND ENTRY POINT TO: 50% DAC LOCATIONS	
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	
GAIN	(39)										
REF. DB.	(40)										

CALIBRATION CHEC

(34)

Continuation sheets attached

Transfer record attached

This examination was performed in ac

with the procedure stated above

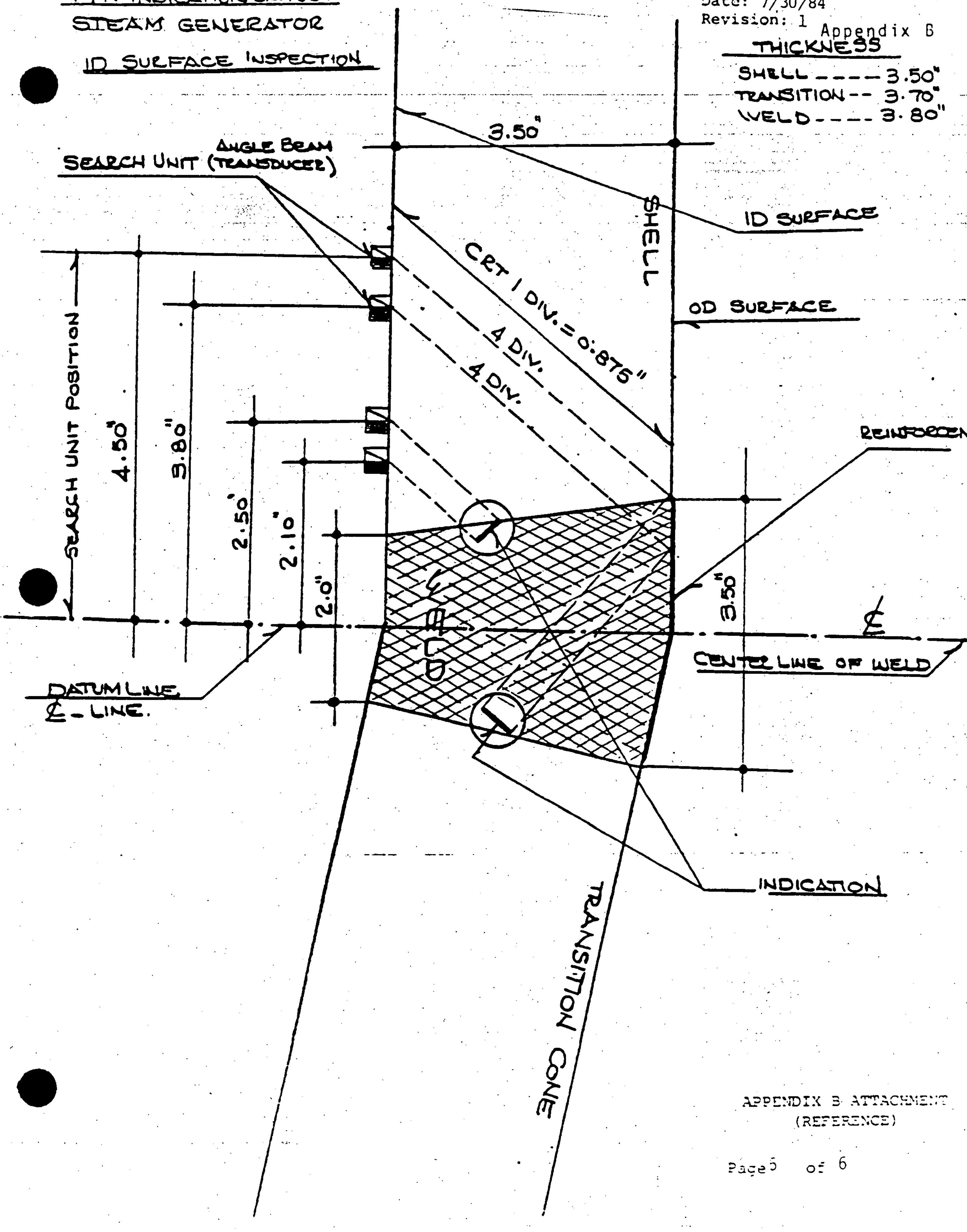
(38)

OPERATORS SIGNA

WELD NUMBER	REFR CHECK	BASE METAL SCAN	SCAN DIRECTION 2	SCAN DIRECTION 5	SCAN DIRECTION 7 & 8	SCAN DIRECTION 0	INSPECTION LIMITATIONS	SURFACE CONDITION: BASE METAL	SURFACE CONDITION: WELD	EXAMINATION RESULTS: U.T.	EXAMINATION RESULTS: VISUAL	REMARK
(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)

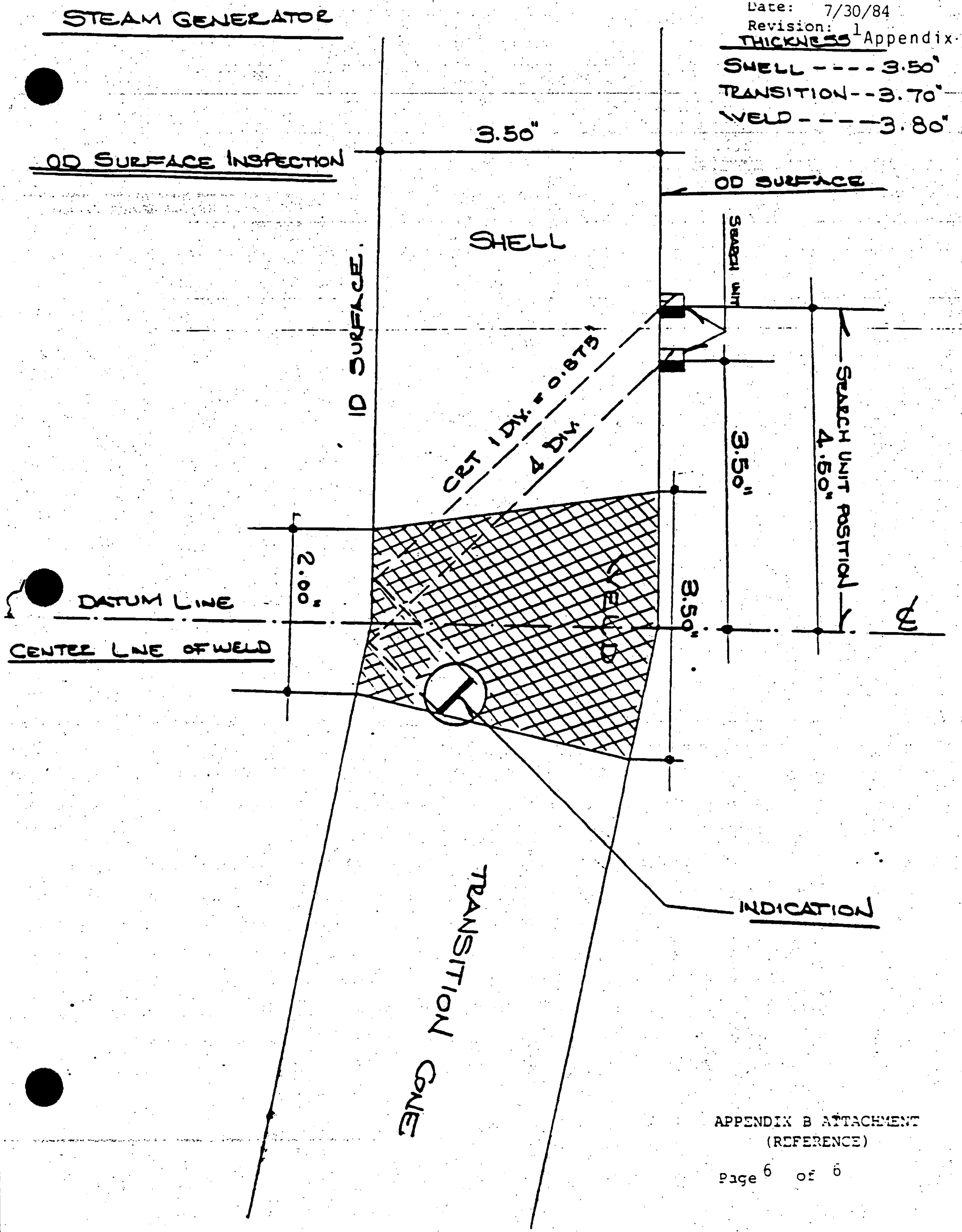
APPENDIX B ATTACHMENT (Ref. Page 4 of 6)

TYP. INDICATION LAYOUT
STEAM GENERATOR
ID SURFACE INSPECTION



APPENDIX B ATTACHMENT
(REFERENCE)

Date: 7/30/84
Revision: 1
Appendix I



APPENDIX B ATTACHMENT
(REFERENCE)

APPENDIX C

ULTRASONIC INDICATION DATA SHEET

The ultrasonic indication data sheet shall be completed in accordance with the following requirements. (Refer to the attached sample form for block number references.)

Block No.	INFORMATION REQUIRED
1	Enter Plant Name
2	Enter Plant unit number
3	Enter Date of examination
4	Enter Unit loop idnetity (if applicable)
5	Enter Identity of component or system
6	Enter Sketch or Iso number
7	Enter identity of operator performing examination
8	Enter the thickness of the calibration standard ulilized to establish the DAC
9	Enter examination procedure number
10	Enter the identity (as given on the referenced sketch) of the weld being examined
11	Measure and record here the distance from the reference datum point to the nearest end of the indication at the point where the response signal has reduced to an amplitude of 50 percent of the DAC
12	Similarly measure and record the distance from the datum point to the furthest end of the indication
13	Measure and record the sound path distance (depth) to the half amplitude point of the reflector nearest to the surface (i.e. minimum depth)
14	Measure and record the distance from the point of sound entry to the reference datum point
15	Measure and record the sound path distance to the half amplitude point of the reflector furthese from the surface (i.e. maximum depth)
16	Again measure and record the distance from the point of sound entry for maximkm depth to the reference datum point
17	Record the maximum signal response from the indication either as a percentage of DAC (i.e. 150%) or in terms of the attenuation required to reduce the signal amplitude to the DAC level (i.e. DAC + 6db)

Block No.	INFORMATION REQUIRED
18	REcord the search unit refracted angle in the material
19	Indicate the direction that the search unit is pointing when recording the indication. This may be achieved by utilizing the scan direction references of Figure 3 (i.e. 2, 5, 7 or 8)
20	Measure and record the base metal thickness on the side of the weld opposite the direction of the ISO arrow
21	Measure and record the weld thickness at or near the centerline of the weld
22	Measure and record the base metal thickness on the side of the weld in the direction of the ISO arrow
23	Record any additional informmation necessary to characterize the reflector

ULTRASONIC INDICATION DATA SHEET

PLANT: (1)	UNIT: (2)	DATE: (3)
LOOP: (4)	SYSTEM OR COMPONENT: (5)	SKETCH NO. (6)
OPERATOR(S): (7)	STD. THICK. (8)	PROCEDURE NO: (9)

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS
(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)

APPENDIX C ATTACHMENT

APPENDIX D

ULTRASONIC TRANSFER DATA SHEET

The ultrasonic transfer data sheet shall be completed in accordance with the following. (Refer to the attached sample form for block number references.)

Block No.	INFORMATION REQUIRED
1	Date examination performed
2	Procedure utilized
3	Signature of operator(s) performing the examination
4	Plant name
5	Plant unit number
6	Sketch or ISO number as applicable
7	Calibration reference level db value
8	Db value from calibration block with amplitude at 80%
9	Db value from examination area with amplitude at 80%
10	Db difference between A and B above
11	Enter the corrected reference calibration db value
12	List weld numbers for which the above transfer is applicable

DATE ____1____

PROCEDURE ____2____

OPERATOR ____3____

PLANT ____4____ UNIT ____5____ SKETCH/ISO No. ____6____

REF. CAL DB VALUE ____7____

DB VALUE CAL. BLOCK (A) ____8____

DB VALUE EXAM. ITEM (B) ____9____

DB DIFFERENCE BETWEEN A & B ____10____

IF (B) IS LESS THAN (A) CHANGE REF. DB VALUE BY THIS AMOUNT TO INCREASE SENSITIVITY. IF (B) IS GREATER THAN (A) CHANGE THE REF. DB VALUE BY THIS AMOUNT TO DECREASE SENSITIVITY. RECORD CORRECTED REF. CAL. DB VALUE ____11____.

THE ABOVE TRANSFER CORRECTION IS APPLICABLE TO WELD(S) NUMBERS:

____12____ ________ ________ ________ ________ ________

________ ________ ________ ________ ________ ________

APPENDIX D ATTACHMENT

APPENDIX E

INSTRUMENT CALIBRATION DATA FOR WELDS

2 1/2 INCHES THICK OR GREATER IN FERRITIC VESSELS

The instrument calibration data sheet shall be completed in accordance with the following requirements. (Refer to the attached sample form for block number references.)

Block No.	INFORMATION REQUIRED
1	Date of examination
2	Examination procedure number
3	Signature of operator
4	Plant name
5	Plant unit number
6	Make of instrument (Branson, Automation, etc.)
7	Instrument model number
8	Instrument serial number
9	Couplant used
10	Transducer size
11	Transducer frequency
12	Transducer serial number
13	Beam angle
14	Smaller signal amplitude with larger at 100%
15	Smaller signal amplitude with larger at 90%
16	Smaller signal amplitude with larger at 80%
17	Smaller signal amplitude with larger at 70%
18	Smaller signal amplitude with larger at 60%
19	Smaller signal amplitude with larger at 50%
20	Smaller signal amplitude with larger at 40%
21	Smaller signal amplitude with larger at 30%
22	Smaller signal amplitude with larger at 20%
23	Damping control setting during above verification
24	Reject control setting during above verification
25	Rep. rate control setting during above verification
26	Signal amplitude change from 80% with -6db change
27	Signal amplitude change from 80% with -12db change
28	Signal amplitude change from 40% with -6db change
29	Signal amplitude change from 20% with -12db change
30	Damping control setting during above verification
31	Reject control setting during above verification
32	Rep. rate control setting during above verification

DATE 1

PROCEDURE 2

OPERATOR 3

PLANT 4

UNIT 5

EQUIPMENT

INSTRUMENT		TRANSDUCER	
MAKE	6	SIZE	10
MODEL	7	FREQ.	11
SERIAL NO.	8	SERIAL NO.	12
COUPLANT	9	ANGLE	13

AMPLITUDE LINEARITY VERIFICATION

1ST SIGNAL AMPLITUDE	100%	90%	80%	70%	60%	50%	40%	30%	20%
2ND SIGNAL AMPLITUDE	14	15	16	17	18	19	20	21	22
2ND SIGNAL ALLOWABLE AMPLI.	48-52%	47-43	42-38	37-33	32-28	28-23	22-18	17-13	12-8

CONTROL SETTINGS: DAMPING 23 REJECT 24 REP. RATE 25

AMPLITUDE CONTROL LINEARITY VERIFICATION

ORIGINAL SIGNAL AMPLITUDE	DB CONTROL CHANGE	SIGNAL AMPLITUDE	SIGNAL AMPLITUDE LIMITS
80% FSH	-6DB	26	36 - 42
80% FSH	-12DB	27	16 - 22
40% FSH	+6DB	28	76 - 84
20% FSH	+12DB	29	79 - 92

NOTE: MINUS DENOTES DECREASE IN AMPLITUDE; PLUS DENOTES INCREASE

CONTROL SETTINGS: DAMPING 30 REJECT 31 REP. RATE 32

New York Power Authority

Quality Assurance

Nondestructive Examination Procedure

TITLE: Ultrasonic test method for transfer of O.D. location markings to steam generator I.D. location	NDEP 9.4-11
APPROVAL: [signature] NDE - Level III	DATE 7/30/84
CONCURRENCE: [signature] Director - Quality Assurance	REVISION 0
APPLICABILITY: Nuclear Power Plants	SUPERSEDES: QAI - 4.0 Rev. o 12/20/82

NEW YORK POWER AUTHORITY	NDEP: 9.4-11
NONDESTRUCTIVE EXAMINATION PROCEDURE	DATE: 7/30/84
	REVISION: 0

ULTRASONIC TEST METHOD FOR TRANSFER OF O.D. LOCATION MARKING TO STEAM GENERATOR GIRTH WELD I.D. LOCATION

1.0 PURPOSE

1.1 To establish the requirements and operating procedure for transferring O.D./I.D. location marking for steam generator girth weld repairs by use of a manual contact, pulse-echo, pitch-catch Ultrasonic technique.

2.0 APPLICABILITY

2.1 This procedure is limited in its application to the effective thickness range of instrument readout capabilities, and to material and product forms with accoustic properties and physical geometry which will propagate ultrasonic energy and allow reflection from the opposite boundary back to the transducer. (In the pitch-catch method, one transducer will act as a transmitter and one transducer will act as a receiver).

3.0 REFERENCES

3.1 The following documents form a part of this procedure to the extent specified herein.

3.1.1 Documents

3.1.1.1 NDEP 1.1, Procedure for Qualification and Certification of Nondestructive Examination Personnel.

3.1.2 Codes and Standards

3.1.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

A. Section III, Nuclear Vessels, 1965 Edition, Summer '65 Addenda.

B. Section XI, Inservice Inspection, 1974 Edition, Summer '75 Addenda.

3.1.2.2 American Society for Nondestructive Testing (ASNT).

A. SNT-TC-1A Nondestructive Testing Personnel Qualifications, 1975 and 1980 Editions.

4.0 ATTACHMENTS

4.1 Figure #1 - Map for transferring location marking

4.2 Figure #2 - Typical Calibration Data Sheet

5.0 GENERAL

5.1 Personnel Requirements

5.1.1 All personnel performing the nondestructive examinations in accordance with this procedure shall be qualified and certified to at least Level I in accordance with SNT-TC-1A and NDEP 1.1 Procedure for Qualification and Certification of Nondestructive Examination Personnel.

Note: At least one member of each examination crew shall have a minimum qualification of Level II. A Level II or III individual shall be responsible for the recording and acceptance of required data on ultrasonic examination reports.

5.2 Equipment

5.2.1 Pulse-echo ultrasonic equipment (Krautkramer USM-2, USL-38, or equivalent) shall be used. The electronic apparatus used shall be specifically designed so that at least one of its functions is the measurement of thickness by ultrasonic means utilizing the A-scan method.

5.2.2 Straight Beam Serach Units

Either ceramic, lithium sulphate, or abrium titanate, 2.25 or 5.0 MHz, single element search units, having an effective area of .5 square inches inclusive, shall be used for the straight beam longitudinal wave examination. If grain structure or surface condition is such that 2.25 MHz cannot penetrate, a 1.0 MHz search unit of the types listed above may be substituted.

5.2.3 At the discretion of the Level III, transducers of different size, shape, and frequency may be used as permitted by SEction III - 1965, Article 6, para. N-625.3. These changes shall be documented on the data sheets.

5.3 Surface Preparation and Couplant

5.3.1 The contact surfaces shall be clean and free of dirt, dust, weld spatter, loose scale or other material which would interfere with free movement of the transducer or impair transmission of ultrasonic energy into the material.

5.3.2 Couplant

A suitable liquid, simi-liquid, or paste couplant medium such as water, oil, glycerin, grease, or ultra-gel shall be applied to the examination surface.

5.4 Scanning Requirements

5.4.1 Starting at the zero ("O") reference location at the centerline of the feedwater nozzle on the upper shell to transition cone girth weld circumferential seam, O.D. measurements shall be transferred to the I.D. surface at 5 foot intervals. Measurements are clockwise looking down as indicated on the map (Figure #1).

6.0 PROCEDURE

The instrument shall be calibrated using the back reflection pitch-catch method. Calibration Standards: S/G GW-1, (A-302 Gr B) or International Institute of Welding (II-W) calibration block may be used. The calibration data shall be recorded on the calibration sheet (Figure #2).

6.1 Back Reflection Calibration - Pitch Catch Method

A 75 foot coax BNC cable shall be attached to the "Receive" connection and a 6 or 12 foot BNC cable shall be attached to the "Transmit" connection. (For the USL-38 instrument the "Thru transmission" mode must be selected).

Connect transducers to cables, apply couplant to calibration block and adjust instrument to 100% of full screen height.

The original and final calibration must be performed on the basic calibration block.

6.2 Procedural Steps for ALARA considerations

A. U. T. operators to be provided with walkie/talkie or head sets for communication.

B. U.T. instrument to be located at vessel O.D. with "Transmit" cable at the 'O' position.

C. Operator with 75 foot cable to enter vessel I.D. and proceed to feedwater nozzle location.

D. Outside operator couples transmit transducer to 'O' position.

E. Inside operator scans area until indication appears on instrument screen.

F. Outside operator notifies inside operator. When signal is maximized inside operator marks I.D. location to coincide with O.D. mark (Transfer).

G. Proceed to 5', 10', 15', 20', 25', 30', 35', and 40' locations and locate and mark as above.

H. Intermediate (1 foot) segments shall be marked by use of a graduated template. (Layout)

6.3 Reports

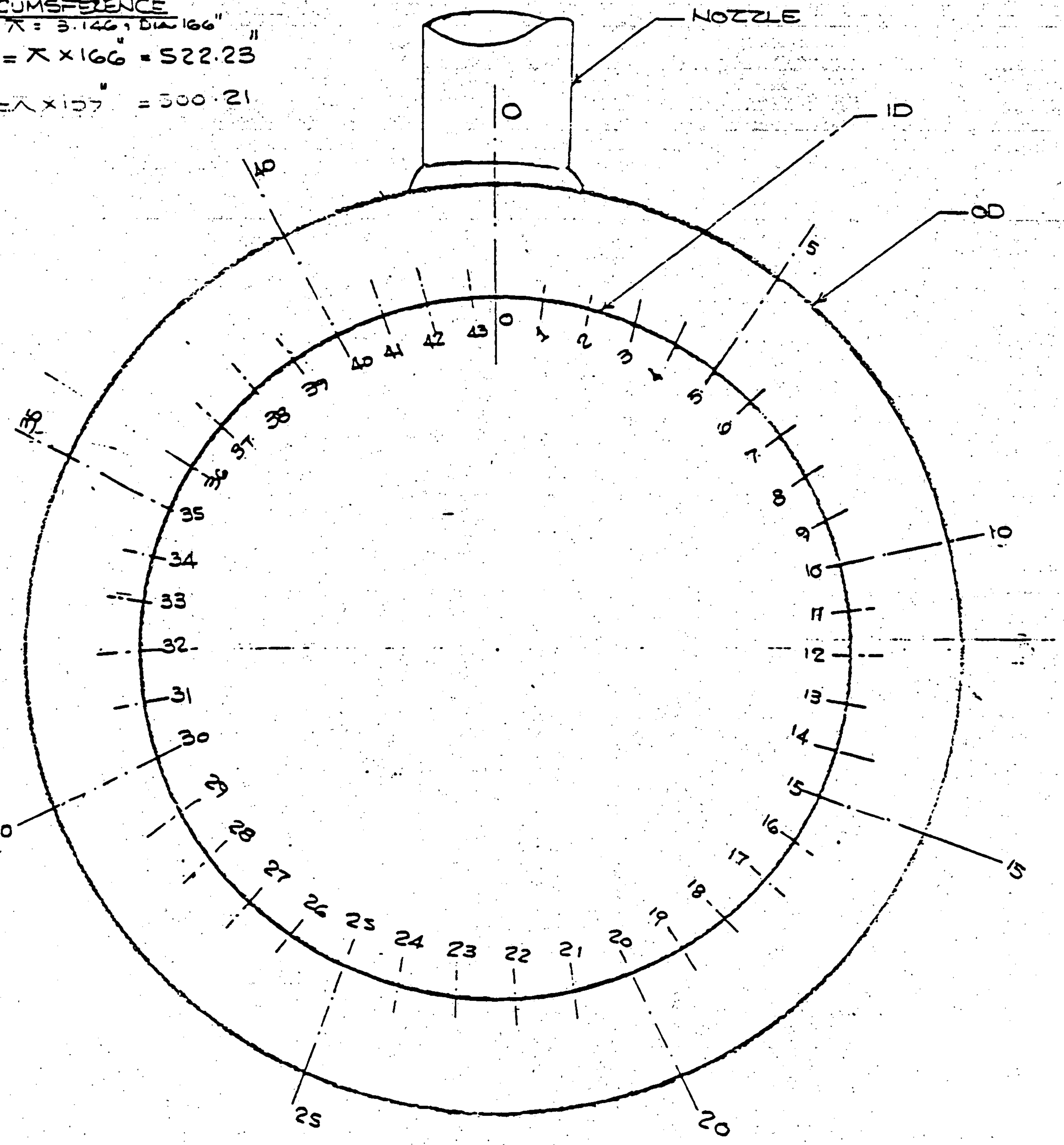
6.3.1 A detailed ultrasonic examination report is not required. I.D. Marking layout provides required data. The "comment" section of the calibration sheet when completed provides the required documentation for this procedure.

TYP. STEAM GENERATORS.

?CUMSFERENCE
π = 3.146, DIA 166"

OD = π × 166" = 522.23"

ID = π × 157" = 500.21



S/G. NO

Plant/Unit ____________
Comp/System ____________

POWER AUTHORITY OF
THE STATE OF NEW YORK
CALIBRATION SHEET-FIG # 2

Data Sheet No. ____________
Procedure No. ____________
Subject ____________
Rev/Change No. ____________
Calibration
Block No. ____________
Surface ____________
Block Temp ____________ °F
Comp. Temp ____________ °F

INSTRUMENT SETTINGS
Model No.:
Serial No. :
Sweep Length :
Sweep Delay :
Pulse Length/Damping:
Freq.: Rep. Rate:
Filter: Video: Jack:
DEC/Gate Switch: Range:
Mode Select: Reject:
Gain (coarse): (fine):

SEARCH UNIT
Scan Angle: Mode:
Fixturing (if any):
Style or Type No. :
Size & Shape:
Frequency :
Serial No/Brand:
Measured Angle :
Cable Type & Length:
Couplant Brand:
Couplant Batch:

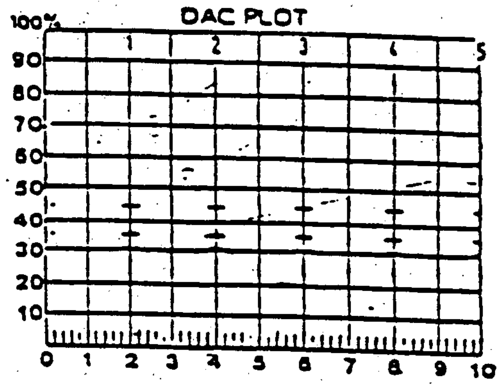
IDENT	DEPTH in.	AMPL. %	ATTEN. dB

INSTR. LINEARITY CAL.					
Amplitude					
	High	Low		High	Low
1			5		
			6		
			7		
4			8		

CALIBRATION BLOCK SIMULATOR
SERIAL NO. ________ SCREEN RANGE ________ IN
SIGNAL AMP ________ % SCREEN READING ________ IN
COURSE GAIN DB ________ FINE GAIN DB ________

SCAN AREA	
0° WRV	
0° Mat'l	
⊥ to Weld	
= to Weld	

DAC PLOT



AMPL. CONTROL LINEARITY		
Initial	Δ dB	Result
80	-6	
80	-12	
40	+6	
20	+12	

EXAMINATION WELD/AREA	RECORDABLE INDICATION		COMMENTS/REASON FOR INCOMPLETED SCAN(S)
	Yes	No	

CALIBRATION CHECKS	TIME
Initial Cal.	
Intermediate	
Intermediate	
Intermediate	
Final Cal.	

ADDITIONAL SHEETS? (CHECK BOX)			
Continuation		Beam Plot	
Supplements		None	

EXAMINERS 1 ____________ Date ________ Level ________

2 ____________ Date ________ Level ________

NEW YORK POWER AUTHORITY

INDIAN POINT 3 NUCLEAR POWER STATION

QUALITY ASSURANCE INSTRUCTION

TITLE:	ALTERNATIVE METHOD FOR EVALUATION OF ULTRASONIC TEST RESULTS	QAI: 4.0 REV: 1
PREPARED BY: [signature], LEVEL III	DATE: 7/24/85	DATE OF ISSUE: 7/24/85
QC REVIEW: [signature] (LEVEL III)	DATE: 7/24/85	
QA REVIEW: [signature]	DATE: 7/24/85	
APPROVED BY: F. X. [signature]	DATE: 7/24/85	
SUPERCEDES:	QAI 4.0, Rev. 0 dated 7/18/85	

1.0 PURPOSE

1.1 To provide guidelines and clarification of the ultrasonic examination methods to be used by NDE personnel to evaluate non-uniform surface conditions caused by grind-outs or weld build-ups which result in misinterpretation of reflector locations when performing ASME Code, Section XI ultrasonic examinations of circumferential and longitudinal butt welds in ferretic vessels of 2½" thickness and greater.

2.0 APPLICABILITY

2.1 This instruction is applicable to and provides alternative examination requirements for evaluation of ultrasonic examination results by IP-3 NDE personnel.

2.2 The instructions listed herein meet the intent of ASME Code, Section XI, Subsection IWA 2240 for alternative examination methods and supplements, IP-3 Nondestructive Examination Procedures NDEP 9.4-9, Rev. 1 and NDEP 9.4-11, Rev. 0 for steam generator inspections.

3.0 REFERENCES

3.1 ASME Code Section XI

3.1.1 Subsection IWA-2240 Alternative Examinations
3.1.2 Subsection IWB-3514-5 Ultrasonic Reflectors of Geometric and Metallurgical Origin

3.2 Nondestructive Examination Procedures

3.2.1 NDEP 9.4-9, Rev. 1 Manual Ultrasonic Examination of Circumferential and Longitudinal Butt Welds in Ferretic Vessels 2½" thick and greater.

3.2.2 NDEP 9.4-11, Rev. 0 Ultrasonic Test method for Transfer of OD Location Markings to Steam Generator ID Location.

4.0 ATTACHMENTS

4.1 Shear Wave Technique
4.2 Thru Transmission Technique (Pitch-Catch)
4.3 View (actual) showing grindout which caused mode conversion to longitudinal and surface wave resulting in misjudged location
4.4 View (actual) showing grindout edge which caused mode conversion to longitudinal wave resulting in misinterpretation
4.5 Map of grindouts in SG 34 areas 39' to "0" and "0" to 5' as obtained from 1983 final radiographic film overlays

5.0 GENERAL

5.1 ASME Code Section XI requires ultrasonic examination of steam generator welds to be performed from the OD surface without access to the ID surface. Examination is performed using approved ISI procedures and techniques. Any reflection point observed will return a signal to the CRT screen that will vary in sound-path length depending on its location. This reflection produces, on the CRT screen, a blip that corresponds to the time required for the sound wave to travel between the test surface and the discontinuity. Applying trigonometric functions, the technician calculates the location accurately to pinpoint the source, a plate surface, corner, gap or weld discontinuity. Records are documented and evaluations performed in accordance with Code acceptance standards.

Recently conducted examinations, which required inspection of the back surface, have shown that grind-outs where surface indications have been removed or weld built-ups will produce reflectors which can easily be misinterpreted or erroneously located and reported. OD surface irregularities, weld crowns and transition cone weld sections cause shifts in the sound entry angles. Shifts of as little as 5° will deflect the sound beam enough to produce a signal that appears to come from an interior defect instead of its true source, such as the edge of a grind-out. Angle beam shear waves which strike acoustic boundaries at critical angles can convert to surface waves or to longitudinal waves called mode conversion. Conversion of shear waves to longitudinal or surface waves, may also give false readings. Ref. Attachment(s) 4.3 and 4.4.

Since longitudinal waves travel about twice as fast as shear waves, an inspector can misjudge the locations of a reflector and erroneously interpret a grind-out edge as a recordable/reportable indication.

The greater speed of longitudinal waves make reflecting points appear closer than they are. Use of 60° search units and grind-out edges exaggerate mode conversion, raising sound pressure enough to make signals from tiny discontinuities easier to detect. Use of the couplant-dampened finger technique greatly enhances the interpreters ability to verify the source of the reflector to assist in defect location when access to the back surface is available.

6.0 INSTRUCTIONS

Upon completion of the required ASME Code, Section XI ultrasonic examination, reportable indications which cannot be verified by visual and/or magnetic particle examination on the ID surface, shall be evaluated utilizing the following thru transmission damping technique to verify whether or not these readings were influenced by grind-outs or other surface conditions which resulted in misinterpretation of the indication location.

a. Re-establish location of UT indication from the OD surface with the proper angle beam transducer, utilizing location and search unit position data from earlier inspection per procedure NDEP 9.4-9, Rev. 1. Ref. Attachment 4.1.

b. Mark axial and circumferential location of angle beam transducer on OD surface, once maximized indication location is established.

c. Tabulate axial position of indication utilizing peak position, search unit position, and the appropriate beam angle data using trigonometric functions.

d. Mark axial position of indication on OD surface wall.

e. Adjust UT scope for thru wall transmission.

f. Connect transmitting lead and receiving lead to UT scope and install straight beam transducers to each as per procedure NDEP 4.9-11, Rev. 0. Ref. Attachment 4.2.

g. Re-locate UT scope and receiving transducer on ID surface of weldment.

h. Place transmitting straight beam transducer on OD surface at the established position (step d).

i. Place receiving straight beam transducer on ID surface and scan at approximately the same axial and circumferential location.

j. Adjust receiving transducer from the ID to receive maximum thru transmission signal and mark on ID surface.

k. Position angle beam transducer on previously established reference position on OD (step b).

l. From ID, apply couplant to thru transmission location mark established in step j.

m. From ID, finger dampen spot where couplant was applied and observe peak position signal on UT scope.

n. If peak signal oscillates during damping process, then signal is being interrupted at the surface indicating geometrical or metallurgical condition.

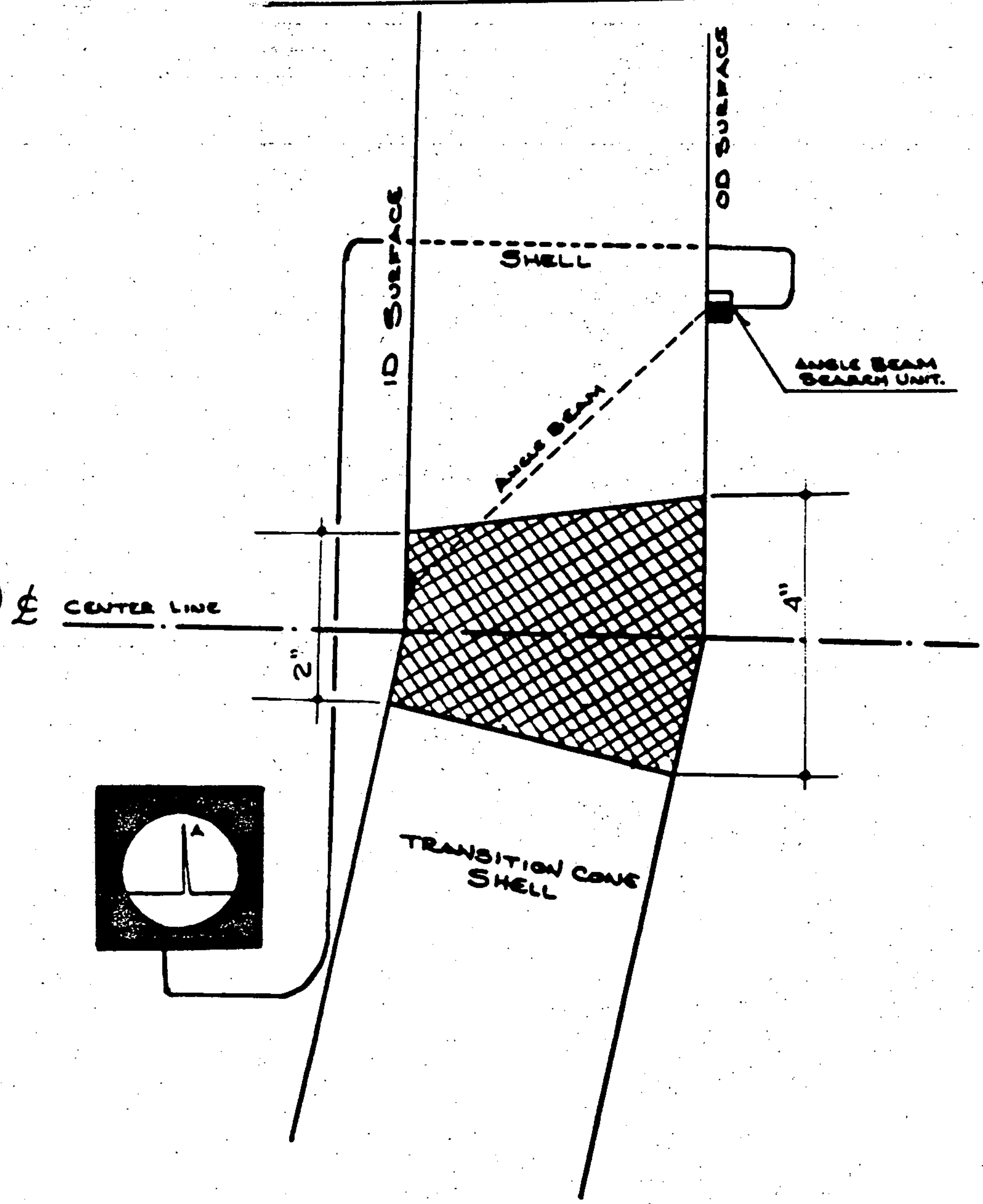
o. If peak signal does not oscillate during damping process, then the signal is not being interrupted at the surface thereby indicating a sub-surface indication requiring further evaluation.

p. If grind-outs or other surface conditions are observed which would provide corner reflectors or if mode conversion is suspected use the finger dampened technique to attempt to locate re-directed sound paths.

q. Record all data and submit to the NDE Level III and/or Project Engineer for evaluation purposes and comparison with tabulated radiographic overlays. Ref. Attachment 4.5.

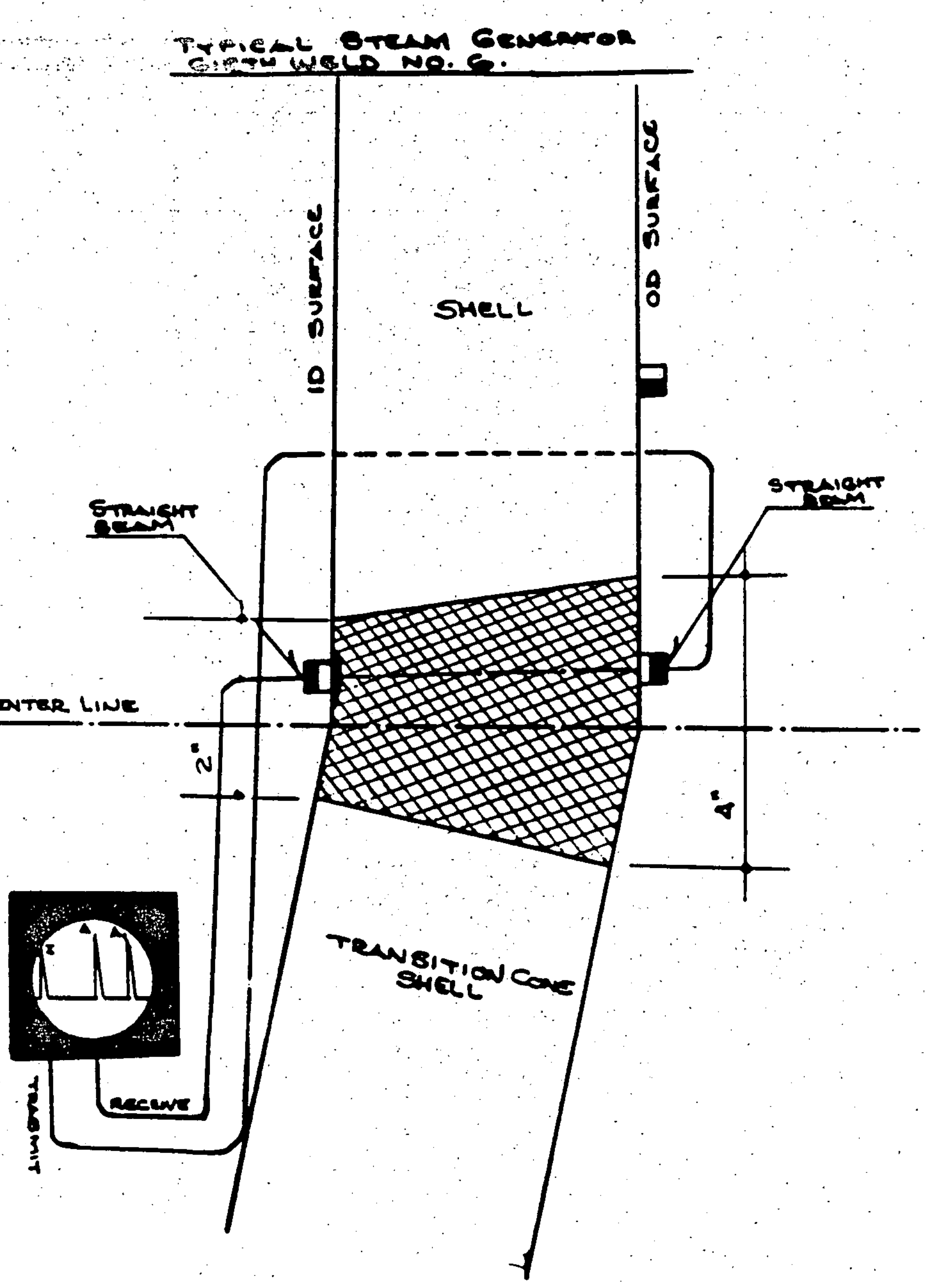
NOTE DELETED Rev. 1

TYPICAL STEAM GENERATOR
GIRTH WELD NO. 6.



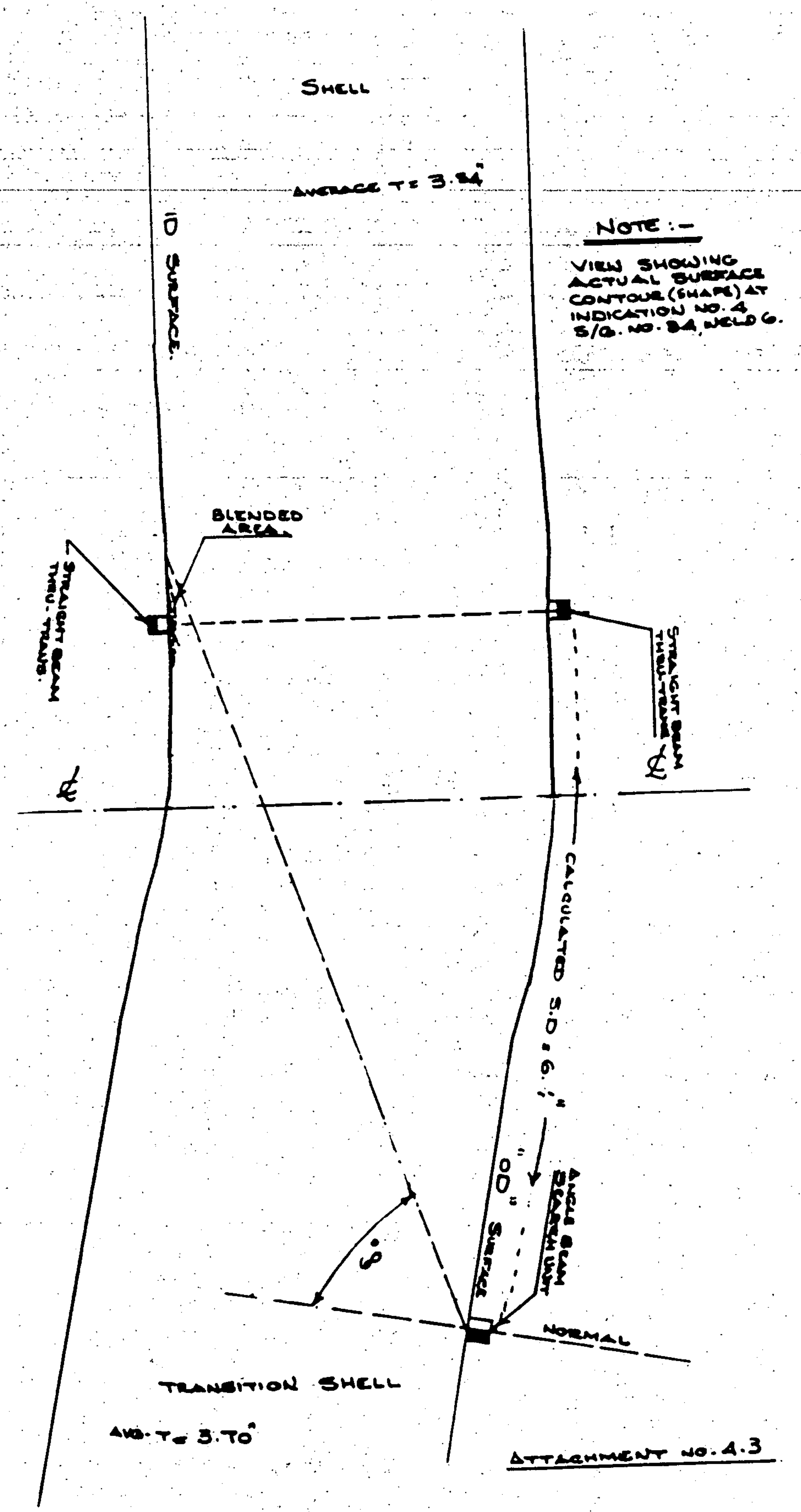
ATTACHMENT 4.1

"SHEAR WAVE TECHNIQUE"

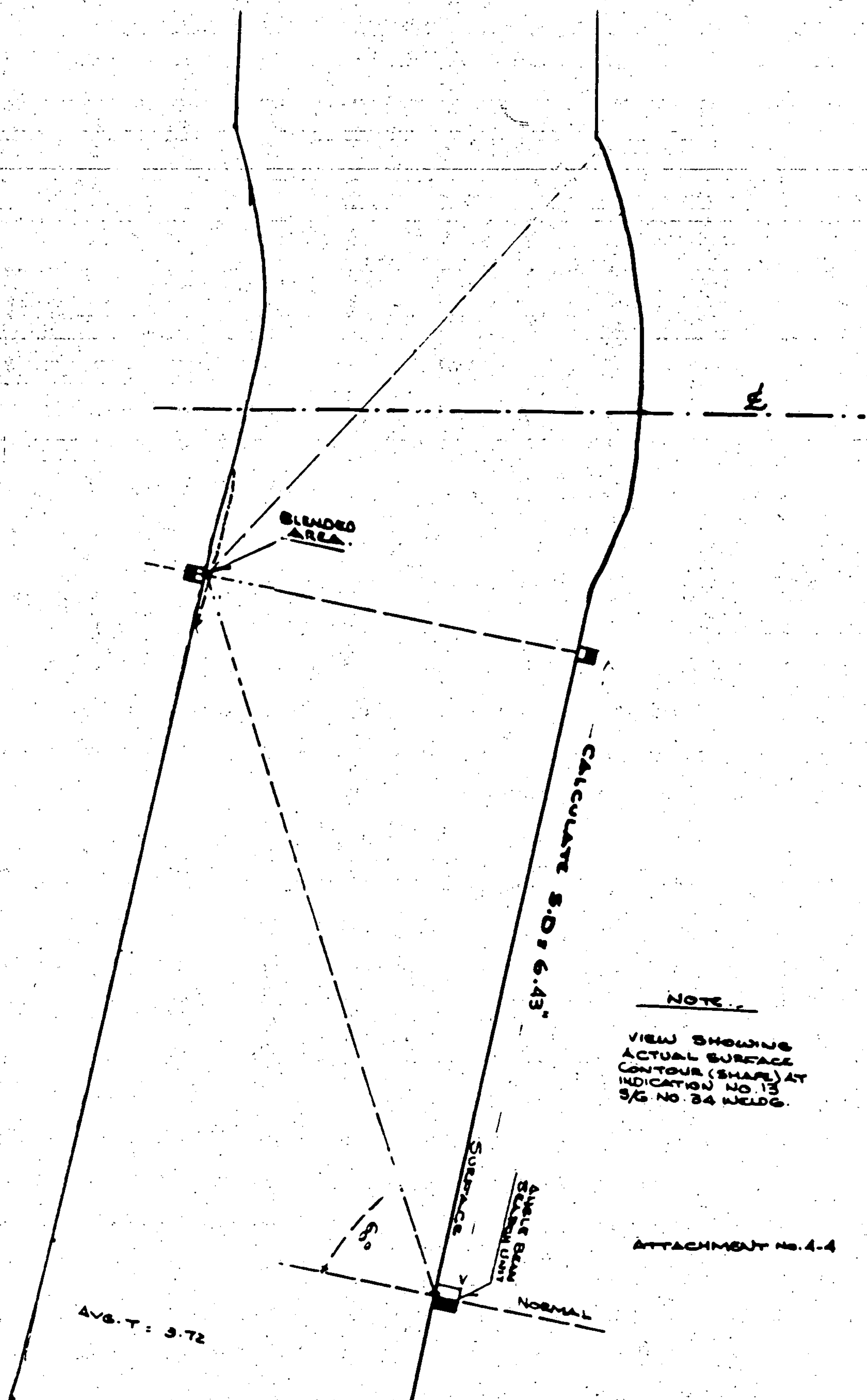


ATTACHMENT 4.2

"THROUGH-TRANSMISSION TECHNIQUE (PITCH CATCH)"



ATTACHMENT NO. 4.3



NOTE.

VIEW SHOWING ACTUAL SURFACE CONTOUR (SHARP) AT INDICATION NO. 13 S/G NO. 34 WELDG.

ATTACHMENT No. 4-4

ATTACHMENT 4.5

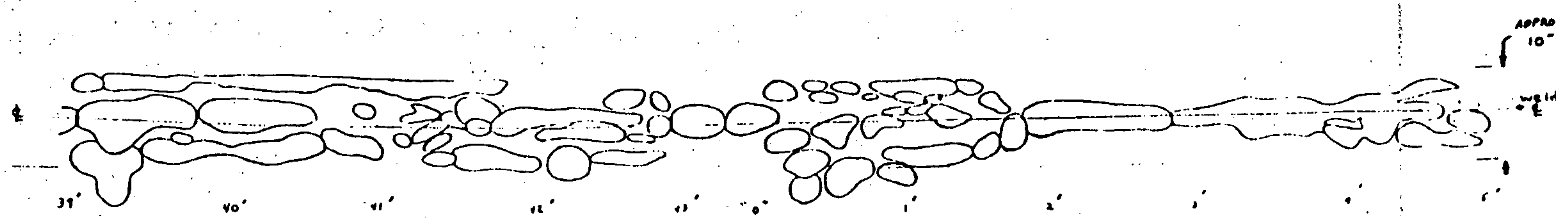
STEAM GENERATOR NO. 34

GIRTH SEAM 34-6

MAP OF BLENDED AREAS - 4:1 TAPER

LOCATION(S): 39' TO "0" & "0" TO 5' SEGMENTS ("0" IS CENTERLINE OF FEEDWATER NOZZLE)

DATA OBTAINED FROM FINAL ACCEPTED RADIOGRAPHIC FILM - 1983



REDUCED - NOT TO SCALE

[signature] 7/16/85

FIRST

SAMPLE

INSPECTION

AREA

(REFERENCE

FIG. 2-1 TO

FIG 2-4)

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POWER NO. 3 NUCLEAR POWER PLANT

ULTRASONIC INDICATION DATA SHEET

PLANT: IP | UNIT: 3 | DATE: 6/18/8

LOOP: 31 | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-1

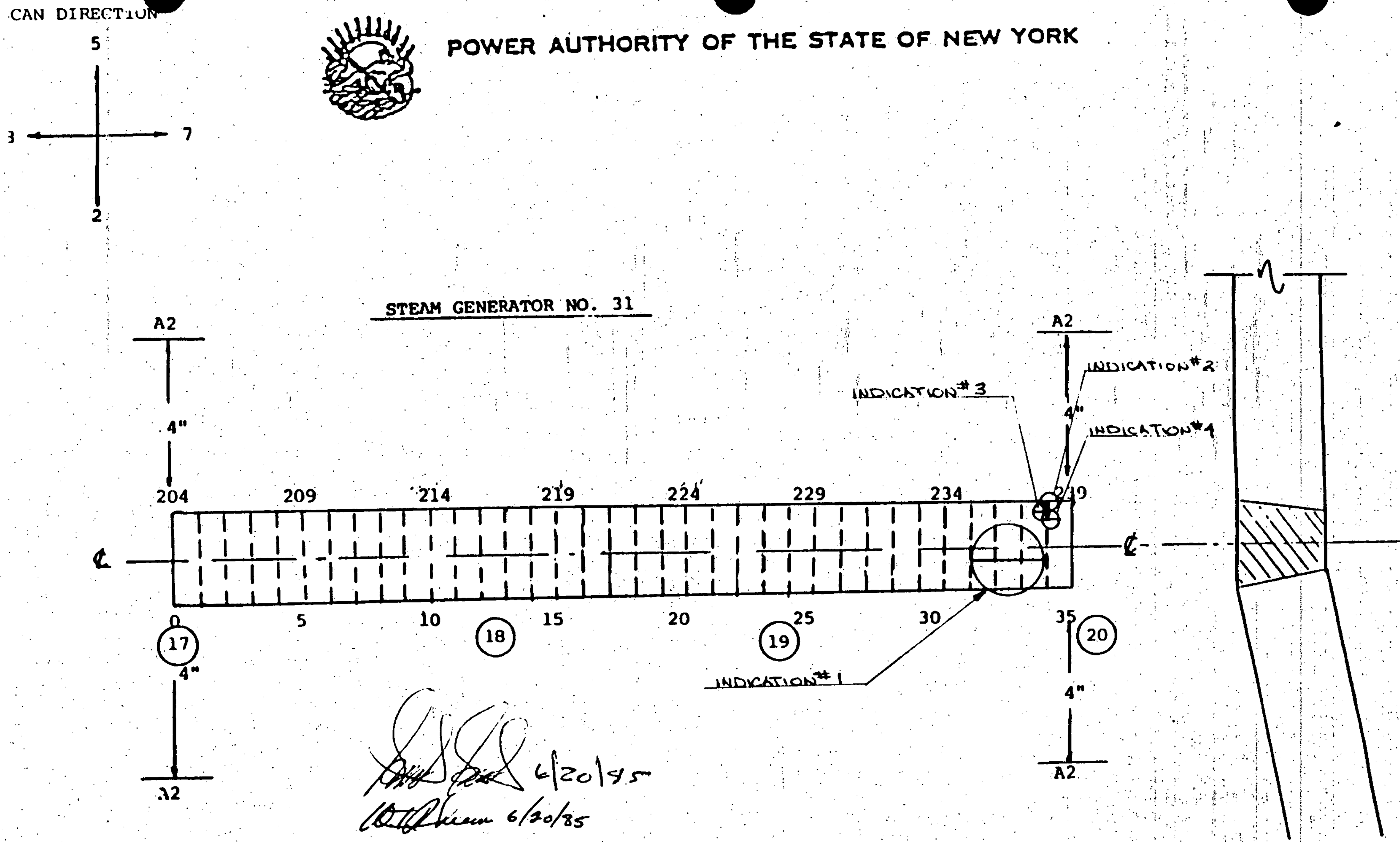
OPERATOR(S): S. MEMON W.T. RHEAUME | STD. THICK. 3.5" | PROCEDURE NO. 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	PEAK
31-6	235.50	237.75	5.9	5.75"	6.8	6.50"	50%	60°	2	-	3.80	-		① 6.3
SEG.	238.50	238.50	4.8	4.50"	5.2	5.50"	25%	45°	2	-	3.80	-	SPOT	② 5.0
7-20	237.50	238.00	7.8	3.00"	8.8	4.75"	50%	45°	5	-	3.80	-		③ 8.4
AREA	239.00	239.75	5.0	6.00"	5.6	6.50"	45%	60°	2	-	3.80	-		④ 5.2
204"-239"														

[signature] (LEVEL III)

PAGE

POWER AUTHORITY OF THE STATE OF NEW YORK



6/20/85
6/20/85

Note: U.T. Examination performed on o.d. surface of s/g #31

NO SCALE

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWEF

ULTRASONIC INDICATION DATA SHEET

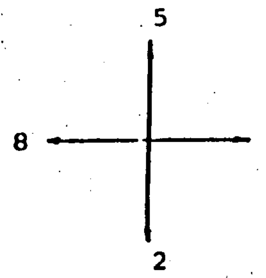
NT: IP	UNIT: 3	DATE: 6/19/85
F: 32	SYSTEM OR COMPONENT: STEAM GENERATOR	SKETCH NO. INT-2-11
RATOR(S): S. MENON W.T. RHEAUME	STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH, IN. FROM	INDICATION LENGTH, IN. TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS	PEAK F
2-6	321.50	324.38	6.0	6.00	6.6	6.75	55%	45°	5	–	3.65	–		①	6.2
EG	328.50	329.50	2.8	3.38	3.8	4.63	20%	60°	5	–	3.80	–	NEW IND	②	3.0
6-28	331.0	331.5	6.2	1.0	6.8	1.50	25%	45°	2	–	3.80	–		③	6.4
9-31	348.0	348.5	5.8	4.25	6.4	3.88	+8db 100%	45°	2 (5 SIDE)	–	–	3.60		④	6.0
REA	356.75	357.25	6.2	6.0	7.5	7.75	25%	60°	2	–	3.69	–		⑤	6.2
6"-334"	365.0	365.5	5.0	2.50	5.4	3.0	25%	45°	2	–	3.80	–		⑥	5.2
8"-365"															

[signature] (LEVEL III)

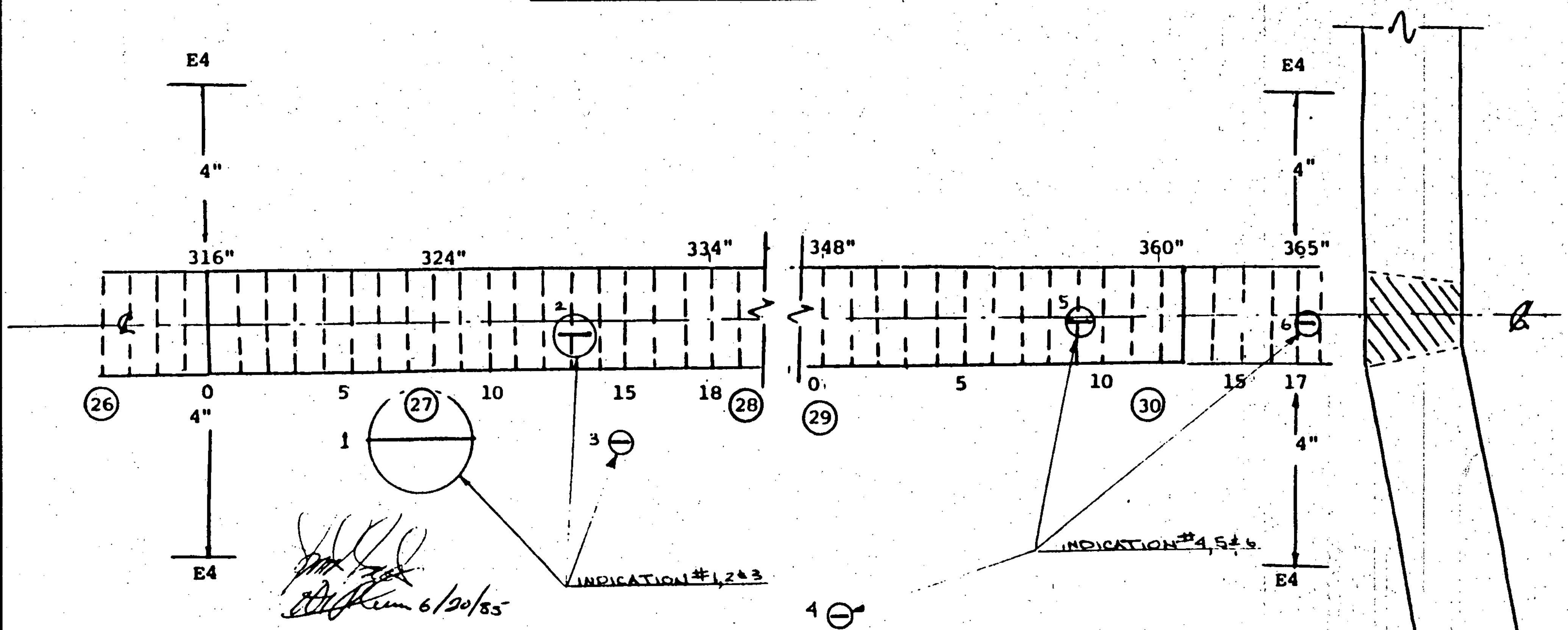
PAGE

SCAN DIREC N



POWER AUTHORITY OF THE STATE OF NEW YORK

STEAM GENERATOR NO. 32



Note: U.T. performed
on o.d. surface of S/G#32

NO SCALE

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER PLANT

ULTRASONIC INDICATION DATA SHEET

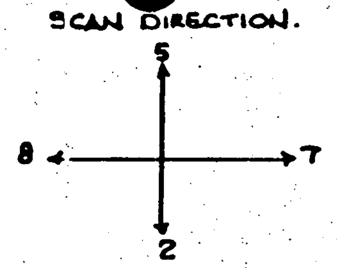
PLANT: IP | UNIT: 3 | DATE: 6/21/8

LOOP: 33 | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-1

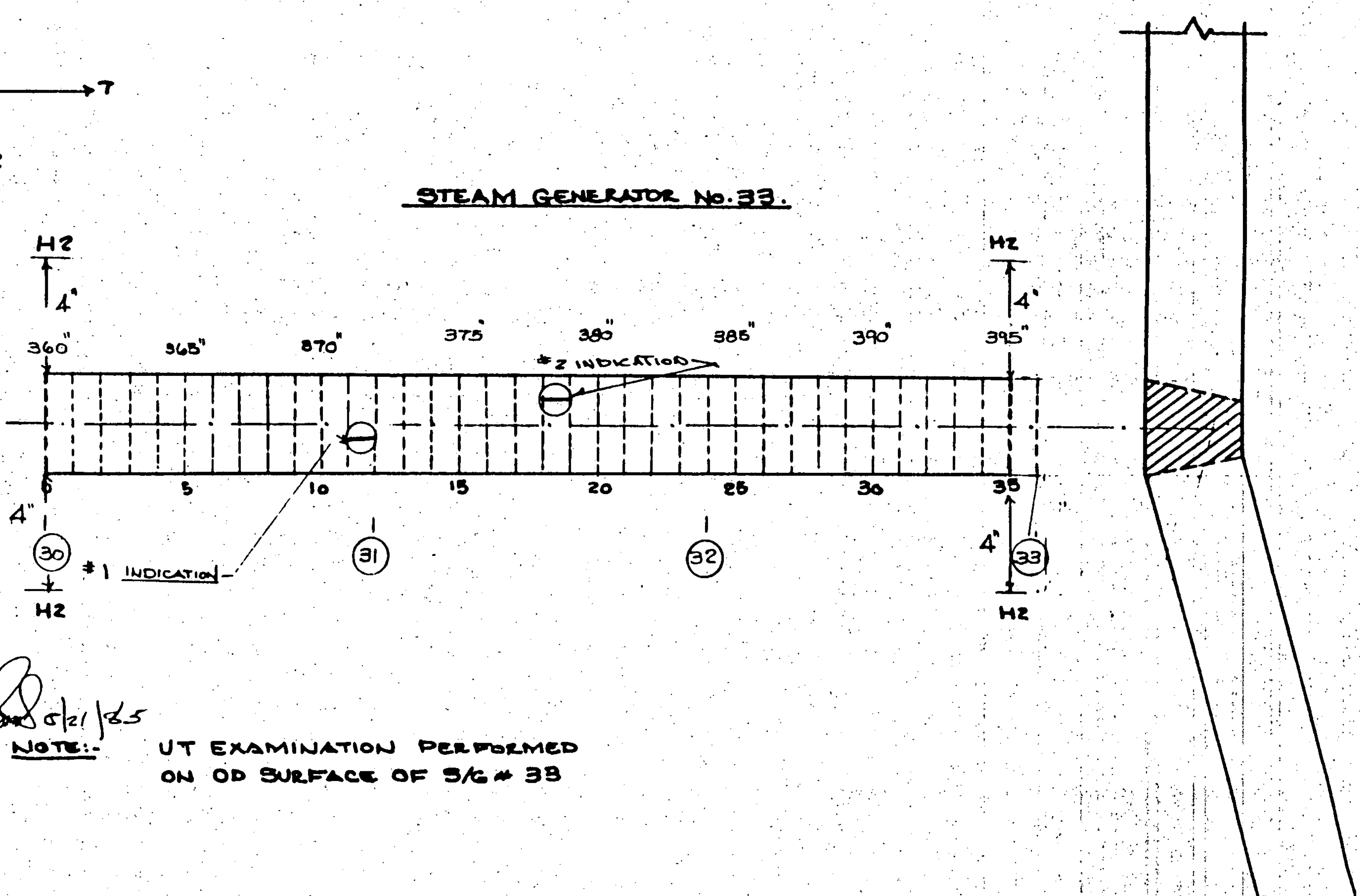
OPERATOR(S): S. MEMON (LEVEL III) W.T. RHEAMUE (LEVEL II) | STD. THICK. 3.5" | PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS	
															PEAK
33-6	377.0	377.85	5.2	2.25	6.0	3.75	18%	45°	S	—	3.8	—		②	5.6
SEG.	371.0	372.0	4.4	4.75	5.6	5.5	25%	60°	S	—	3.8	—		①	
30-33															
AREA															
360-395															
				[signature]	[signature]	6/21/85									

PAGE



STEAM GENERATOR No. 33.



5/21/85

NOTE:- UT EXAMINATION PERFORMED ON OD SURFACE OF S/G # 33

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER

P. 1

ULTRASONIC INDICATION DATA SHEET

NT: IP	UNIT: 3		DATE: 6/17/8
: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-11
RATOR(S): S. MCMOR! WT KHEALCME		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD ...ANNER	INDICATION LENGTH, IN. FROM	INDICATION LENGTH, IN. TO	MIN. DEPTH, DIV.	S.U. POS., IN.	MAX. DEPTH, DIV.	S.U. POS., IN.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS		PEAK P
-6	0.0	1.5	5.6	4.25	6.0	5.0	25%	45°	5	–	3.83	–		①	5.9
EG	0.5	1.5	5.8	3.5	6.8	4.5	25%	45°	2	–	3.81	–		②	6.0
-2	0.93	1.5	4.8	5.25	5.6	6.8	25%	60°	5	–	3.83	–		③	5.2
2-0	1.75	1.75	6.4	11.75	6.8	12.5	15%	45°	8 (2 SIDE)	–	3.87	–	SPOT	④	6.6
REA	5.0	5.25	3.6	0.0	4.0	0.5	20%	45°	2	–	3.78	–		⑤	3.8
"-18"	4.75	5.68	3.0	4.8	4.2	6.3	20%	60°	5	–	3.86	–		⑥	3.4
5"-	8.0	8.13	5.0	4.93	6.2	5.93	40%	60°	5	–	3.93	–		⑦	5.4
522"	11.5	12.38	6.0	6.0	6.4	6.88	75%	45°	5	–	—	3.66		⑧	6.1
	14.06	16.30	6.2	4.18	8.0	7.0	30%	60°	2	–	3.89	–		⑨	7.0
	14.38	15.25	6.0	6.50	6.8	7.25	95%	45°	5	–	—	3.67		⑩	6.4
	15.63	16.13	2.6	5.0	3.2	5.88	15%	60°	2	–	3.89	–		⑪	2.8
	16.75	18.25	4.6	3.63	5.8	5.75	25%	60°	5	–	3.94	–		⑫	4.8

[signature] 6/17/85

PAGE

P. 2

ULTRASONIC INDICATION DATA SHEET

...NT: IP	UNIT: 3		DATE: 6/18/85
...: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110...
...ERATOR(S): [illegible] W.T. [illegible]		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD ...NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS		PEAK P...
...4-6	506.66	507.50	6.2	3.63	6.8	4.38	75%	45°	5	3.45	3.68	—		(13)	6.6
...EG	507.0	507.75	5.6	3.5	6.2	4.0	25%	45°	2	—	3.86	—		(14)	6.2
...-2	508.5	509.0	6.0	6.5	6.4	7.0	20%	60°	2	—	3.80	3.55		(15)	6.2
...2-0	510.0	510.5	6.0	3.88	6.5	4.5	55%	45°	2	-	3.80	3.53		(16)	6.4
...ONT'D	511.0	511.75	5.4	3.5	6.0	4.0	90%	45°	2	—	3.55	—		(17)	5.6
	511.5	513.0	6.6	6.5	7.6	7.5	55%	60°	5	—	3.81	—		(18)	7.0
	513.0	514.75	6.2	4.88	6.8	5.38	45%	45°	5	—	3.80	—		(19)	6.6
	511.68	512.50	5.2	2.88	5.8	3.88	100%	45°	2	—	3.53	—		(20)	5.6
	522.0	522.0	5.8	3.88	6.2	4.25	75%	45°	2	—	3.55	—	SPOT	(24)	6.0
	512.38	512.88	6.2	3.88	6.8	4.63	90%	45°	5		3.67		NEW IND	(25)	6.4
	520.5	0.5	5.5	4.5	6.0	4.75	100%	45°	2		3.70		NEW IND	(26)	5.8

[signature] 6/18/85

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER [PLANT]

ULTRASONIC INDICATION DATA SHEET

PLANT: IP	UNIT: 3		DATE: 6/18/85
LOOP: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-11
OPERATOR(S): S MEMON (U) T HEAUME		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD MARKER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS PEAK
NEW	503.-	504.-	↑	↑	↑	↑	40%	60°	2		↑	↑		5.4
INDIC.	504.-	505-					50%							5.4
DATA	505-	506.-					40%					3.55		5.0
IN	506-	507-					55%							5.4
ONE IN.	507-	508.-					25%							5.2
INCREMENTS	508-	509.-	APPROX.	APPROX.	APPROX.	APPROX.	40%				APPROX.			5.2
	509-	510.-	4.8	5.0	6.0	5.5	30%				3.80	↓	(27A)	5.2
	510-	511.-					65%					3.59		5.2
	511.-	512.-					50%					↓		5.2
	512.-	513.-					60%					3.60		5.0
	513.-	514-	↓	↓	↓	↓	40%	↓	↓		↓	↓		5.4

[signature] 6/18/85

PAGE

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER PLANT

ULTRASONIC INDICATION DATA SHEET

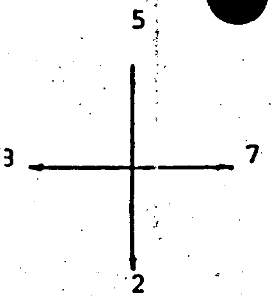
PLANT: IP	UNIT: 3	DATE: 6/18/8
ROOT: 34	SYSTEM OR COMPONENT: STEAM GENERATOR	SKETCH NO. INT-2-11
OPERATOR(S): J. MENON (L)T. RHEAUME	STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS PEAK F
NEW	507 -	508 -	↑	↑	↑	↑	30%	60°	5	↑	↑			6.0
INDIC.	508 -	509 -					25%							6.0
DATA	509 -	510 -					15%							6.0
IN	510 -	511 -	APPROX.	APPROX.	APPROX.	APPROX.	45%				APPROX.			5.8
NE IN.	511 -	512 -	5.2	6.0	6.4	7.0	60%			3.71	3.80		27B	6.0
CREMENTS	512 -	513 -					95%			↓				6.4
	513 -	514 -					15%			3.70				6.0
	514 -	515 -	↓	↓	↓	↓	15%	↓	↓	3.71	↓			6.2

[illegible] 6/18/85

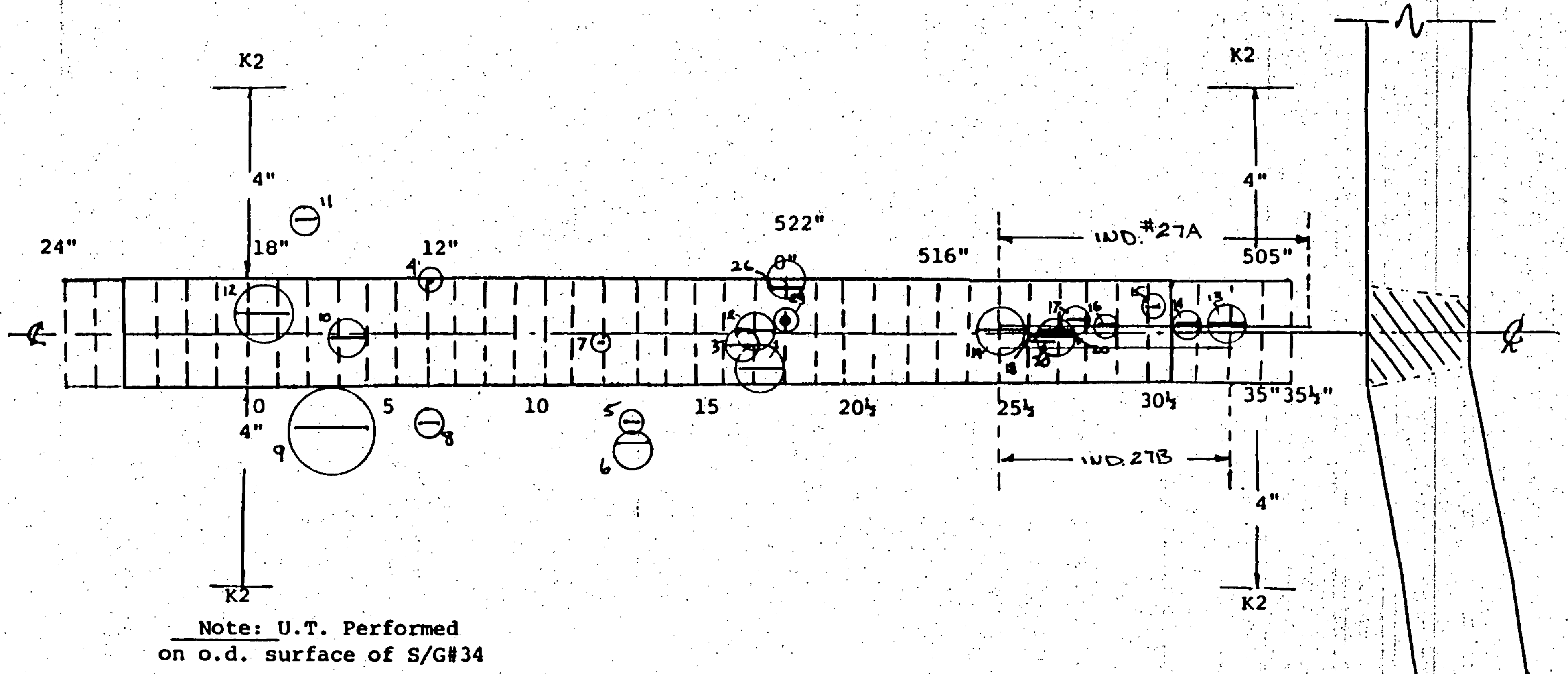
PAGE

Scan direction



POWER AUTHORITY OF THE STATE OF NEW YORK

STEAM GENERATOR NO. 34



Note: U.T. Performed
on o.d. surface of S/G#34

6/21/85

6/16/

ULTRASONIC INDICATION DATA SHEET

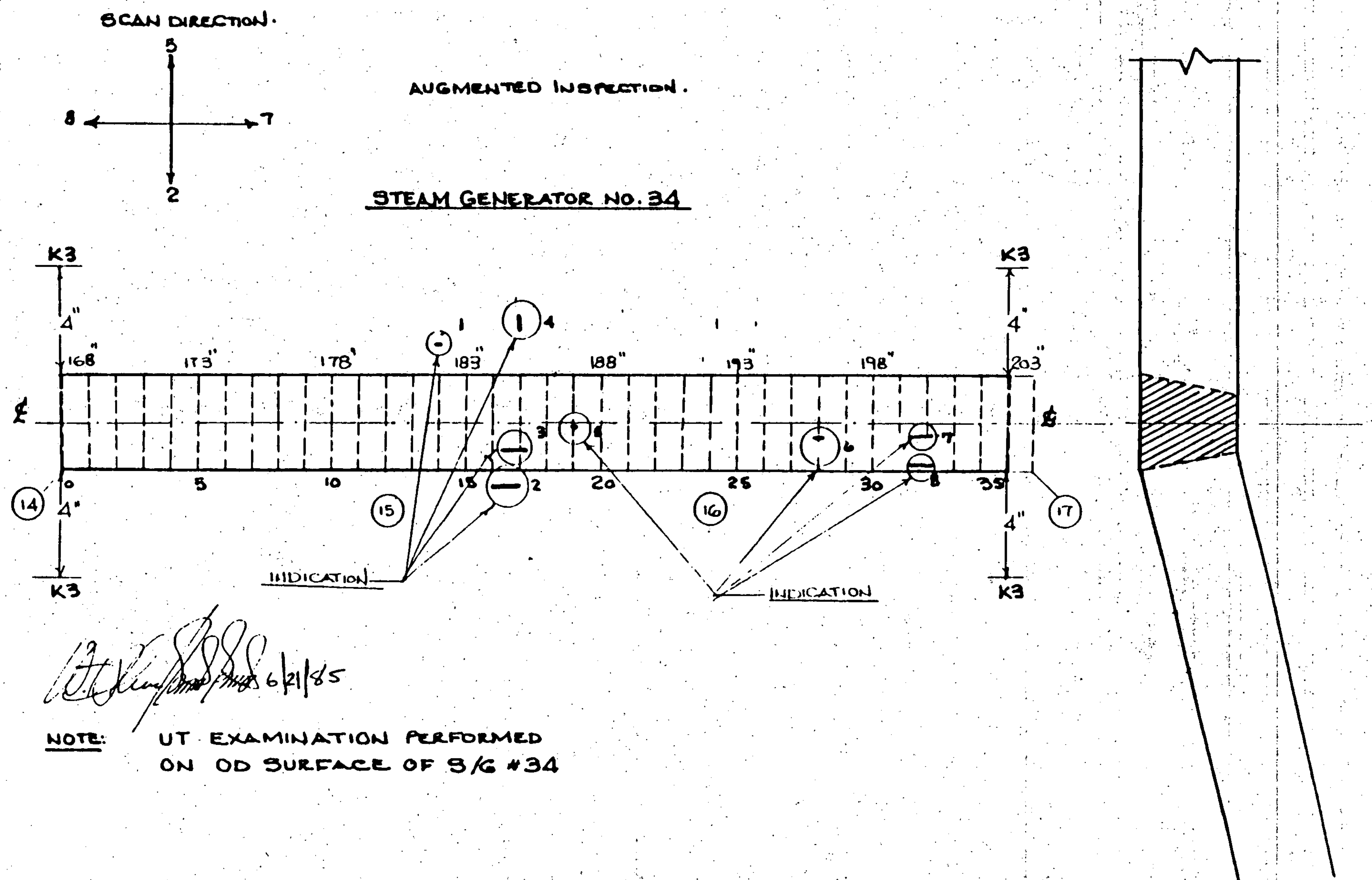
PLANT: IP | UNIT: 3 | DATE: 6/17

LOOP: 34 [illegible] AREA | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-1

OPERATOR(S): S. MEMON (LEVEL III), W.T. RHEAMUE (LEVEL II) | STD. THICK. 3.5" | PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS		PEAK
34-6	182.0"	182.0"	5.8	6.25	6.8	7.5"	25%	45°	2	3.628	–	–	SPOT	①	6.4
3SG	184.0"	185.0"	5.5	5.75	6.0	6.0"	25%	45°	5	–	–	3.7		②	5.8
14-17	184 1/2"	185.18	5.5	4.5	6.8	6.62	25%	60°	2	3.5	–	–		③	6.0
AREA	3.5"	4.0"	6.2	185.0	7.0	186.25	25%	45°	7 (2 SIDE)	3.5	–	–		④	6.6
168"-203"	187.0"	187.0"	5.8	3.0	6.6	4.0	10%	45°	2	3.5	–	–	SPOT	⑤	6.2
	196.0"	196.0"	5.4	4.25	6.0	4.625	10%	45°	5	–	–	3.7	SPOT	⑥	5.8
	199.0"	200.0	6.0	4.75	6.4	5.5	15%	45°	5	–	–	3.7		⑦	6.2
	199.50	200.18	6.0	7.00	7.6	9.75	45%	60°	5	–	–	3.7		⑧	6.4

[signature] 6/17/85



6/21/85

NOTE: UT EXAMINATION PERFORMED ON OD SURFACE OF S/G #34

SECOND

SAMPLE

INSPECTION

AREA

(REFERENCE

FIG. 2-1 TO

FIG 2-4)

INDIAN POINT NO. 3 NUCLEAR POWEF U

ULTRASONIC INDICATION DATA SHEET

...T: IP		UNIT: 3	DATE: 6-24-...
...T: 31	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-11
...RATOR(S): [illegible signature]		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD ...NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	PEAK F...
...-6	27"	28½"	5.7	4⅜"	6.4	5¼"	30%	45°	5				+12 DB	① 6.2
...	23¾"	25¾"	5.3	4½"	6.3	5¾"	45%	45°	5				+12 dB	② 5.8
...-5 AREA	27⅞"	29⅝"	6.0	3⅛"	6.8	3⅝"	30%	45°	2				+12 dB	③ 6.6
" "...-60														

NOTE: LIMITED EXAM DUE TO INSULATION RING AND WELD CROWN

PAGE

ULTRASONIC INDICATION DATA SHEET

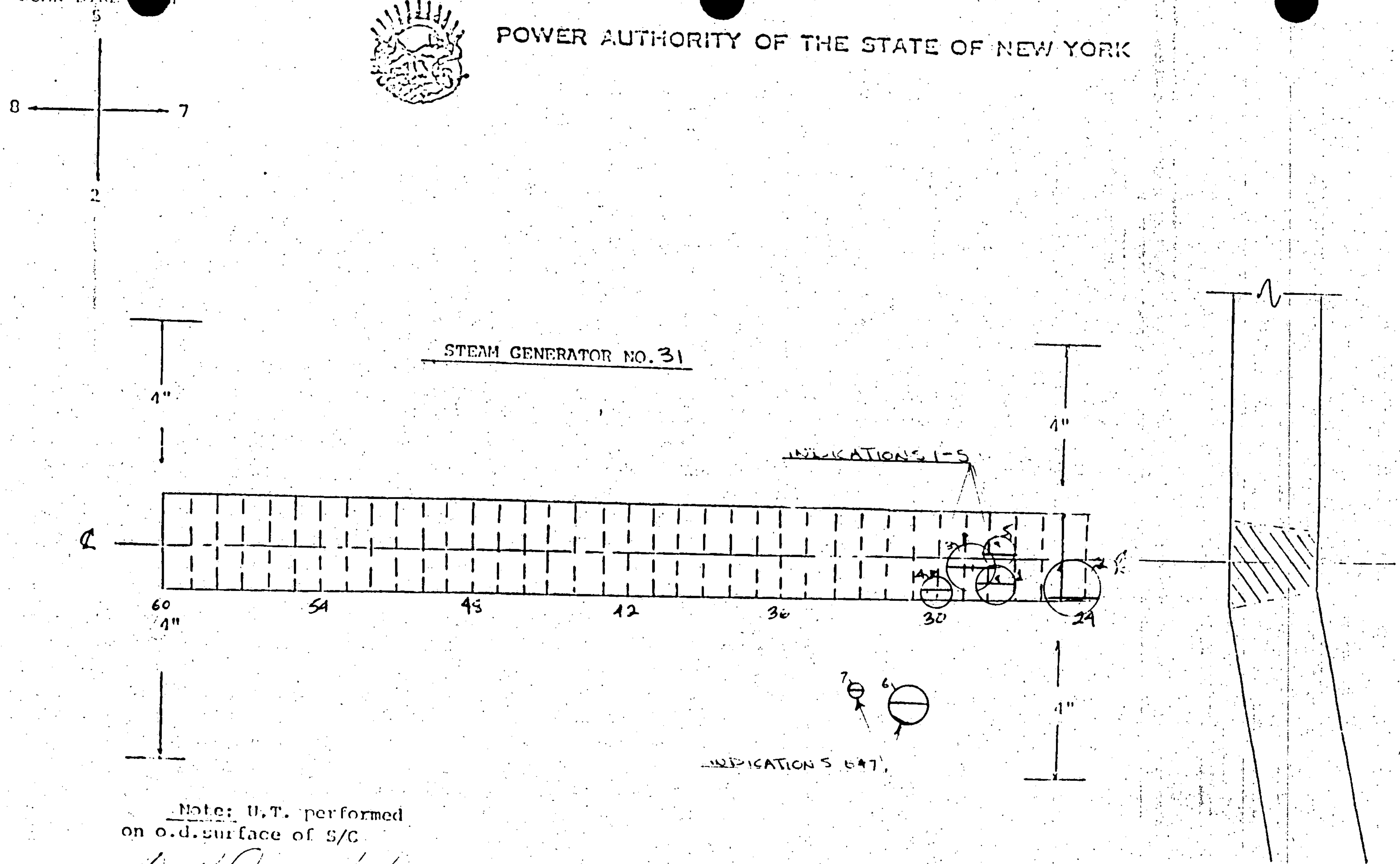
PLANT: IP	UNIT: 3		DATE: 6-24
LOOP: 31	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-1
OPERATOR(S): RHEAUME T. OCONNOR		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	PEAK
1-6	29½	30½	5.3	6¾"	6.2	8¼"	25%	60°	5	CONE			④	5.4
	27	28⅛	5.2	7"	6.0	8¼"	20%	60°	5	CONE			⑤	5.2
SEG	30⅝	31⅝	8.6	3"	9.8	4⅜"	100%	60°	2				⑥	9.0
2-5	33¼	33⅞	7.9	2¾"	8.8	3½"	40%	60°	2				⑦	8.[illegible]
AREA														
21"-60"														

NOTE: LIMITED EXAM DUE TO INSULATION RING + WELD CROWN

SCAN DIRE[illegible]

POWER AUTHORITY OF THE STATE OF NEW YORK



Note: U.T. performed on o.d. surface of S/C

[signature] 6/24/85

- NO SCALE -

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER PLANT

ULTRASONIC INDICATION DATA SHEET

PLANT: IP | UNIT: 3 | DATE: 6/26/85

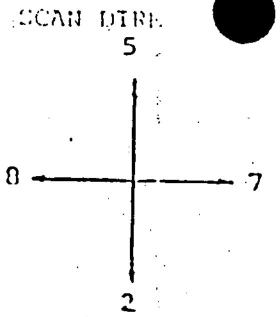
LOOP: 32 | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-1100

OPERATOR(S): S. MEMON (LEVEL III) W.T. RHEAUME (LEVEL II) | STD. THICK. 3.5" | PROCEDURE NO: 9.4-9

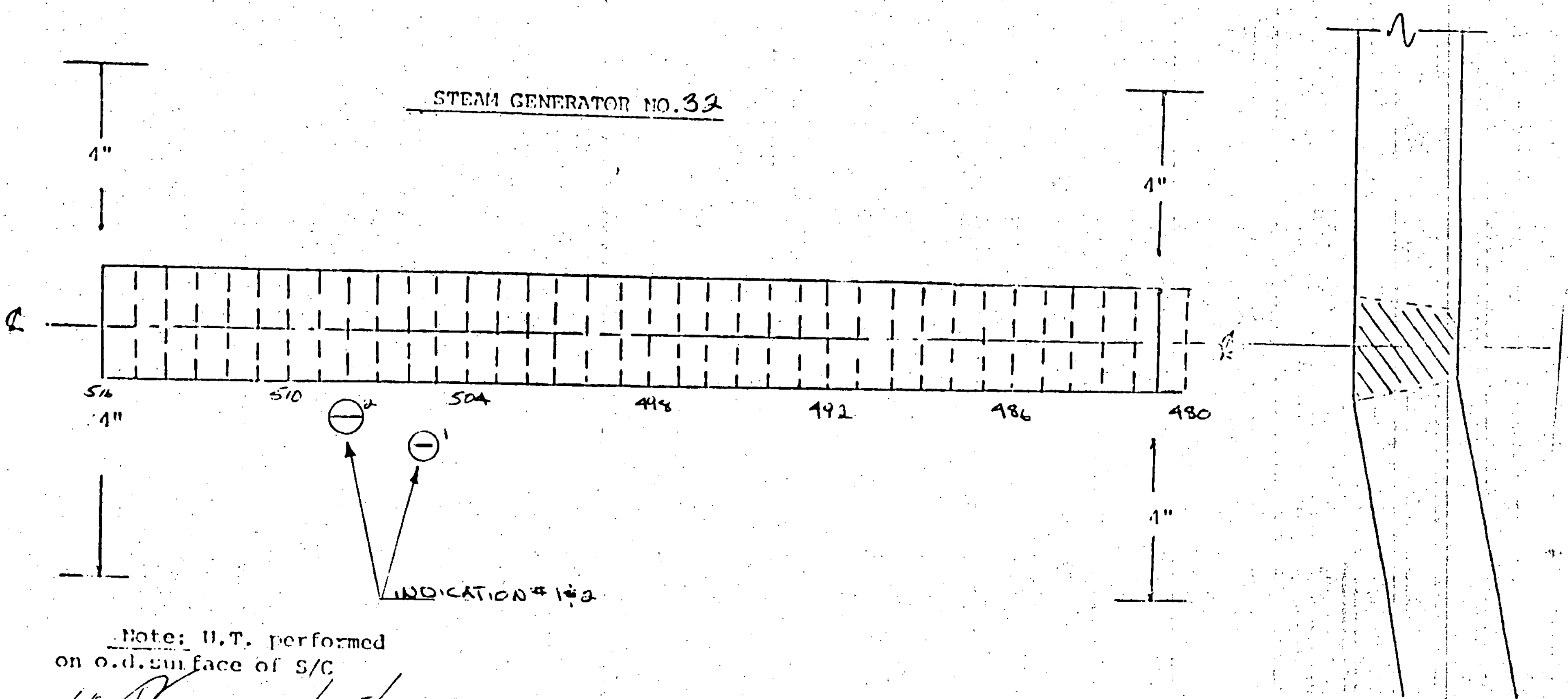
WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS		PEAK POS
32-6	505.8	505.5	4.2	6.5"	5.2	8.5"	25%	60°	S			3.7		(1)	4.8
SEG.	507.5	508.5	5.4	6.25"	6.2	7.25	30%	60°	S			3.7	AT LONG SEAM.	(2)	6.0
40-43															
AREA															
480"-516"															

6/26/85

PAGE



POWER AUTHORITY OF THE STATE OF NEW YORK



Note: U.T. performed on o.d. surface of S/G

6/25/85

POWER AUTHORITY OF THE STATE

INDIAN POINT NO. 3 NUCLEAR POWER PLANT

ULTRASONIC INDICATION DATA SHEET

NT: IP

UNIT: 3

DATE: 6-24-

SKETCH NO. INT-2-1

T: 33

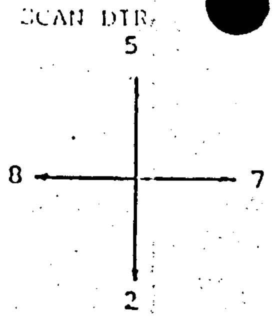
SYSTEM OR COMPONENT: STEAM GENERATOR

STD. THICK. 3.5"

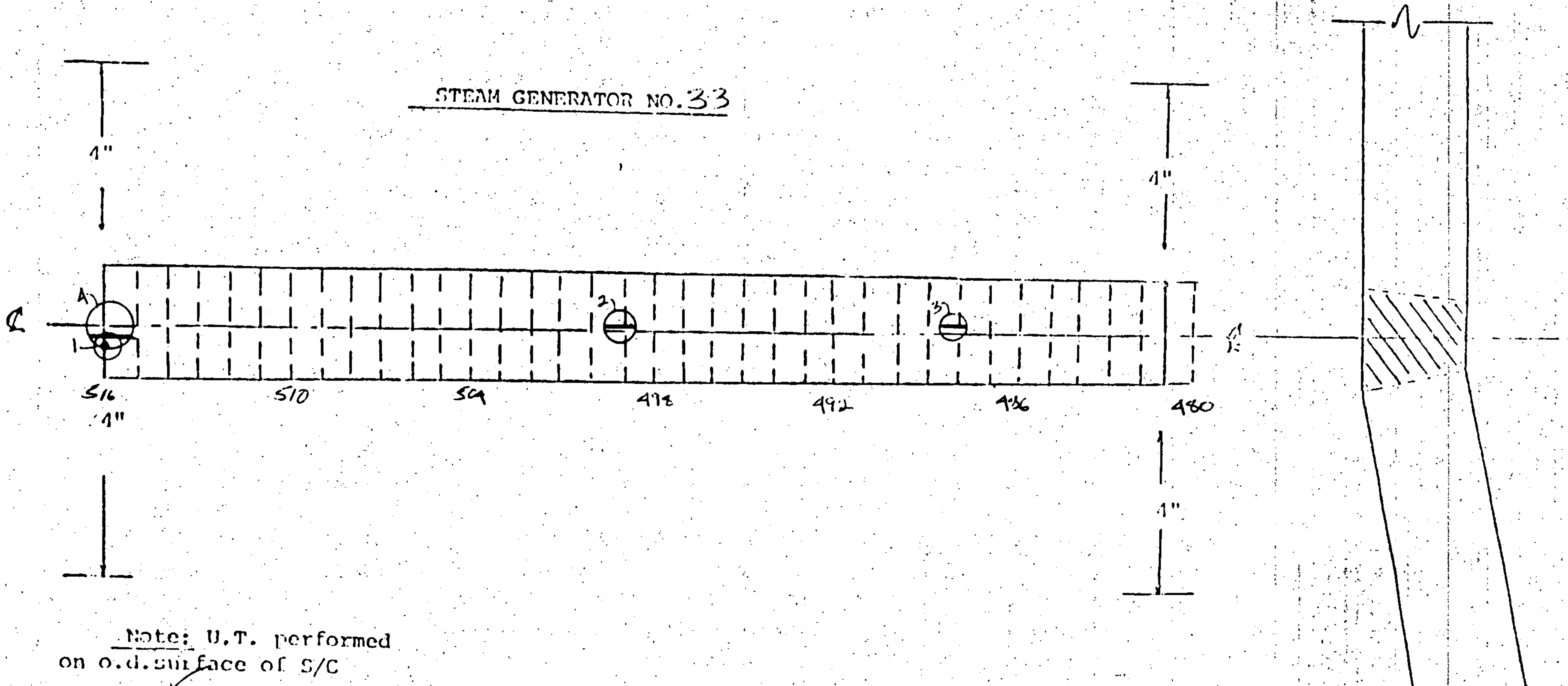
PROCEDURE NO: 9.4-9

RATOR(S): RHEAUME & OCONNOR

WELD	INDICATION LENGTH		MIN.	S.U.	MAX.	S.U.	MAX.	BEAM	BEAM	BASE METAL	WELD	BASE METAL		REMARKS	
NNER	FROM	TO	DEPTH	POS.	DEPTH	POS.	% DAC	ANGLE	DIR.	THICK.	THICK.	THICK.			PEAK
3-6	516"	516"	6.8	8 1/2"	7.8	9 7/8"	25%	60°	5					①	6.
	498 7/8"	499 1/2"	4.0	3 7/8"	5.2	5 1/2"	25%	60°	5					②	4.
EG	487 7/8"	489 3/8"	5.0	4 7/8"	6.2	6 1/4"	40%	60°	5					③	5.
.43	515 1/8"	516 1/2"	5.4	5 1/8"	6.2	6 1/4"	20%	60°	2					④	6.
AREA															
80"-516"															



POWER AUTHORITY OF THE STATE OF NEW YORK



Note: U.T. performed on o.d. surface of S/C

6/29/85

NO SCALE

INDIAN POINT NO. 3 NUCLEAR POWER ANT

ULTRASONIC INDICATION DATA SHEET

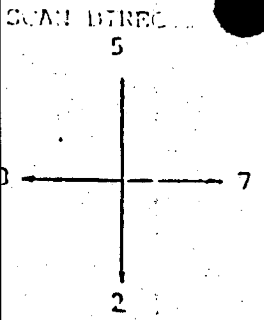
NT: IP	UNIT: 3		DATE: 6-25-8
F: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
RATOR(S): [illegible signature] II		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS	PEAK P
1-6	489"	492½"	5.0	4½"	5.8	5"	25	45	2					①	5.2
" to 505	471¼"	472⅝"	7.0	4"	6.0	5½"	50	45	2 (5)	3.71	3.69			②	6.2
9-42	482"	483⅛"	6.0	4½"	6.6	4"	55	45	2 (5)	3.76	3.80			③	6.4
"-54"	46"	47½"	7.0	6⅞"	6.0	7¾"	55	45	2 (5)	3.72				④	6.2
-5	20"	21¼"	5.8	5"	6.2	6"	45	45	2					⑤	6.0

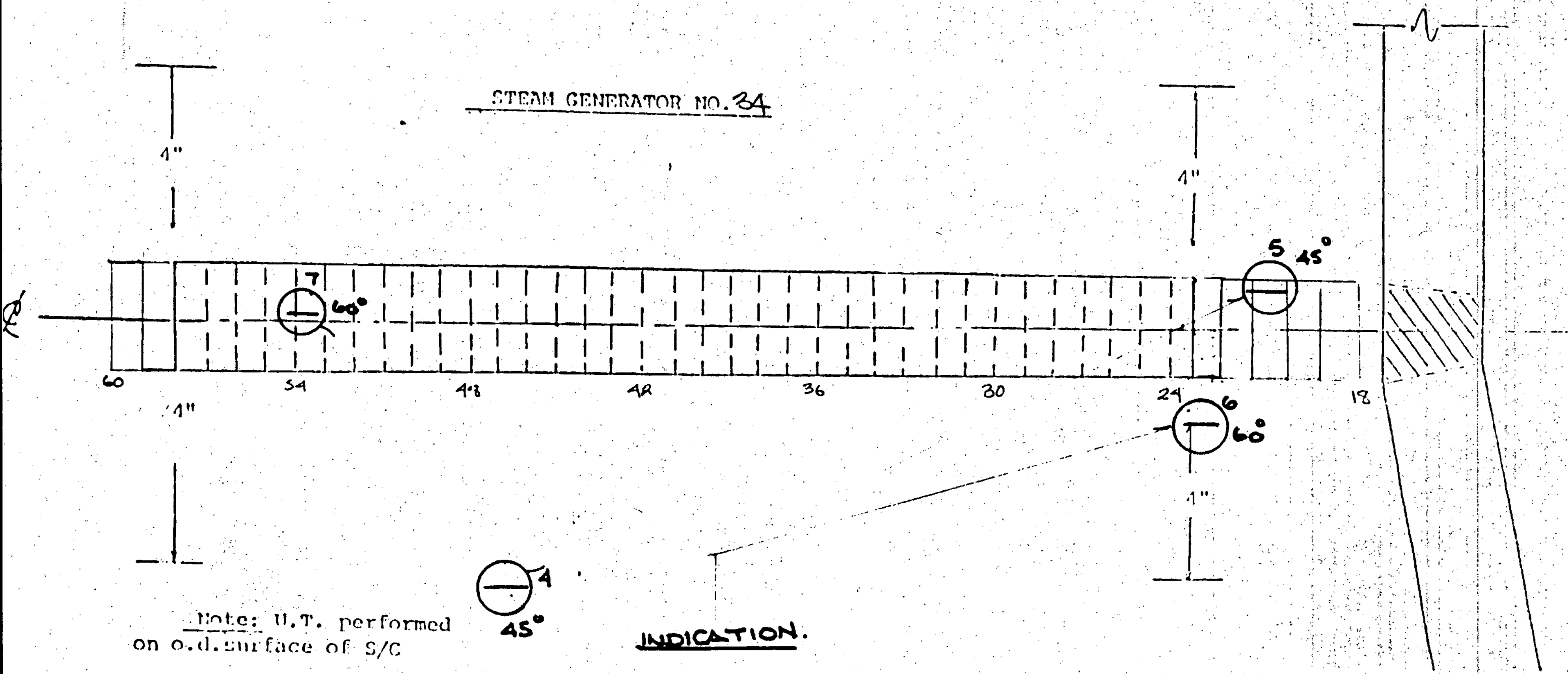
ULTRASONIC INDICATION DATA SHEET

NT: IP	UNIT: 3		DATE: 6-25-85
: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
RATOR(S): RHEAUME & O'CONNER		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	2 TRAN BASE METAL THICK.	WELD THICK.	5 TRAN BASE METAL THICK.	REMARKS PEAK P
4-6	22 3/8	23 1/4	4.4	6 1/2"	5.2	7 3/4"	20%	60°	5	3.56	3.59	3.68	(6) 5.0
	53 1/8	54 1/8	5.2	4 7/8"	6.0	6 1/8"	60%	60°	5	3.57	3.50	3.68	(7) 5.8
EG	484 5/8	485 3/4	4.2	5 1/8"	5.6	7 1/4"	20%	60°	2				(12) 4.4
-5 LAZ	491 1/2	492 3/8	4.8	6 1/4"	5.4	7"	25%	60°	2				(9) 5.5
LSA	487	488	4.3	5 7/8"	5.2	6 3/4"	25%	60°	2				(14) 5.0
"-60" B-SDA	493	494 5/8	4.3	5 1/2"	4.8	6 1/2"	45%	60°	2				(11) 4.6
	484 1/2	485 5/8	4.8	5"	6.0	6 1/2"	25%	60°	5				(8) 5.8
	486 1/4	487 1/4	8.8	9 5/8"	9.9	11"	100%	60°	5	3.55	3.97	3.71	(13) 9.0
	486 1/4	488	5.0	5 1/2"	6.0	6 1/2"	40%	60°	5				5.2



POWER AUTHORITY OF THE STATE OF NEW YORK



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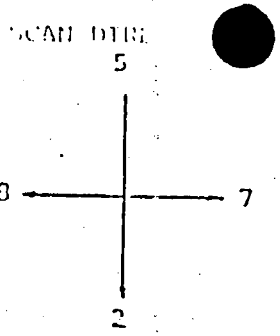
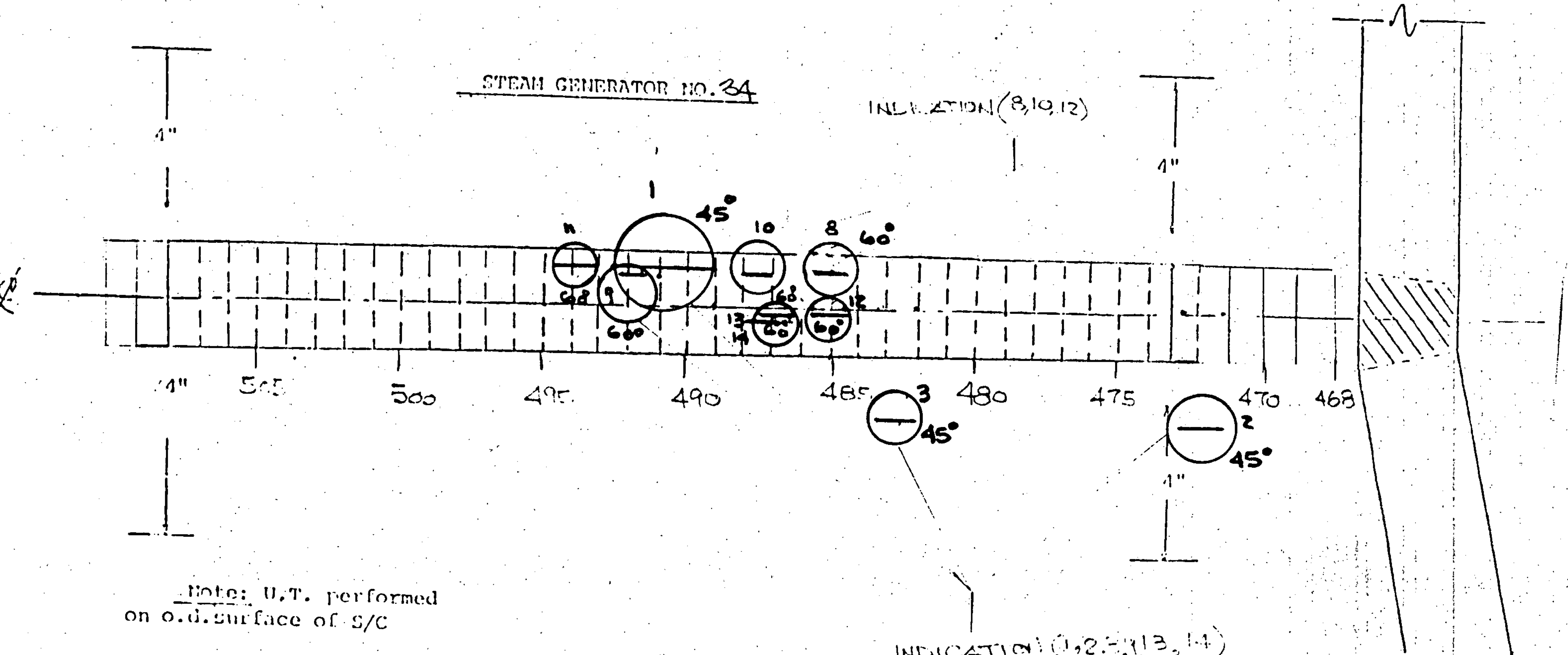




Note: U.T. performed on o.d. surface of S/C

THIRD SAMPLE INSPECTION AREA

(REFERENCE FIG. 2-1 TO FIG. 2-4)

ULTRASONIC INDICATION DATA SHEET

NT: IP | UNIT: 3 | DATE: 6-29-85

: 34 | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-110(

RATOR(S): [signature] | STD. THICK. 3.5" | PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	S BASE METAL THICK.	W WELD THICK.	T BASE METAL THICK.		REMARKS	PEAK PC
4-6	68"	69"	5.7	8½"	6.4	9½"	30	45	5	3.35	3.71	3.68		①	6.0
0" To	73¼"	74½"	5.9	9.0"	6.7	10.0"	90	45	5	3.40	3.71	3.68		②	6.4
68"	76"	77½"	6.8	¾"	7.2	1⅞"	30	45	5	3.39	3.71	3.68		③	7.0

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER

ULTRASONIC INDICATION DATA SHEET

...NT: IP	UNIT: 3	DATE: 6-29-8...
...: 34	SYSTEM OR COMPONENT: STEAM GENERATOR	SKETCH NO. INT-2-11...
...RATOR(S): Mark A. Bellgren II	STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS PEAK P...
...-6	344"	345"	7.4	5½"	8.0	5¾"	25	45	5				(4) 7.8...
...48" TO ...76"	275	276½"	5.7	5¾"	6.1	6¼"	35	45	2				(5) 6.1...

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER A

ULTRASONIC INDICATION DATA SHEET

T: IP	UNIT: 3		DATE:
: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-11(
ATOR(S): Neal A. Bilyin II		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.		REMARKS PEAK R
-6	353 3/4"	355 3/4"	5.7	3 3/4"	6.5	4 1/4"	45	45	2				(6)	6.0
8" TO	361"	365"	5.6	8.0"	6.8	9.0"	50	45	2				(7)	6.0
20"														

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER

ULTRASONIC INDICATION DATA SHEET

ANT: IP	UNIT: 3		DATE: 6-29-85
OP: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
ERATOR(S): Noel A. Baldwin II		STD. THICK. 3.5"	PROCEDURE NO: 9-4-9

WELD NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	PEAK PC
34-6	447½"	448½"	5.3	3½"	6.2	4½"	25	45	2				(8)	5.8
420" TO	444"	445½"	5.5	4"	6.2	4¾"	25	45	5				(9)	6.0
468"														

PAGE

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER

ULTRASONIC INDICATION DATA SHEET

T: IP	UNIT: 3		DATE: 6/29/8
T: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
RATOR(S) Robert H Cline II / Jamie R Slater II		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS PEAK P
4-6	456.25	456.75	3.6	1.75"	3.6	2.75"	100%+2db	0°	5				(10) 3.6
4-6	468	SPOT	2.8	1.75"	2.8	2"	75%	0°	5				(11) 2.8
EG.													
-14													
-39													

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER [T]

ULTRASONIC INDICATION DATA SHEET

[PLA]NT: IP	UNIT: 3		DATE: 6/29/85
[S/G]: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
[OPE]RATOR(S): W. T Rheaume (LEVEL II)		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD [NU]MBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	Peak P[t]
[1]-6	61 5/8	62 5/8"	3.8	4½"	5.0	5 7/8"	50%	68°	5	3.35"	3.71"	3.68"	(12)	4.6
	75½	76½	7.0	3½"	8.2	5"	30%	60°	5				(15)	8.0
[...]EC.	75	76¼"	6.8	5"	8.6	6¾"	40%	60°	5				(18)	7.4
[...]-11	90½	91 7/8"	3.3	5¼"	4.3	6½"	20%	60°	5				(16)	4.0
[...]REA	120	120"	5.3	7"	INSULATION RING	–	20%	60°	2				(17)	5.4
"C-132"	74¾	75¾"	8.8	4 7/8"	OFF SCREEN	INSULATION RING	110%	68°	2	3.40"	3.71"	3.68"	(14)	10

ULTRASONIC INDICATION DATA SHEET

ANT: IP | UNIT: 3 | DATE: 6-29-85

OF: 34 | SYSTEM OR COMPONENT: STEAM GENERATOR | SKETCH NO. INT-2-110

ERATOR(S): W.T. RHEAUME T. OCONNER | STD. THICK. 3.5" | PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS PEAK PC	
4-6	402½"	403½"	8.8	5"	10.0	6½"	70%	60°	5	3.68	3.81	3.56	(19)	9.3
	406"	407¾"	8.8	5"	OFF SCREEN	6¾"	90%	60°	5	3 68	3.81	3.56	(20)	9.4
96"-468"	406½"	407⅛"	5.1	½"	5.3	1"	50%	60°	2 SIDE 5 SCAN	3.63	3.83	3.52	(21)	5.2
	431¼"	432¼"	7.3	7⅝"	8.2	9⅛"	35%	60°	5	3.67	3.82	3.56	(22)	7.9
	445¼"	446¾"	6.0	6⅞"	6.8	7¾"	55%	60°	5				(23)	6.6
	446⅞"	447⅝"	5.9	6¼"	6.2	7"	20%	60°	5	3.69	3.70	3.55	(24)	6.0
	453¾"	453¾"	5.6	6½"	5.6	6½"	20%	60°	2	3.68	3.64	3.54	(25)	5.6
	435⅛"	435¾"	4.8	4½"	5.8	5⅝"	30%	60°	2				(26)	5.2

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER PLANT

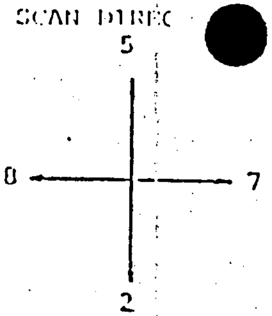
ULTRASONIC INDICATION DATA SHEET

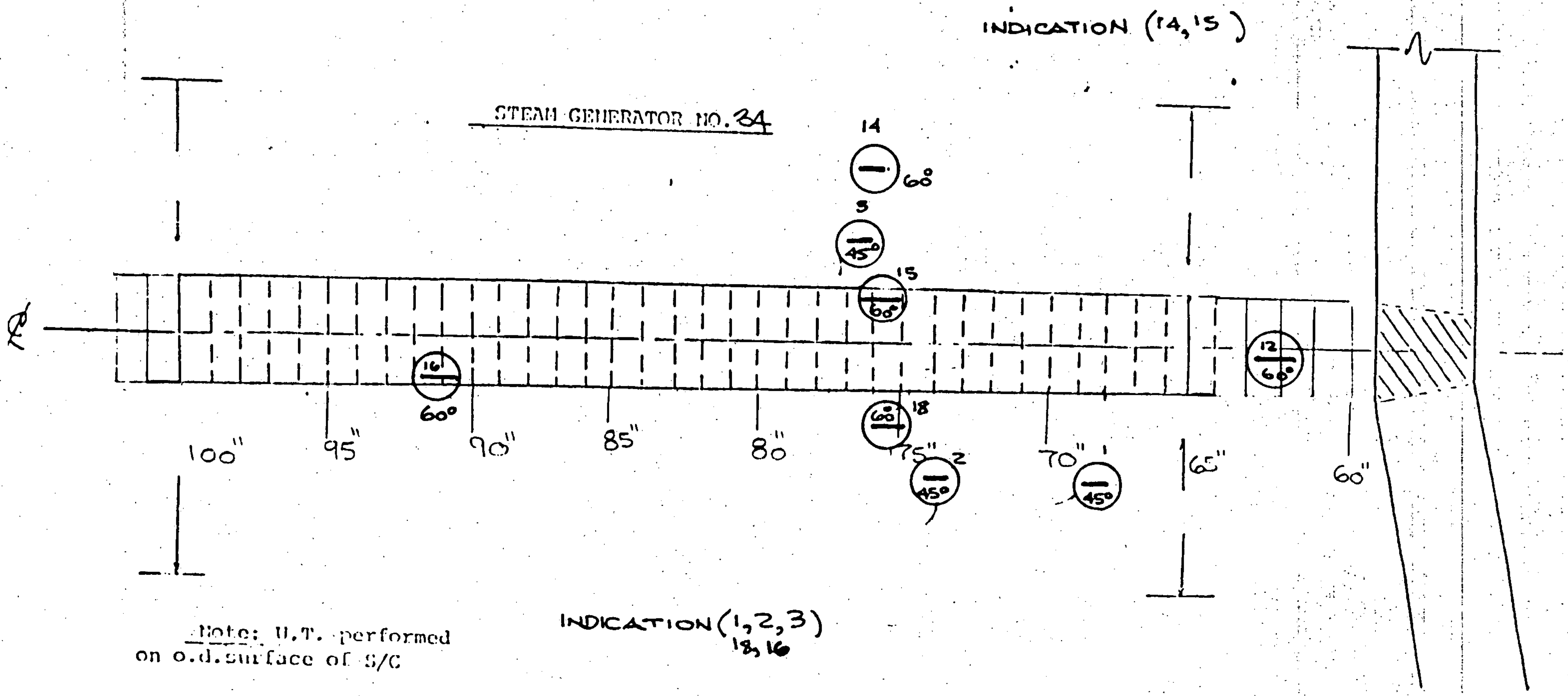
NT: IP	UNIT: 3		DATE: 6-29-85
T: 34	SYSTEM OR COMPONENT: STEAM GENERATOR		SKETCH NO. INT-2-110
RATOR(S): W.T. RHEAUME T. OCONNER		STD. THICK. 3.5"	PROCEDURE NO: 9.4-9

WELD NUMBER	INDICATION LENGTH FROM	TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	BASE METAL THICK.	WELD THICK.	BASE METAL THICK.	REMARKS	PEAK P
4-6	331"	332½"	9.1	3/4"	9.6	1½"	45%	60°	2 SIDE 5 SCAN				13	9.5
	326½"	329¼"	9.2	3/4"	9.8	1½"	50%	60°	2 SIDE 5 SCAN				27	9.3
0"-396"	300¾"	301¼"	4.0	5½"	5.5	7"	25%	60°	5				28	4.6
	344"	345½"	4.9	5"	6.4	7¼"	45%	60°	2				29	5.5

PAGE

POWER AUTHORITY OF THE STATE OF NEW YORK





Note: U.T. performed on o.d. surface of S/C

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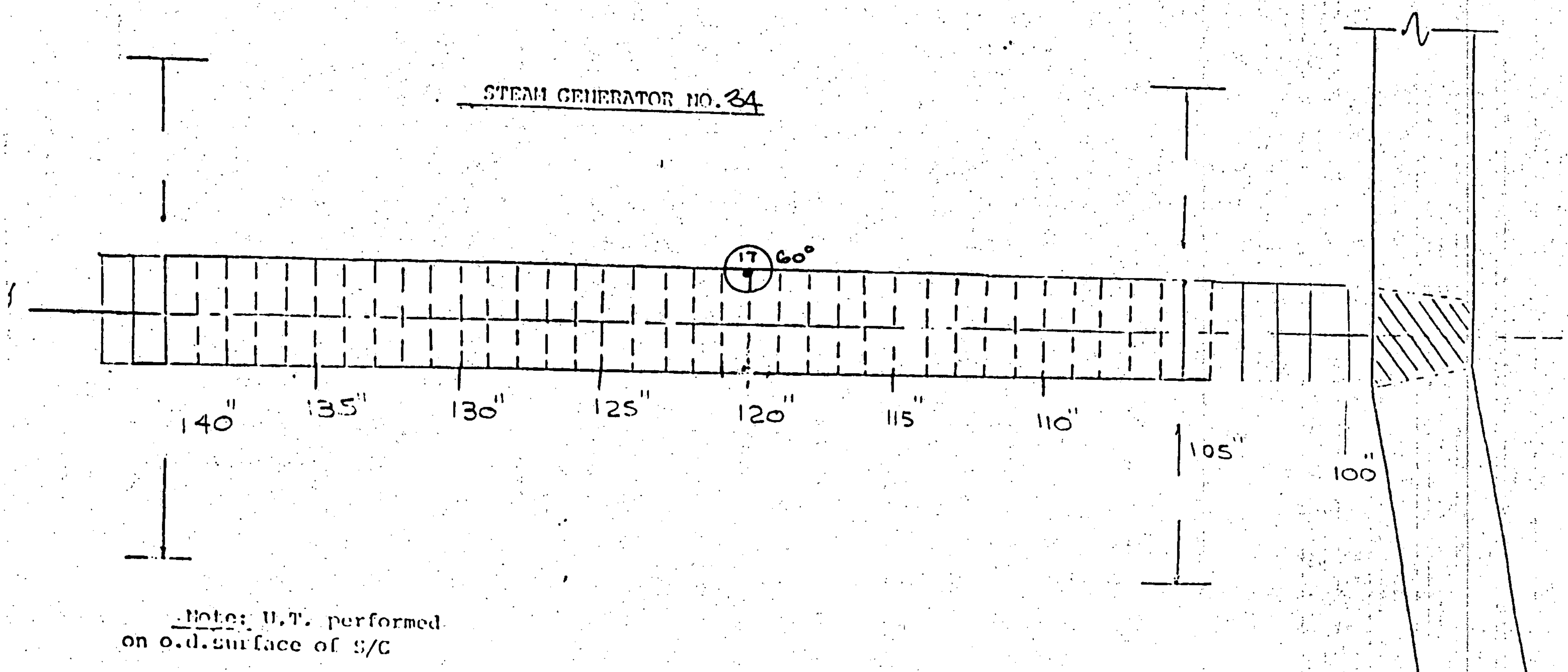
POWER AUTHORITY OF THE STATE OF NEW YORK



Note: U.T. performed on o.d. surface of S/G

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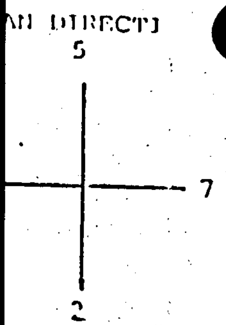
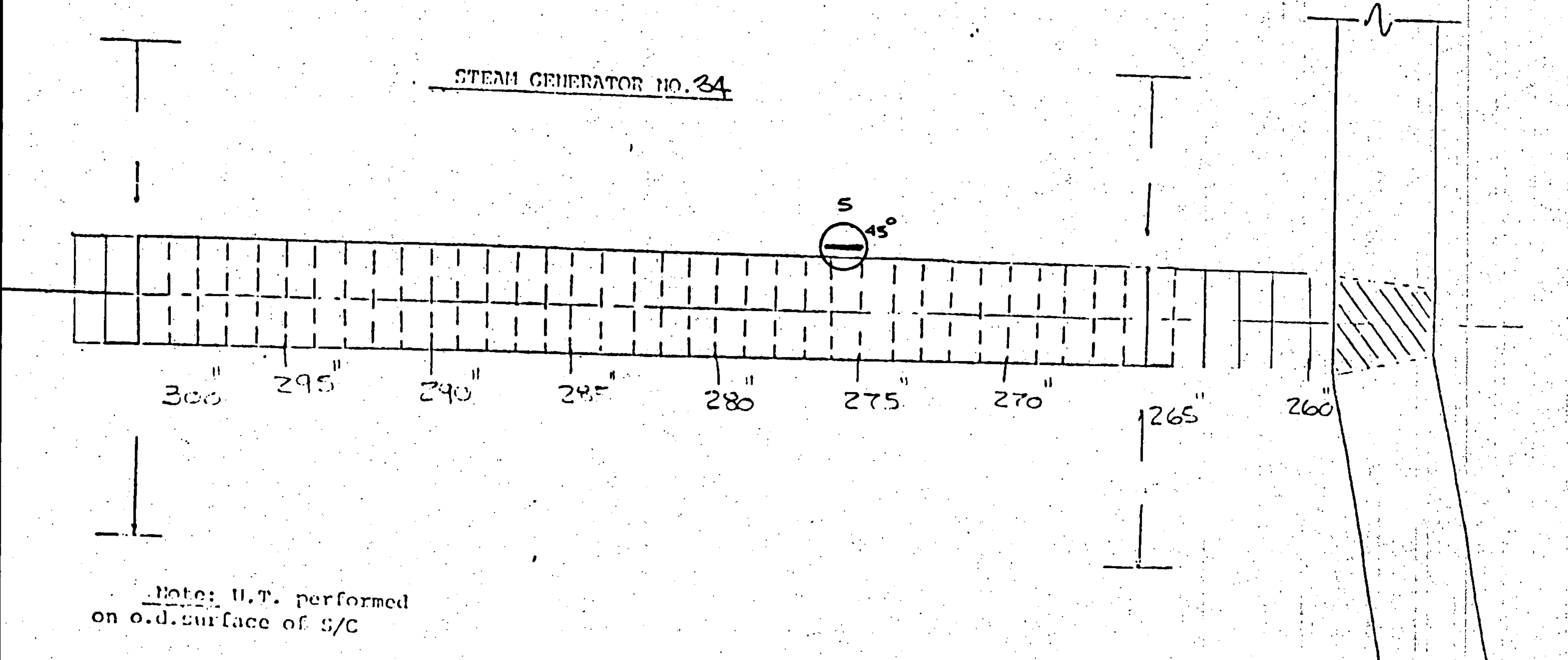
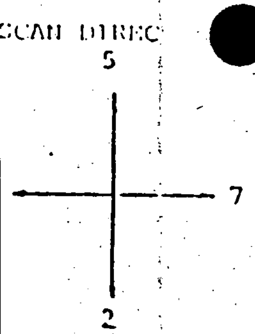


STEAM GENERATOR NO. 34



Note: U.T. performed on o.d. surface of S/C



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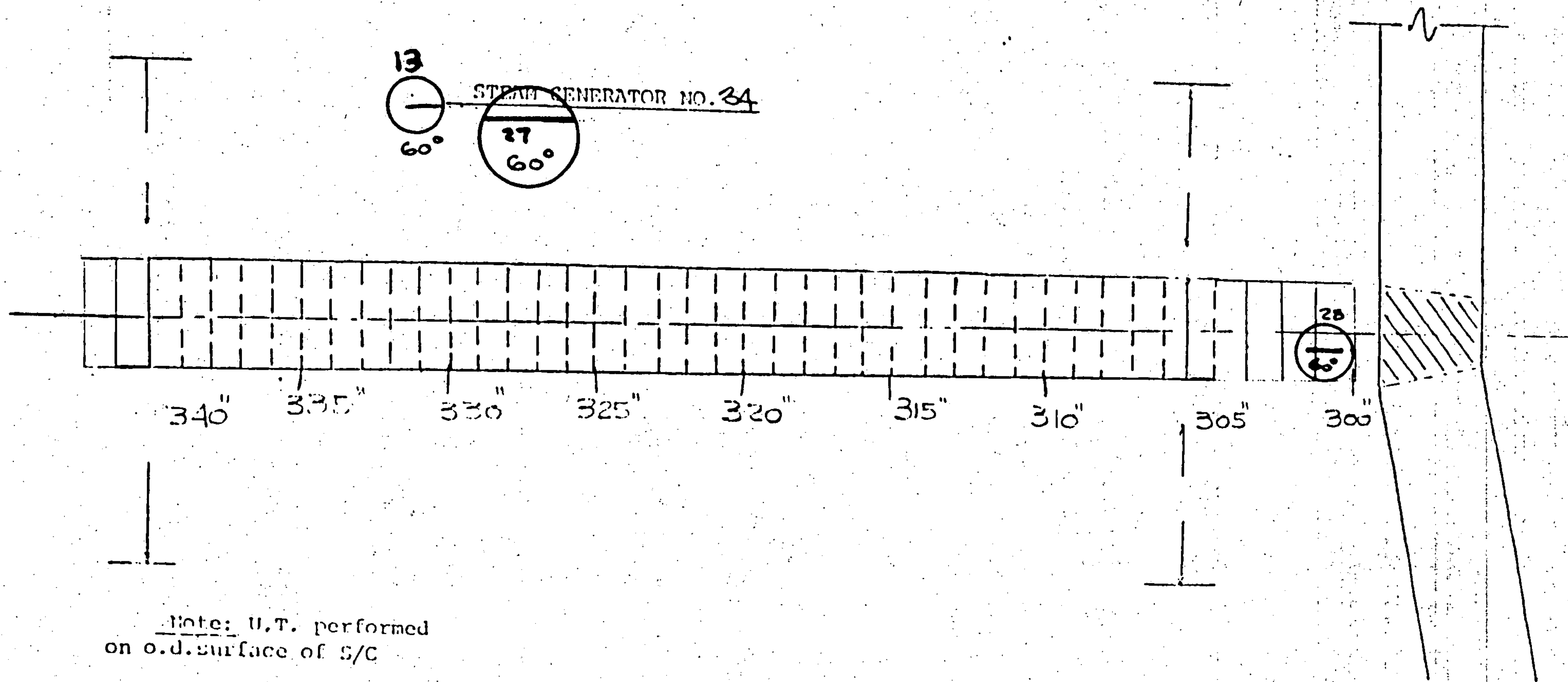
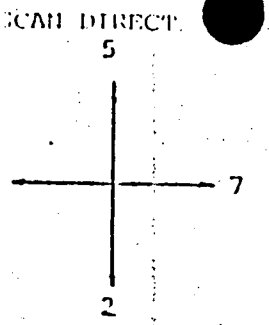
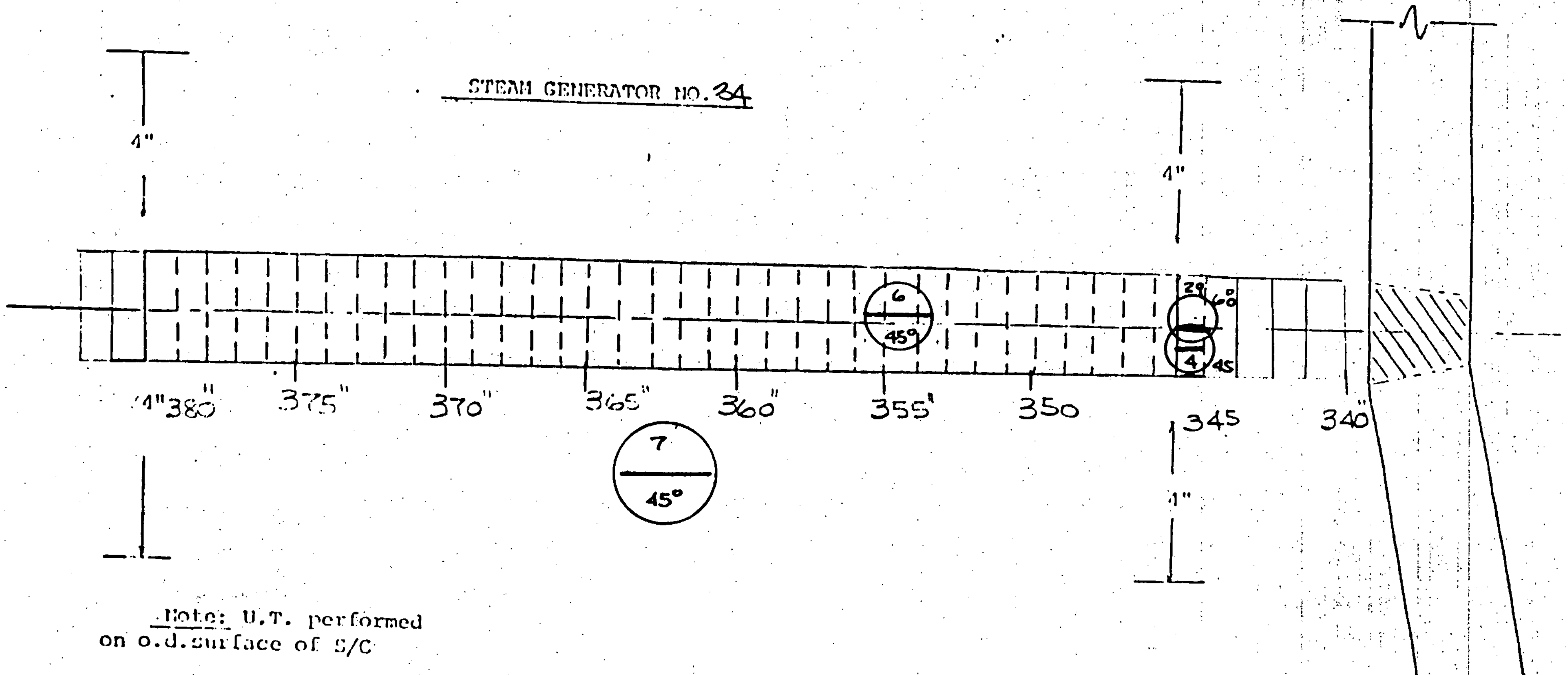


Note: U.T. performed
on o.d.surface of S/G



POWER AUTHORITY OF THE STATE OF NEW YORK

STEAM GENERATOR NO. 34



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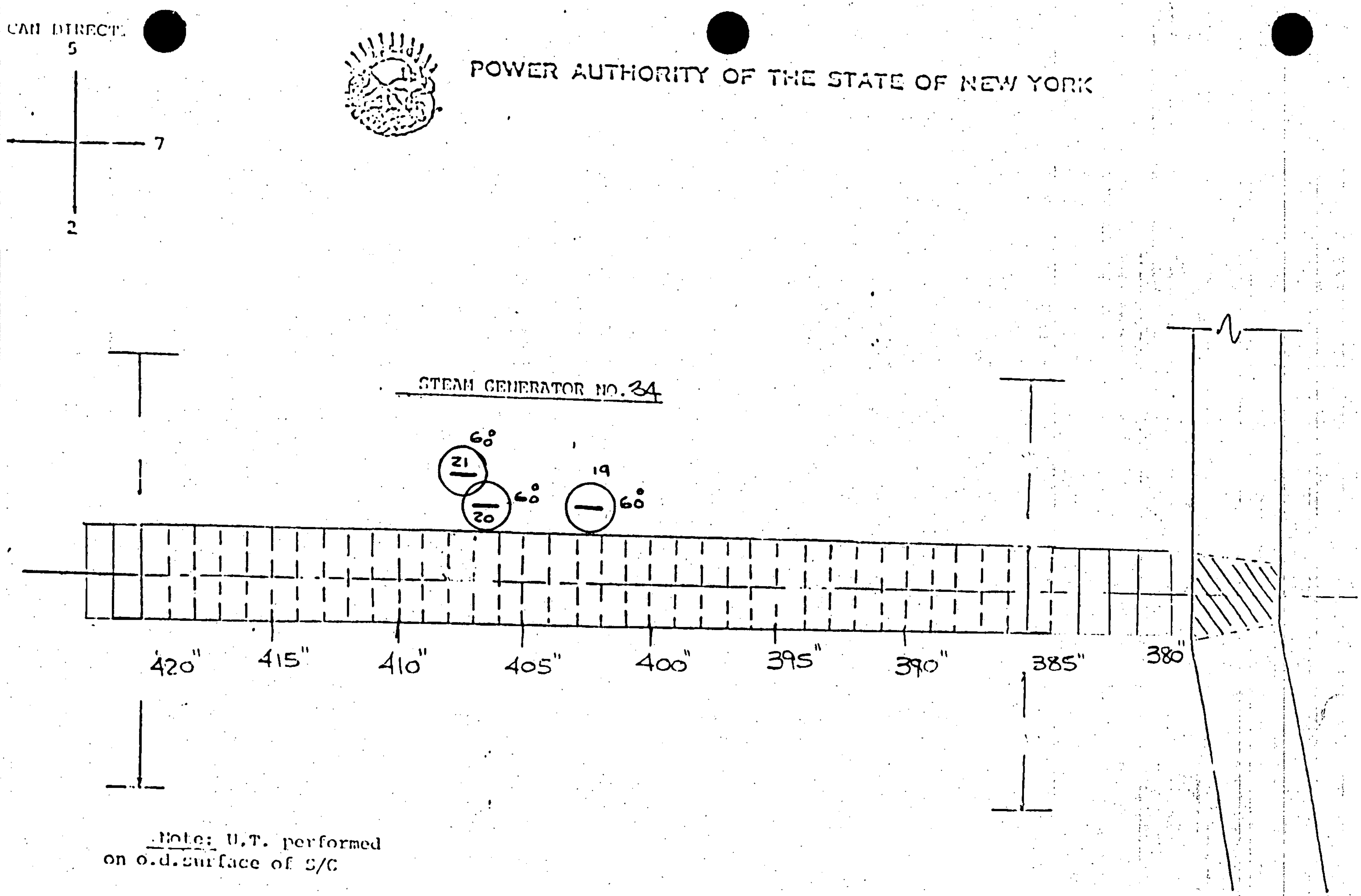

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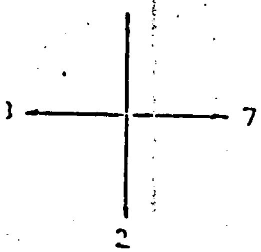

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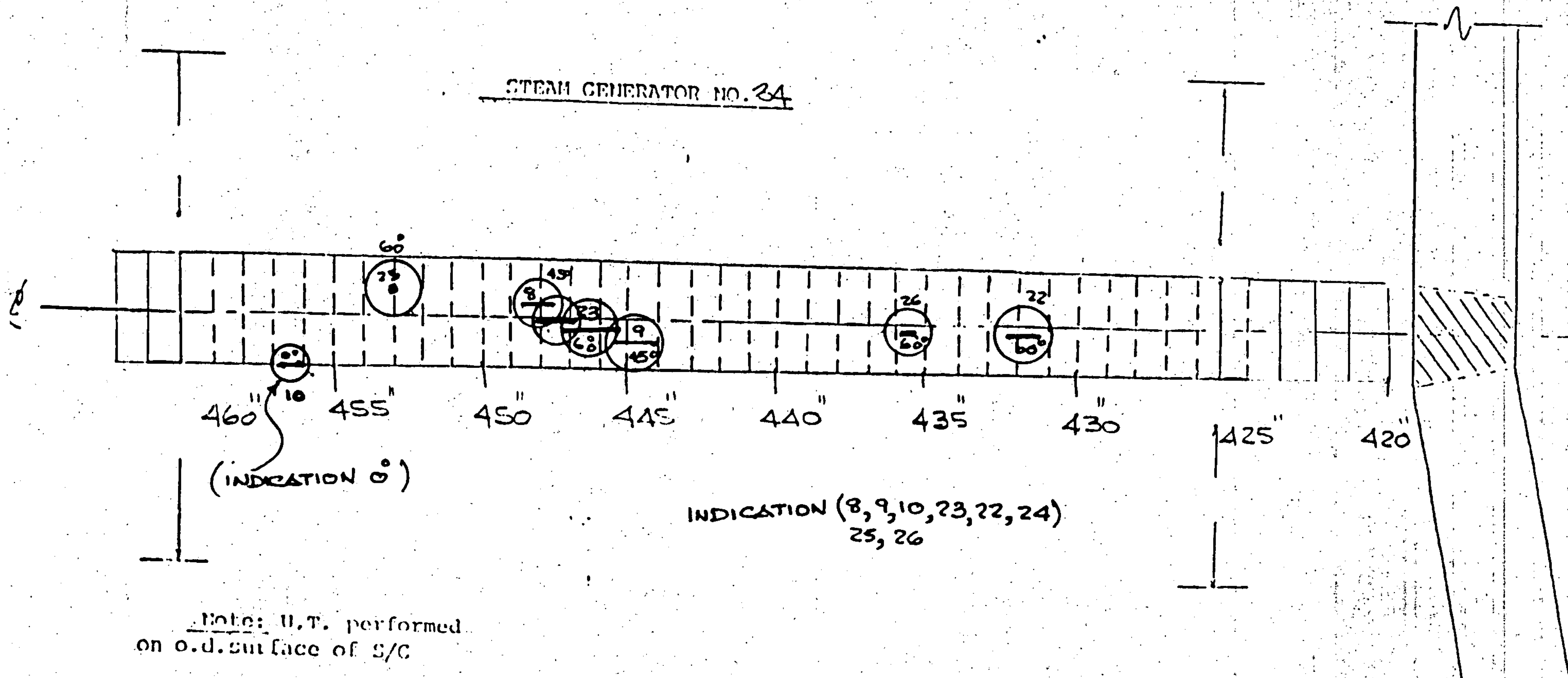
STEAM GENERATOR NO. 34



Note: U.T. performed on o.d. surface of S/G

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POWER AUTHORITY OF THE STATE OF NEW YORK

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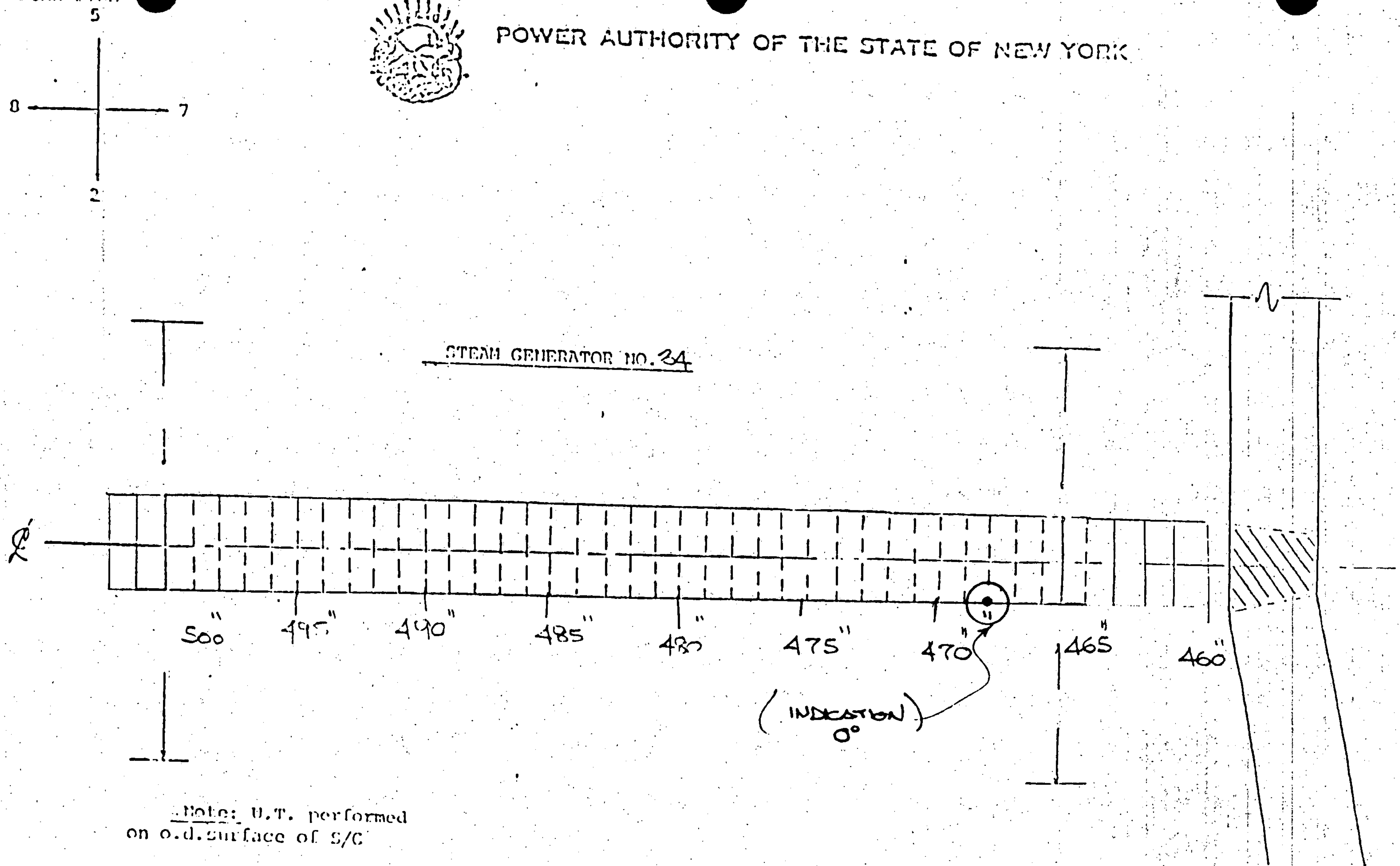


Note: U.T. performed on o.d. surface of S/G

POWER AUTHORITY OF THE STATE OF NEW YORK
Magnetic Partical Examination Report NDEP 9.2-2
IP-3 Nuclear Power Plant Date 7/12/85

se of Inspection: MT I.D. SURFACE OF GIRTH WELD IN S/G #34

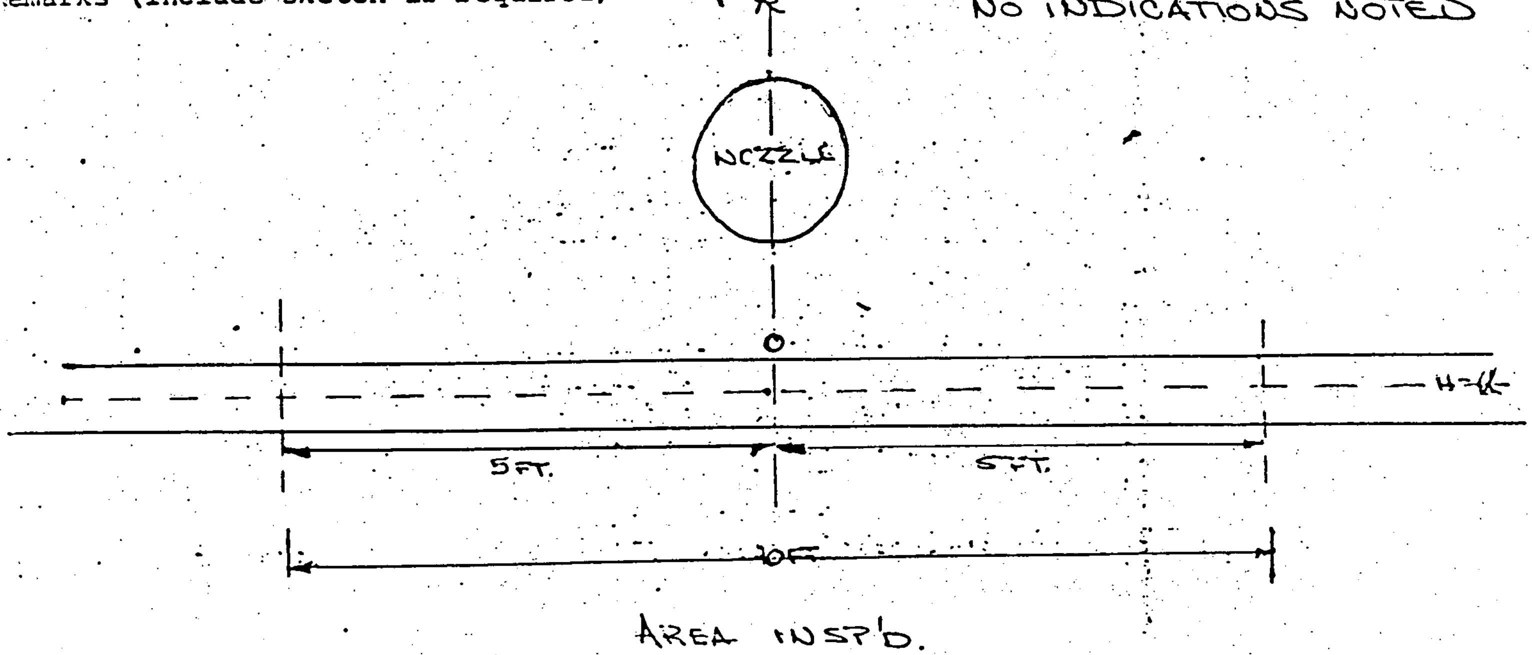
om ant: 34 S/G GIRT WELD	Identification: #6 WELD 5FT BOTH SIDES OF C-REF
urface Condition: SMOOTH	Surface Temp.: AMBIENT — Repair Work: Yes / No ✓
aterial: C.S.	Equipment Type: PARKER PROBE
COIL — No of Turns:	Current: AC + DC.
YOKE ~~PROD~~ — ~~Prod~~ POLE Space: 6 INCHES	Current:

artical Discription: 8A RED

emagnetization: N/A

rea of Examination	Description of Indication	Accept	Reject
5FT. ON BOTH SIDES OF REFERENC (NOZZEL ℄) & 8" ABOVE & BELOW WLD ℄ AS SHOWN B...OW	N/A	✓	

emarks (Include sketch if required) NO INDICATIONS NOTED



e reformed By: C am YLE GERMER Level II EUGENE SIMPSON II Signature [signature] [signature] ate 7/12/85	Evaluation Preformed By: Name [signature] Level II Signature Date 7/12/85	Page 1 of 1

...IT THR TRANSMISSION DAMPING INSP.
...APPLICABLE REPORTABLE INDICATIONS (8)
...EFERENCE QAI 4.0, REV. 0

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER...

ULTRASONIC INDICATION DATA SHEET

...T: TO	UNIT: 3		DATE: 7/15/85
...: SEGMENTS 39' TO 0' AND 0' TO 5'	SYSTEM OR COMPONENT: STEAM GENERATOR 34		SKETCH NO: FIG. D-6
...ATOR(S): SIRAJ MEMON (LEVEL III)		STD. THICK. 3.5"	PROCEDURE NO: 24-9.94-1...

...CATION NUMBER	INDICATION LENGTH FROM	INDICATION LENGTH TO	MIN. DEPTH	S.U. POS.	MAX. DEPTH	S.U. POS.	MAX. % DAC	BEAM ANGLE	BEAM DIR.	CONE BASE METAL THICK.	WELD THICK.	UP. SHELL BASE METAL THICK.	REMARKS	PEAK PO...
2	486 1/4	487 1/4	8.8	9 5/8"	9.9	11"	100	60°	5	3.71	3.97		FOR ALL	9.0
													INDICATIONS	
4	503-	514-	4.8	5-"	6.0	5 1/2"	65	60°	2		3.80	3.55	LISTED -	5.2
													SIGNAL	
5	507-	515-	5.2	6-"	6.4	7-"	75	60°	5	3.71	3.80		DAMPED	6.0
													AT	
7	511 2/3	512 1/2	5.2	2 7/8"	5.8	3 7/8"	100	45°	2		3.80	3.53	I.D. -	5.6
													GEOMETRY	
8	511-	511 3/4	5.4	3 1/2"	6.0	4-"	90	45°	2		3.80	3.55	OF	5.6
													BLENDED	
11	520 1/2	1/2	5.5	4 1/2"	6.0	4 3/4"	100	45°	2		3.72	3.57	AREAS -	5.8
													REFERENCE	
16	53 1/8	54 1/8	5.2	4 7/8"	6.0	6 1/8"	60	60°	5	3.68	3.50		ATT. FIG.	5.8

[signature] 7/15/85

PAGE

FIG. D-6

STEAM GENERATOR NO. 34

GIRTH SEAM 34-6

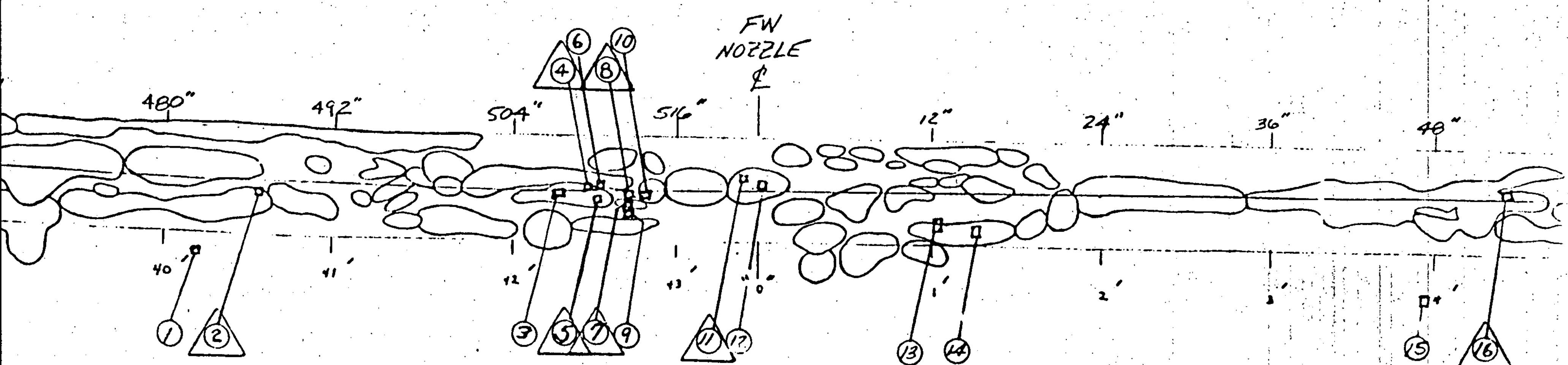
MAP OF BLENDED AREAS - 4:1 TAPER

LOCATION(S) 39' TO "0" & "0" TO 5' SEGMENTS ("0" IS CENTERLINE OF FEEDWATER.

DATA OBTAINED FROM FINAL ACCEPTED RADIOGRAPHIC FILM - 1983.

REPORTABLE INDICATIONS (16)

LOCATIONS



REDUCED - NOT TO SCALE

△ - REPORTABLE INDICATION NUMBERS, APPLICABLE TO QAI 4.0.
O - REPORTABLE INDICATION NUMBERS.

CLASS 3 CUSTOMER DESIGNATED DISTRIBUTION

WCAP 10863

HANDBOOK ON FLAW EVALUATION FOR INDIAN POINT UNIT 3 STEAM GENERATORS

W. H. Bamford

W. T. Kaiser

Y. S. Lee

July 1985

APPROVED: [signature]

J. N. Chirigos, Manager
Structural Materials Engineering

WESTINGHOUSE ELECTRIC CORPORATION
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Pittsburgh, Pennsylvania 15230

TABLE OF CONTENTS

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SECTION 1

INTRODUCTION

This flaw* evaluation handbook has been designed for the evaluation of indications which may be discovered during inservice inspection of the Indian Point Unit 3 steam generators. The tables and charts provided herein allow the evaluation of any indication discovered in the upper shell to cone weld region without further fracture mechanics calculations. The fracture analysis work has instead been done in advance, and is documented in this report. Use of the handbook will allow the acceptability of larger indications than would be allowable by only using the standards tables of Section XI [1]. This report also provides the background and technical basis for the handbook charts.

The geometry of this region is shown in Figure 1-1.

The highlight of the handbook is the design of a series of flaw evaluation charts for both surface flaws and the embedded flaws. Since the characteristics of the two types of flaws are different, the evaluation charts are distinctively different in style. One section of this handbook deals with surface flaws, and another section concentrates on the evaluation of embedded flaws.

The flaw evaluation charts were designed based on the Section XI code criteria of acceptance for continued service without repair. Through use of the charts, a flaw can be evaluated by code criteria instantaneously, and no follow-up hand calculation is required. Most important of all, no fracture mechanics knowledge is needed by the user of the handbook charts.

---

* The use of the term "flaw" in this document should be taken to be synonymous with the term "indication" as used in Section XI of the ASME Code.

It is important to note that indications which are large enough that they exceed the standards limits, and must be evaluated by fracture mechanics, will also require additional inservice inspection in the future, as discussed in Section XI, paragraph IWB 2420.

1.1 CODE ACCEPTANCE CRITERIA

There are two alternative sets of flaw acceptance criteria for continued service without repair in paragraph IWB-3600 of ASME Code Section XI [1]. Namely,

1. Acceptance Criteria Based on Flaw Size (IWB-3611)
2. Acceptance Criteria Based on Stress Intensity Factor (IWB-3612)

Both criteria are comparable in accuracy for thick sections, and the acceptance criteria (2) have been assessed by past experience to be generally less restrictive for thin sections, and for outside surface flaws in many cases. In all cases, the most beneficial criteria has been used, generally criteria (2).

1.1.1 CRITERIA BASED ON FLAW SIZE

The code acceptance criteria stated in IWB-3611 of Section XI are:

$$a_f \leq .1\ a_c$$ For normal conditions (upset & test conditions inclusive)

and $$a_f \leq .5\ a_i$$ For faulted conditions (emergency condition inclusive)

where

a_f = The maximum size to which the detected flaw is calculated to grow at the end of 40 years design life, or till the next inspection time.

a_c = The minimum critical flaw size under normal operating conditions (upset and test conditions inclusive)

a_i = The minimum critical flaw size for initiation of nonarresting growth under postulated faulted conditions. (emergency conditions inclusive)

To determine whether a flaw is acceptable for continued service without repair, both criteria must be met simultaneously. However, both criteria have been considered in advance before the charts were constructed. Only the most restrictive results were used in the charts.

1.1.2 CRITERIA BASED ON STRESS INTENSITY FACTOR

As mentioned in the preceeding paragraphs, the criteria used for the construction of the charts in this handbook are from the least restrictive of IWB 3611 or IWB 3612 of Section XI. The criteria in IWB 3612 are based on safety margins between the applied stress intensity factor and the fracture toughness of the material.

The term stress intensity factor (K_I) is defined as the driving force on a crack. It is a function of the size of the crack and the applied stresses, as well as the overall geometry of the structure. In contrast, the fracture toughness (K_{Ia}, K_{Ic}) is a measure of the resistance of the material to propagation of a crack. It is a material property, and a function of temperature.

The criteria are stated in IWB 3612:

$K_I \le \frac{K_{Ia}}{\sqrt{10}}$ For normal conditions (upset & test conditions inclusive)

$K_I \le \frac{K_{Ic}}{\sqrt{2}}$ For faulted conditions (emergency conditions inclusive)

where

K_I = The maximum applied stress intensity factor for the flaw size a_f to which a detected flaw will grow, during the conditions under consideration, at the end of design life, or to the next inspection.

K_{Ia} = Fracture toughness based on crack arrest for the corresponding crack tip temperature.

K_{Ic} = Fracture toughness based on fracture initiation for the corresponding crack tip temperature.

To determine whether a flaw is acceptable for continued service without repair, both criteria must be met simultaneously. However, both criteria have been considered in advance before the charts were constructed. Only the most restrictive results were used in the charts.

1.1.3 PRIMARY STRESS LIMITS

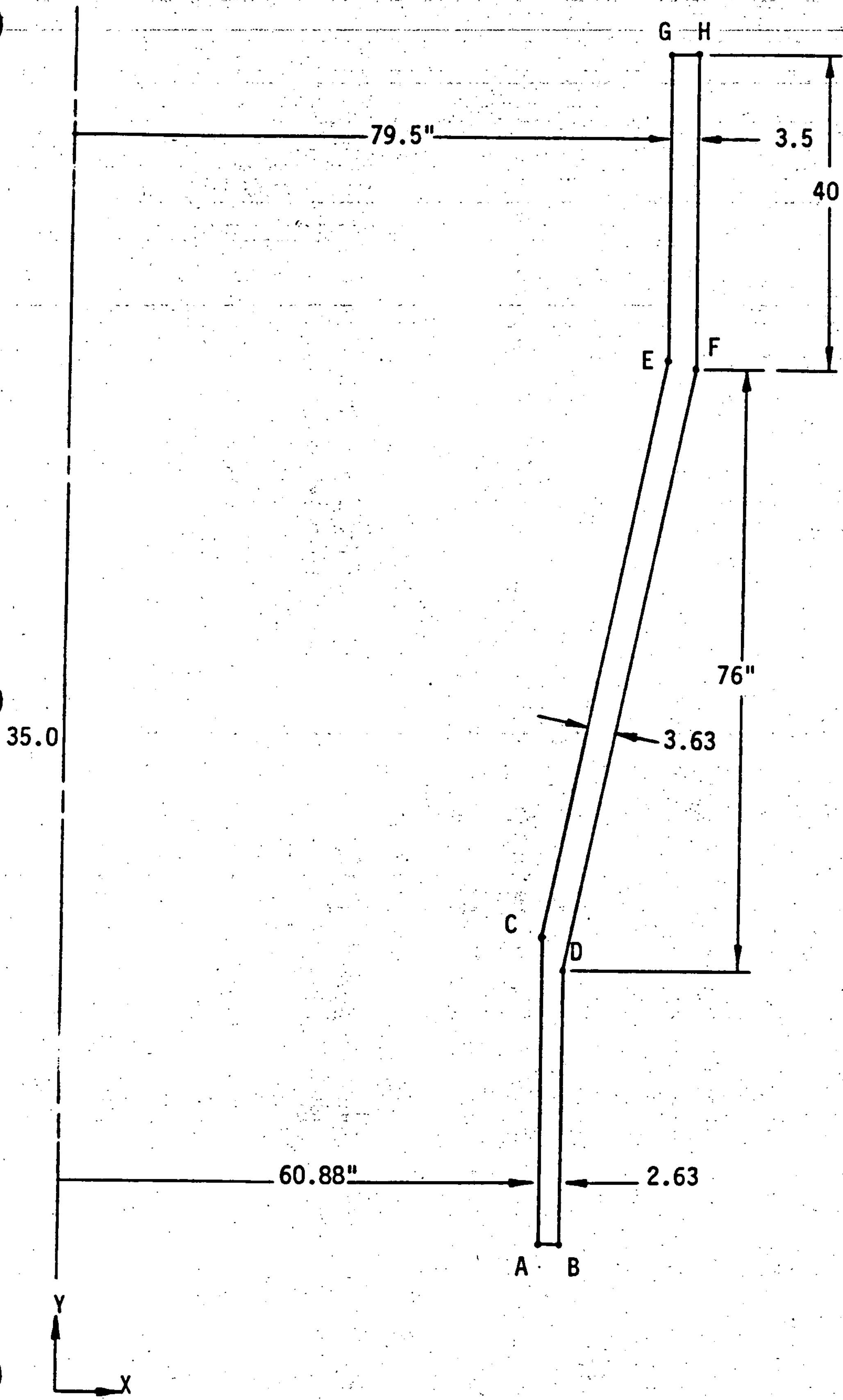
In addition to satisfying the fracture criteria, it is required that the primary stress limits of Section III, paragraph NB 3000 be satisfied. A local area reduction of the pressure retaining membrane must be used, equal to the area of the indication, and the stresses increased to reflect the smaller cross section. All the flaw acceptance tables provided in this handbook have included this consideration, as demonstrated herein. The allowable flaw depth determined using this criterion is 1.462 in. for the upper shell to cone weld region.

1.2 GEOMETRY

The geometry of the upper shell to cone weld region of the Indian Point Unit 3 steam generators is shown in Figure 1-1. The dimensions shown are the minimum values from the design drawings. The outside surfaces have been assumed to be insulated. The notation used for both surface and embedded flaws in this work is illustrated in Figure 1-2.

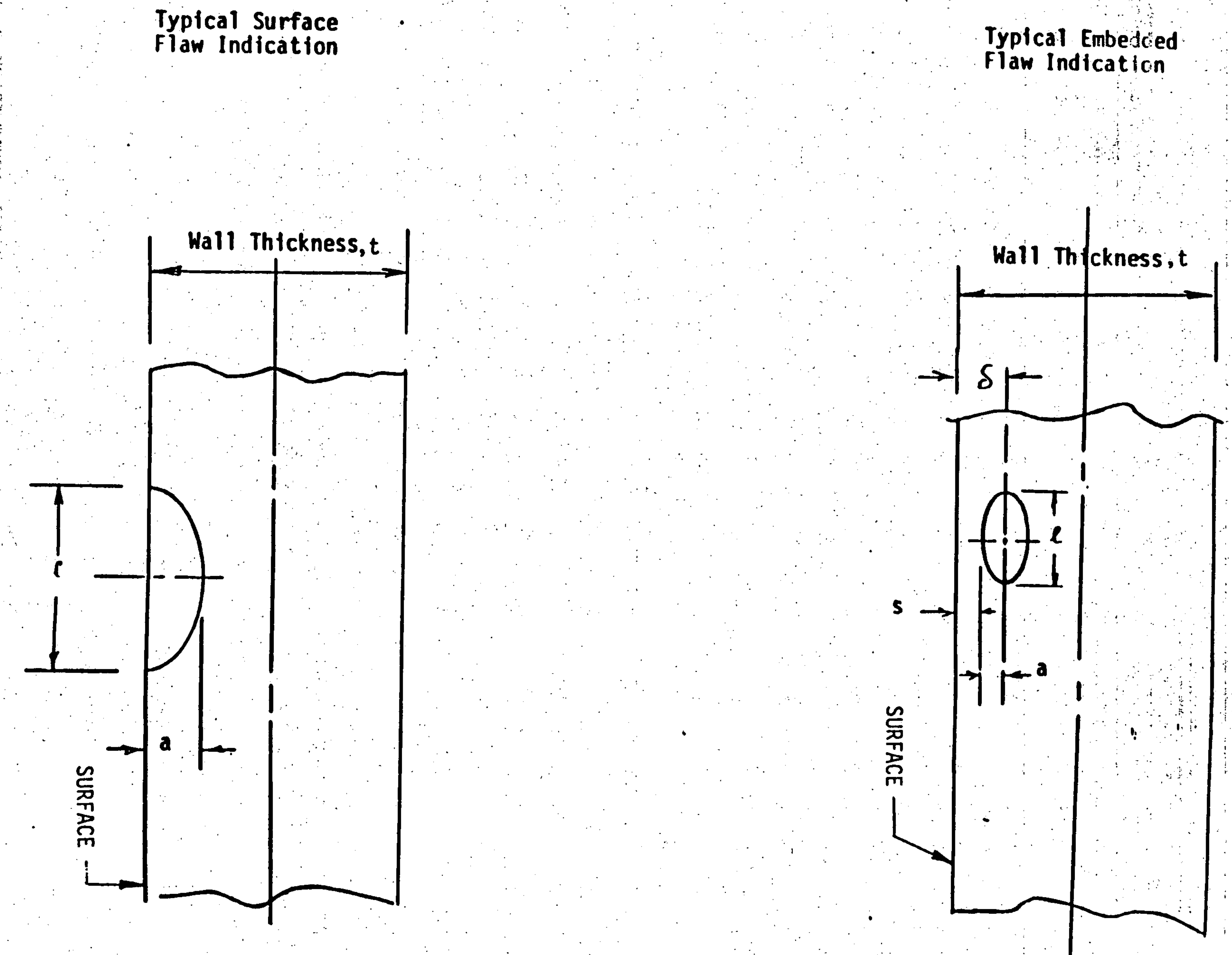
FIGURE 1-1

GEOMETRY OF UPPER SHELL TO CONE INTERSECTION FOR INDIAN POINT UNIT 3



	X	Y
A	60.88	0
B	63.51	0
C	60.88	39.358
D	63.51	35.0
E	79.5	111.965
F	83.0	111.0
G	79.5	151.0
H	83.0	151.0

FIGURE 1-2 Typical Notations of Surface and Embedded Flaw Indications



SECTION 2

LOAD CONDITIONS, FRACTURE ANALYSIS METHODS AND MATERIAL PROPERTIES

2.1 TRANSIENTS FOR THE STEAM GENERATOR

The design transients for the Indian Point Unit 3 steam generators are listed in Table 2-1. Both the minimum critical flaw sizes, such as a_c under normal operating conditions, or a_i under faulted conditions for criteria (1) of IWB-3611, and the stress intensity factors, K_I, for criteria (2) of IWB-3612, are a function of the stresses at the cross-section where the flaw of interest is located, along with the material properties. Therefore, the first step for the evaluation of a flaw indication is to determine the appropriate limiting load conditions for the location of interest.

The key parameters used in the evaluation of any indications discovered during inservice inspection are the critical depths, first, that for the governing normal, upset, and test conditions and second, that for the governing emergency and faulted conditions.

For the region of interest, the upper shell to cone weld, the full range of design transients was considered. Transients such as pressure tests, including both hydro and leak tests, can be controlled by setting the test temperature. Therefore, in determining the governing normal condition (level A and B) only the operational transients were considered, and a separate determination was made as to any required changes in the pressure test temperatures, to ensure that they would not be limiting. A discussion of this subject is provided in Appendix A. On this basis, the governing normal conditon (level A and B) is the loss of power event, while the governing emergency and faulted condition (level C and D) is the steamline break.

2.2 STRESS INTENSITY FACTOR CALCULATIONS

One of the key elements of the critical flaw size calculations is the determination of the driving force or stress intensity factor (K_I). This was done using expressions available from the literature. In all cases the stress intensity factor for the critical flaw size calculations utilized a representation of the actual stress profile rather than a linearization. This was necessary to provide the most accurate determination possible of the critical flaw size, and is particularly important for consideration of emergency and faulted conditions, where the stress profile is generally nonlinear and often very steep. The stress profile was represented by a cubic polynomial:

$$\sigma(x) = A_0 + A_1 \frac{x}{t} + A_2 \left(\frac{x}{t}\right)^2 + A_3 \left(\frac{x}{t}\right)^3$$

where x is the coordinate distance into the wall

t = wall thickness

σ = stress perpendicular to the plane of the crack

For the surface flaw with length six times its depth, the stress intensity factor expression of McGowan and Raymund [2] was used.

The stress intensity factor $K_I(\phi)$ can be calculated anywhere along the crack front. The point of maximum crack depth is represented by $\phi = 0$. The following expression is used for calculating $K_I(\phi)$:

$$K_I(\phi) = \frac{\sqrt{\pi a}}{Q} \left(\cos^2\phi + \frac{a^2}{c^2} \sin^2\phi\right)^{1/4} \left(A_0 H_0 + \frac{2}{\pi} \frac{a}{t} A_1 H_1 + \frac{1}{2} \frac{a^2}{t^2} A_2 H_2 + \frac{4}{3\pi} \frac{a^3}{t^3} A_3 H_3\right)$$

The magnification factors $H_0(\phi)$, $H_1(\phi)$, $H_2(\phi)$ and $H_3(\phi)$ are obtained by the procedure outlined in Reference [2].

The stress intensity factor calculation for a semi-circular surface flaw, (aspect ratio 2:1) was carried out using the expressions developed by Raju and Newman [3]. Their expression utilizes the same cubic representation of the stress profile and gives precisely the same result as the expression of McGowan and Raymund for the 6:1 aspect ratio flaw, and the form of the equation is similar to that of McGowan and Raymund above.

The stress intensity factor expression used for a continuous surface flaw was that developed by Buchalet and Bamford [4]. Again the stress profile is represented as a cubic polynomial, as shown above, and these coefficients as well as the magnification factors are combined in the expression for K_I below:

$$K_I = \sqrt{\pi a}\ [A_0 F_1 + \frac{2a}{\pi} A_1 F_2 + \frac{a^2}{2} A_2 F_3 + \frac{4}{3\pi} a^3 A_3 F_4]$$

where F_1, F_2, F_3, F_4 are magnification factors, available in [4].

The stress intensity factor calculation for an embedded flaw was taken from work by Shah and Kobayashi [5] which is applicable to an embedded flaw in an infinite medium, subjected to an arbitrary stress profile. This expression has been shown to be applicable to embedded flaws in a thick-walled pressure vessel in a recent paper by Lee and Bamford [6].

2.3 FRACTURE TOUGHNESS

The other key element in the determination of critical flaw sizes is the fracture toughness of the material. The fracture toughness has been taken directly from the reference curves of Appendix A, Section XI. In the transition temperature region, these curves can be represented by the following equations:

$$K_{Ic} = 33.2 + 2.806 \exp. [0.02 (T-RT_{NDT} + 100°F)]$$

$$K_{Ia} = 26.8 + 1.233 \exp. [0.0145 (T-RT_{NDT} + 160°F)]$$

where K_{IC} and K_{Ia} are in ksi$\sqrt{\text{in}}$.

The upper shelf temperature regime requires utilization of a shelf toughness which is not specified in the ASME Code. A value of 200 ksi$\sqrt{\text{in}}$ has been used here. This value is consistent with general practice in such evaluations, as shown for example in reference [7], which provides the background and technical basis of Appendix A of Section XI.

The other key element in the determination of the fracture toughness is the value of RT_{NDT}, which is a parameter determined from Charpy V-notch and drop-weight tests.

To allow determination of RT_{NDT} for the upper shell and cone materials, a compilation was made of the properties listed on the original material test certificates. The materials used in the steam generators were tested after a post-weld heat treatment cycle of 1100-1150°F for 20 hours. The Charpy impact properties of these materials are listed in Table 2-2.

The upper shell to cone weld which now exists in the steam generators of Indian Point Unit 3 is a composite of two welds. The innermost portion of the weld was deposited in the repair completed in 1983, while the outer portion of the weld is the original weld metal. The properties of both these materials are provided in Table 2-2 as well.

The U.S. Nuclear Regulatory Commission has established guidelines for estimating the value of RT_{NDT} from Charpy properties in their Standard Review Plan [8]. Review of Table 2-2 shows that in general the materials in the shell and cone region have excellent Charpy properties, and therefore the value of RT_{NDT} is equal to the test temperature, which is 10°F for all the materials except the repair weld, where RT_{NDT} = -20°F. The only exception is the upper shell material for steam generator 34, where the average Charpy energy is 36 ft lbs for heat C3073-2, and the procedure mandates a conservative estimate of RT_{NDT} = 30°F. In some cases this difference in RT_{NDT} has resulted in separate flaw evaluation charts.

Once the value of RT_{NDT} is established, the reference toughness curves of the ASME Code discussed above may be used directly, since the materials are A302B and A302B (Nickel modified) which have minimum specified yield strength lower than 50 ksi.

2.4 CRITICAL FLAW SIZE DETERMINATION

The applied stress intensity factor (K_I) and the material fracture toughness values (K_{Ia} and K_{Ic}) were used to determine the allowable flaw size values used to construct the handbook charts. For normal, upset and test conditions, the critical flaw size a_c is determined as the depth at which the applied stress intensity factor K_I exceeds the arrest fracture toughness K_{Ia}.

For emergency and faulted conditions the minimum flaw size for crack initiation is obtained from the first intersection of the applied stress intensity factor (K_I) curve with the static fracture toughness (K_{Ic}) curve.

TABLE 2-1

TRANSIENT SUMMARY FOR INDIAN POINT UNIT 3 STEAM GENERATORS

Envelope Transient	Initial Condition	Enveloped Transients	Cycles
1. No Load	Zero Stress	Heatup/Cooldown	200
		Loss of Secondary Pressure	6
2. Hot Standby	No Load	Hot Standby Oper.	25000
3. Full Load	No Load	Plant Loading/ Unloading	14500
		10% Step Load In/Dec.	2000
4. Loss of Load	Full Load	Loss of Load	80
		Reactor Trip	400
		50% Step Load Dec.	200
		Loss of Flow	80
5. Loss of Power	Full Load	Loss of Power	10
6. Steady State Fluct.*	Full Load	Steady State Fluct.	1×10^6
7. Secondary Side*** Pressure Test	Zero Stress	Secondary Side Pressure Test	50
		Primary Side Pressure Test	50
		Secondary Leak Test	5

*Stresses variation about Full Load obtained by scaling Full Load Stresses by 50/755.

***Stresses obtained by scaling Full Load stresses by 1085/755.

TABLE 2-2 INDIAN POINT UNIT 3 S/G CL W[illegible] [illegible]TERIALS & PWHT DATA

S/G Unit	Upper Shell Heat No's	Impact Data +10°F @20 Hrs 1125°F	Tensile Data	Material Type	Cone Material Heat No's	Impact Data	Tensile Data	FAB * Location	FAB PWHT(Hrs)	Closure PWHT(Hrs)	Repair PWHT(Hrs)	Total Hours	Hours Remaining
	MECHANICAL TEST DATA							**PWHT (EFFECTIVE)**					
31	C 4218-4	55,55,55	65/92.9 90.0	A302B	B7121-1	87,118,123	68.6/93.5 92.2	FW Upper	8 Hrs 30 Min	2.5	6 Hrs 20 Min	17 Hrs 20 Min	7 Hrs 40 Min
	A 2388-1	84,72,69	71.4/100.0 95.0	A302B Mod.	-2	135,113,122	70.0/89.4 94.5	SUN Lower	12 Hrs 30 Min	2.5	6 Hrs 20 Min	21 Hrs 20 Min	3 Hrs 40 Min
					-3	103,101,87	71.4/95.0 92.6	WELD W TAMPA		2.5	6 Hrs 20 Min	~ 9 Hrs	31 Hrs
32	C2888-1	86,82,76	63.4/93.6 97.0	A302B Mod.	C3139-3	111,112,116	64.5/93.0 87.2	FW	8 Hrs 30 Min	2.5	7 Hrs 30 Min	18 Hrs 30 Min	6 Hrs 30 Min
	C3267-1	77,79,62	72.0/94.6 96.0	A302B	-5	113,133,110	68.3/91.7 88.9	SUN WELD W TAMPA	13 Hrs	2.5	7 Hrs 30 Min	23 Hrs 10 Hrs	2 Hrs 30 Hrs
33	A1930-4	65,67,82	70.5/94.6 93.5	A302B	C3139-1	139,106,101	67.7/91.5 91.5	FW	8 Hrs 30 Min	2.5	4 Hrs	15 Hrs	10 Hrs
	A2443-4	80,97,127	69.5/95.0 93.1	A302B	B7121-1	87,118,123	68.6/93.5 92.2	SUN WELD W TAMPA	21 Hrs 30 Min	2.5	4 Hrs	28 Hrs 6.5 Hrs	(-3 Hrs) 33 Hrs
34	A3158-1	79,97,99	69.5/95.2 92.1	A302B Mod.	C2966-1	105,101,110	66.5/87.5 87.7	FW Upper	8 Hrs 30 Min	2.5	8 Hrs	19 Hrs	6 Hrs
	C3073-2	35,41,32	58.2/93.0 97.5	A302B Mod.	-5	89,98,82	60.7/89.0 83.6	LUKENS WELD W TAMPA	16 Hrs 10 Min	2.5	8 Hrs	26 Hrs 40 Min 10 Hrs 30 Min	(-1 Hr 40 Min) 29 Hrs 30 Min

WELD METAL TEST DATA

	Heat	Impacts +10°F 48 Hrs PWHT	Tensile Yield x 1000	Ultimate x 1000	Test No.
Fabrication Wire/Flux Combination	308524/ L3958	78, 89, 92	64.9/67.5	80/80.2	To 1374 Wire To 1262 Flux
WTAMPA	3998/L3958	78, 63, 41 44, 65, 67	68.7/70.6	84.9/86.4	To 1375 Wire To 1262 Flux
Repair Weld Metal NYPA	32681	118, 122, 98	66.6	82.0	

* FW - Foster Wheeler - All Upper Assemblies
SUN - Sun Ship - Transition Cone - Units 31, 32 & 33
LUKENS - Lukens Steel - Transition Cone Unit 34

SECTION 3
FATIGUE CRACK GROWTH

In applying code acceptance criteria as introduced in Section 3, the final flaw size a_f used in criteria (1) is defined as the minimum flaw size to which the detected flaw is calculated to grow at the end of the design life, or until the next inspection time. In this handbook, ten-, twenty-, and thirty-year inspection periods are assumed.

These crack growth calculations have been carried out for the upper shell to cone weld of the Indian Point Unit 3 steam generators for which evaluation charts have been constructed. This section will examine the calculations, and provide the methodology used as well as the assumptions.

The crack growth calculations reported here are rather extensive, because a range of flaw shapes have been considered, to encompass the range of flaw shapes which could be encountered in service.

3.1 ANALYSIS METHODOLOGY

The fatigue crack growth analysis procedure involves postulating an initial flaw at a specific region and predicting the growth of that flaw due to an imposed series of loading transients. The input required for a fatigue crack growth analysis is basically the information necessary to calculate the parameter ΔK_I which depends on crack and structure geometry and the range of applied stresses in the area where the crack exists. Once ΔK_I is calculated, the growth due to that particular stress cycle can be calculated by equations given in Section 3.3 and Figure 3-1. This increment of growth is then added to the original crack size, and the analysis proceeds to the next transient. The procedure is continued in this manner until all the transients known to occur in the period of evaluation have been analyzed.

The transients considered in the analysis are all the design transients contained in the steam generator equipment specification, as shown in Section 2, Table 2-1. These transients are spread equally over the design lifetime of the steam generator, with the exception that the preoperational tests are considered first. Faulted conditions are not considered because their frequency of occurrence is too low to affect fatigue crack growth.

Crack growth calculations were carried out for a range of flaw depths, and three basic types. The first type was a surface flaw with length equal to six times its depth, and whose analysis was previously reported. The second was a continuous surface flaw, which represents a worst case for surface flaws, and the third was an embedded flaw, with length equal to three times its width. For all cases the flaw was assumed to maintain a constant shape as it grew.

3.2 STRESS INTENSITY FACTOR EXPRESSIONS

Stress intensity factors were calculated from methods available in the literature for each of the flaw types analyzed. The surface flaw with aspect ratio 6:1 was analyzed using an expression developed by McGowan and Raymund [2] where the stress intensity factor K_I is calculated from the actual stress profile through the wall at the location of interest.

The maximum and minimum stress profiles corresponding to each transient are represented by a third order polynomial, such that:

$$\sigma (X) = A_0 + A_1 \frac{x}{t} + A_2 \frac{x^2}{t^2} + A_3 \frac{x^3}{t^3}$$

The stress intensity factor $K_I (\phi)$ can be calculated anywhere along the crack front. The point of maximum crack depth is represented by $\phi = 0$. The following expression is used for calculating $K_I (\phi)$.

$$K_I(\phi) = \frac{\sqrt{\pi a}}{Q} \left(\cos^2\phi + \frac{a^2}{c^2} \sin^2\phi\right)^{1/4} \Big(A_0 H_0 + \frac{2}{\pi} \frac{a}{t} A_1 H_1$$

$$+ \frac{1}{2} \frac{a^2}{t^2} A_2 H_2 + \frac{4}{3\pi} \frac{a^3}{t^3} A_3 H_3\Big)$$

The magnification factors $H_0(\phi)$, $H_1(\phi)$, $H_2(\phi)$ and $H_3(\phi)$ are obtained by the procedure outlined in reference [2].

The stress intensity factor for a continuous surface flaw was calculated using an expression for an edge cracked plate [9]. The stress distribution is linearized through the wall thickness to determine membrane and bending stress and the applied K is calculated from:

$$K_I = \sigma_m Y_m \sqrt{a} + \sigma_B Y_B \sqrt{a}$$

The magnification factors Y_m and Y_B are taken from [9] and a is the crack depth.

For an embedded flaw, the stress intensity factor expression provided in Appendix A of Section XI was used directly, which again requires linearizing the stresses. The flaw shape was set with length equal to three times the width, and the eccentricity was set at 2.5, which corresponds to a flaw near the inside surface of the vessel, although still embedded. This flaw will provide a worst case calculation of stress intensity factor for embedded flaws. Since the calculated crack growth was very small for this case, no further consideration of other flaw shapes or locations was deemed necessary for an embedded flaw.

3.3 CRACK GROWTH RATE REFERENCE CURVES

The crack growth rate curves used in the analyses were taken directly from Appendix A of Section XI of the ASME Code. Water environment curves were used for all inside surface flaws, and the air environment curve was used for embedded flaws and outside surface flaws.

For water environments the reference crack growth curves are shown in Fig. 3-1, and growth rate is a function of both the applied stress intensity factor range, and the R ratio (K_{min}/K_{max}) for the transient.

For R<0.25

$$(\Delta K_I < 19 \text{ ksi}\sqrt{\text{in}}) \quad \frac{da}{dN} = (1.02 \times 10^{-6}) \, \Delta K_I^{5.95}$$

$$(\Delta K_I > 19 \text{ ksi}\sqrt{\text{in}}) \quad \frac{da}{dN} = (1.01 \times 10^{-3}) \, \Delta K_I^{1.95}$$

where $\frac{da}{dN}$ = Crack Growth rate, micro-inches/cycle.

For R>0.65

$$(\Delta K_I < 12 \text{ ksi}\sqrt{\text{in}}) \quad \frac{da}{dN} = (1.20 \times 10^{-5}) \, \Delta K_I^{5.95}$$

$$(\Delta K_I > 12 \text{ ksi}\sqrt{\text{in}}) \quad \frac{da}{dN} = (2.52 \times 10^{-1}) \, \Delta K_I^{1.95}$$

For R ratio between these two extremes, interpolation is recommended.

The crack growth rate reference curve for air environments is a single curve, with growth rate being only a function of applied ΔK. This reference curve is also shown in Figure 3-1.

$$\frac{da}{dN} = (0.0267 \times 10^{-3}) \, \Delta K_I^{3.726}$$

where, $\frac{da}{dN}$ = Crack growth rate, micro-inches/cycle

ΔK_I = stress intensity factor range, ksi$\sqrt{\text{in}}$

$= (K_{Imax} - K_{Imin})$

3.4 FATIGUE CRACK GROWTH RESULTS

The fatigue crack growth results upon which handbook charts were developed are summarized in Table 3-1, and shown graphically in Figure 3-2.

Fatigue Crack [illegible] for [illegible] Surface Flaws ($a/\ell = 0.0$)

INITIAL CRACK LENGTH	CRACK LENGTH AFTER YEAR 10	20	30	40
.100	.108	.112	.116	.121
.150	.164	.172	.181	.191
.200	.221	.237	.254	.275
.250	.282	.308	.339	.379
.300	.344	.386	.439	.513
.350	.410	.473	.561	.702
.400	.479	.571	.718	.940
.500	.631	.813	1.078	1.558

Fatigue Crack Growth for Surface Flaws ($a/\ell = 0.1667$)

INITIAL CRACK LENGTH	CRACK LENGTH AFTER YEAR 10	20	30	40
.100	.106	.108	.110	.113
.150	.158	.162	.165	.170
.200	.211	.217	.223	.229
.250	.265	.273	.282	.292
.300	.319	.331	.343	.356
.350	.373	.389	.405	.423
.400	.428	.447	.468	.491
.500	.538	.567	.598	.633

Fatigue Crack Growth for Embedded Flaws ($a/\ell = 0.1667$)

INITIAL CRACK LENGTH	CRACK LENGTH AFTER YEAR 10	20	30	40
.050	.050	.050	.050	.050
.100	.100	.100	.100	.100
.150	.150	.151	.151	.151
.200	.201	.201	.201	.202
.250	.251	.252	.252	.253
.300	.302	.302	.303	.304
.350	.352	.353	.355	.356
.500	.505	.508	.511	.514

Table 3-1 Fatigue Crack Growth Results - Indian Point Unit 3 Steam Generator Upper Shell to Cone Weld Region

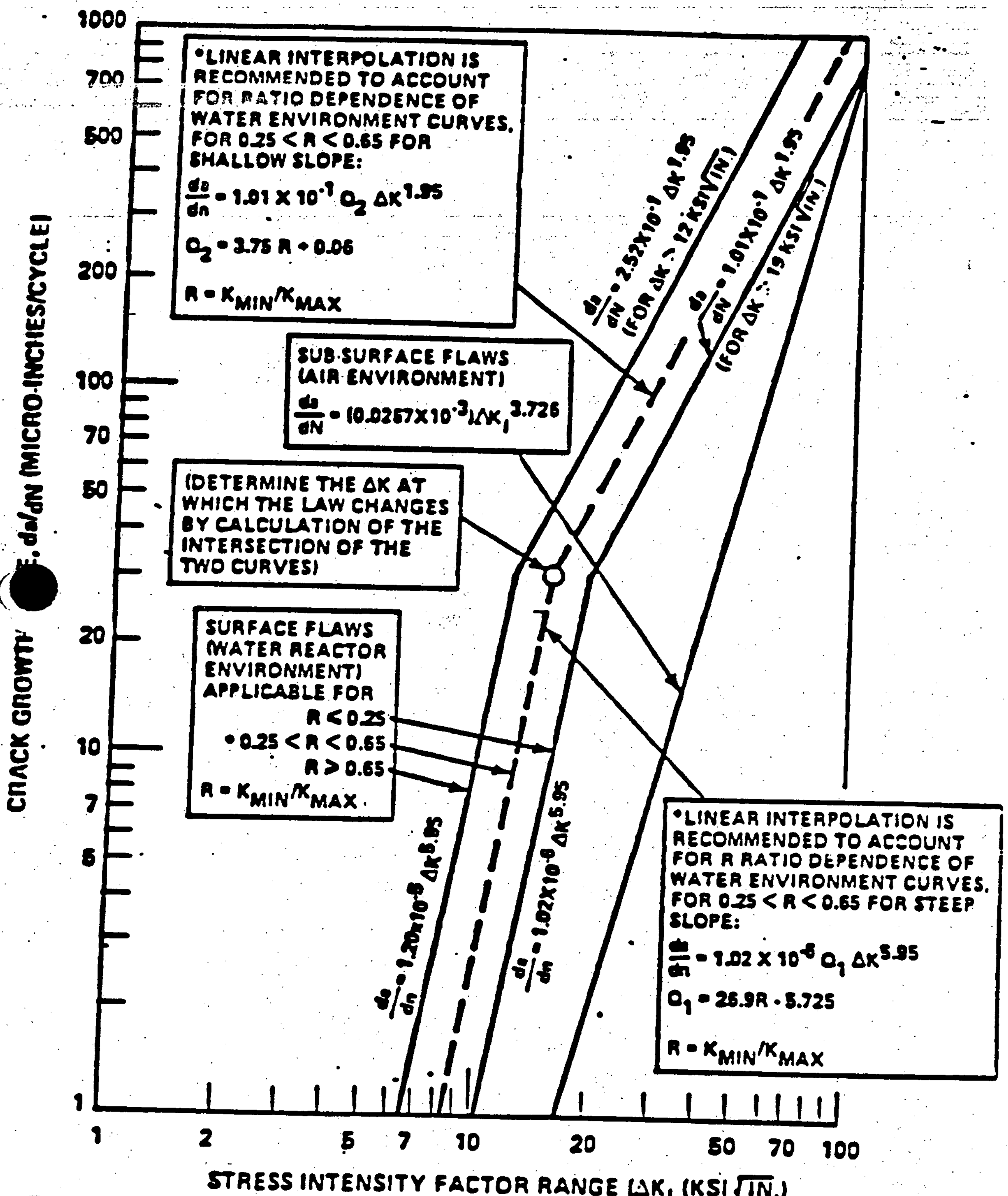


FIG. 3-1 REFERENCE FATIGUE CRACK GROWTH CURVES FOR CARBON AND LOW ALLOY FERRITIC STEELS

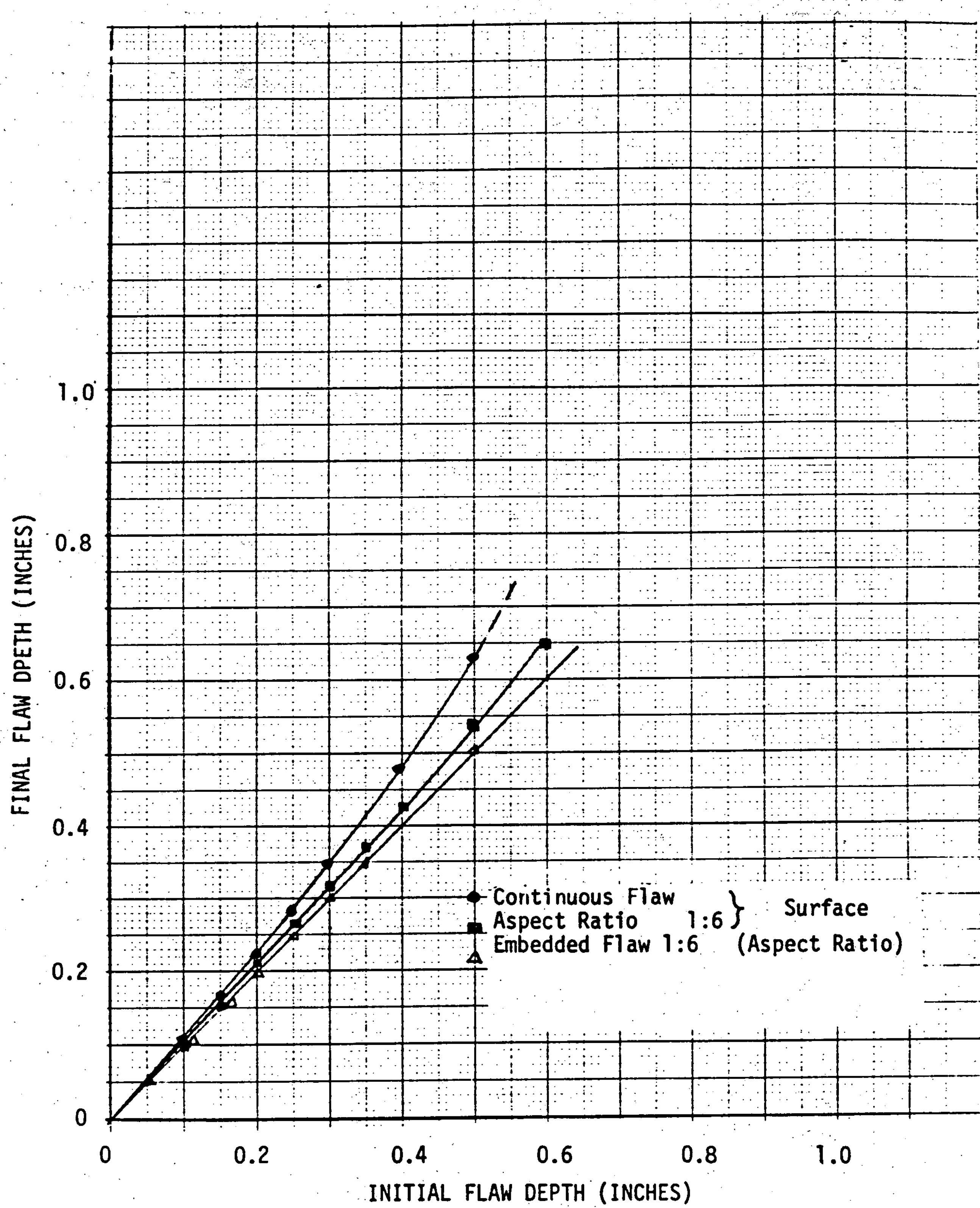


FIGURE 3-2 FATIGUE CRACK GROWTH RESULTS - UPPER SHELL CONE WELD SECTION CIRCUMFERENTIAL FLAWS FOR 10 YEAR PERIOD

SECTION 4

SURFACE FLAW EVALUATION

4.1 SCOPE OF EVALUATION

The surface flaw evaluation covers the upper shell to cone weld region. This section describes the development of the inside surface flaw charts for that region.

4.2 CODE CRITERIA

The acceptance criteria for flaws have been readily presented in Section 1. For convenience they are repeated as follows:

$a_f \leq .1\ a_c$ For normal conditions (upset & test conditions inclusive)

and

$a_f \leq .5\ a_i$ For faulted conditions (emergency condition inclusive)

where

a_f – The maximum size to which the detected flaw is calculated to grow at the end of the design life, or the period till the next inspection. 10, 20, and 30 year periods have been considered in this handbook.

a_c = The minimum critical flaw size under normal operating conditions (upset and test conditions inclusive)

a_i = The minimum critical flaw size for initiation of nonarresting growth under postulated faulted conditions. (emergency conditions inclusive)

Alternatively, criteria based on applied stress intensity factors may be used:

$$K_I \leq \frac{K_{Ia}}{\sqrt{10}}$$ For normal conditions (upset & test conditions inclusive)

$$K_I \leq \frac{K_{Ic}}{\sqrt{2}}$$ For faulted conditions (emergency conditions inclusive)

where

K_I = The maximum applied stress intensity factor for the flaw size a_f to which a detected flaw will grow, during the conditions under consideration.

K_{Ia} = Fracture toughness based on crack arrest for the corresponding crack tip temperature.

K_{Ic} = Fracture toughness based on fracture initiation for the corresponding crack tip temperature.

The larger flaw size determined by these two criteria is used to develop the flaw charts.

4.3 BASIC DATA

In view of the criteria, it is noticed that three groups of basic data are required for the construction of charts for surface flaw evaluation. Namely, a_f, driving force (K_I), and fracture toughness (K_{Ia} and K_{Ic}).

The preparation of these three groups of basic data will be discussed in the following paragraphs. They are the key elements of the allowable flaw size and fatigue crack growth calculations upon which the evaluation charts are based. A schematic diagram of the evaluation procedure is shown in Figure 4-1. K_{Ic} and K_{Ia} are the initiation and arrest fracture toughnesses (respectively) of the vessel material at which the flaw is located. They can be calculated by formulas:

$$K_{Ic} = 33.2 + 2.806 \exp. [.02(T-RT_{NDT} + 100°F)] \quad (1)$$

and

$$K_{Ia} = 26.8 + 1.233 \exp. [.0145(T-RT_{NDT} + 160°F)] \quad (2)$$

Notice that both K_{Ic} and K_{Ia} are a function of crack tip temperature T, the material property of RT_{NDT} at the tip of the flaw as discussed earlier, in Section 2.3. The upper shelf fracture toughness of the steam generator steel is assumed to be 200 ksi$\sqrt{in}$.

The driving force, K_I, used in the determination of the flaw evaluation charts is the maximum stress intensity factor of the surface flaw under evaluation. The methods used for determining the stress intensity factors for surface flaws have been discussed in Section 2. It is important to note that the flaw size used for the calculation of K_I is not the flaw size detected by inservice inspection. Instead, it is the calculated flaw size which will be grown from the flaw size detected by inservice inspection. That means that the surface flaw size used for the calculation of K_I had to be determined by using fatigue crack growth results. This is equivalent to working backward in the chart of Figure 4-1 to determine the largest allowable flaw size.

As defined in IWB-3611 of Code Section XI, a_f is the maximum size resulting from growth during a specific time period, which can be the next scheduled inspection of the component, or until the end of steam generator design lifetime. Therefore, the final depth, a_f after a specific service period of time must be used as the basis for evaluation. The charts have been constructed to allow the initial (measured) indication size to be used directly. Charts have been constructed for operational periods of 10, 20, and 30 years from the time of detection.

The final flaw size a_f has been calculated by fatigue crack growth analysis, which has been performed covering the range of postulated flaw sizes, and flaw shapes at various locations of the steam generator needed for the construction of surface flaw evaluation charts in this handbook. All crack growth results have been summarized in Table 3-1, and plotted in Figure 3-2.

Notice that all the finite surface flaws and embedded flaws analyzed are semi-elliptical in shape. Crack growth analyses for finite surface flaws with aspect ratio (length to depth) less than 6:1 have utilized the results of 6:1, and for any flaw with aspect ratio larger than 6:1, the results of the continuous flaw are used. This is conservative in both cases. It is noted that only the crack growth analysis for circumferential flaws was performed.

4.4 TYPICAL SURFACE FLAW EVALUATION CHART

The two basic dimensionless parameters, which can fully address the characteristics of a surface flaw are used for the evaluation chart construction. Namely,

- o Flaw Shape Parameter a/ℓ
- o Flaw Depth Parameter a/t

where,

t - wall thickness, in.
a - flaw depth, in.
ℓ - flaw length, in.

Now, consider the chart for the governing transient. Section 2.1 indicated that the most limiting normal condition expected to occur during the remaining plant life is the loss of power. In addition, the governing faulted condition is the large steam line break (LSB). The fracture and fatigue analyses showed that the loss of power is the most governing of these transients. Figure 4-2 shows the results for the loss of power transient, and it is constructed as follows:

- o The flaw shape parameter a/ℓ was plotted as the abscissa from 0 (continuous flaw) to .5 (semi-circular flaw)

- o The flaw depth parameter a/t in % was plotted as the ordinate.

- The lower curve was the code acceptable flaw depth tabulated in Table IWB-3511-1 of Code Section XI. This curve indicates the acceptance standards of the 1983 Winter Addendum of the ASME Code, below which analytical evaluation is not required.

- The upper boundary curves show the maximum acceptable flaw depth by code criteria beyond which no surface flaw is acceptable for continued service without repair. These upper bound curves have been determined by the fracture and fatigue evaluations described herein, and they are applicable for 10 years, 20 years, or 30 years as indicated.

- Any surface indication which falls between the two sets of boundary curves will be acceptable by the code, with the analytical justification provided herein. However, IWB-2420 of ASME Section XI requires future monitoring of such indications.

The inside surface flaw evaluation charts constructed for the upper shell to cone weld region of the Indian Point Unit 3 steam generators are presented in Figure 4-2, and repeated in Section 6, where instructions are given for their use. These surface flaw evaluation charts are based on an RT_{NDT} of 30°F which exists in the upper shell material for steam generator 34. They are also conservatively applicable to the steam generators with an RT_{NDT} of 10°F.

4.5 PROCEDURE FOR THE CONSTRUCTION OF A SURFACE FLAW EVALUATION CHART

This section describes how the inside surface flaw evaluation charts were constructed for the upper shell to cone weld region.

<u>Step 1</u>

Determine the critical flaw sizes from Table 4-1 as follows:

Load Condition	Flaw Orientation	Critical Flaw Sizes Continuous	AR=6.0	AR=2.0
N/U/T*	Circumferential	$a_c = 3.50$	$a_c = 3.50$	$a_c = 3.50$
E/F*	Circumferential	$a_i = 3.50$	$a_i = 3.50$	$a_i = 3.50$

*N/U/T normal, upset, and test conditions
E/F emergency and faulted conditions

Step 2

Determine the maximum code acceptable flaw depth (a_c or a_i). We have:

Load condition	Flaw Orientation	Code Criteria	Critical Flaw Sizes Continuous	AR=6.0	AR=2.0
N/U/T *	Circumferential	$.1\ a_c$	0.35	0.35	0.35
E/F *	Circumferential	$.5\ a_i$	1.750	1.750	1.750
Therefore the allowable flaw depth (in.) is:			0.35	0.35	0.35

Step 3

Determine the corresponding initial flaw sizes which will grow to the above critical flaw sizes after 10, 20, and 30 years of service.

We define the above limiting critical flaw depth as a_f. The initial flaw size a_o can be found from the fatigue crack growth results of Table 3-1 and have been plotted in Figure 3-2.

---

* N/U/T normal, upset, and test conditions
E/F emergency and faulted conditions

The values of a_o which are applicable to 10 years of service are listed as follows:

	Continuous Flaw	AR=6	AR=2
a_f	0.35	0.35	0.35
a_o	0.3043	0.3286	0.3286 (Conservative)

This shows that the effect of fatigue crack growth in this region is very small. (Such is not always the case, however.)

Step 4

Determine a/ℓ vs. a/t% in the upper shell to cone weld region where t = 3.5", and $a = a_o$. For 10 years of service, the values are:

	Continuous Flaws	Finite Surface Flaws AR=6	Finite Surface Flaws AR=2
a/ℓ	0	.167	.5
a/t	$\frac{0.3043}{3.5} = 8.69$	$\frac{.3286}{3.5} = 9.39$	$\frac{0.3286}{3.50} = 9.39\%$

Step 5

The upper bound curves result from the plots of a/ℓ vs. a/t% for 10, 20, 30 years of service as shown by Figure 4-2.

Step 6

Plot a/ℓ vs. a/t% data from Table IWB-3511-1 of Section XI as the lower curve of Fig. 4-2.

The values of Table IWB-3511-1 for the 1983 Winter Addendum of the ASME Code are:

Aspect Ratio, a/ℓ	Surface Indication, a/t, %
0.00	2.0
0.05	2.1
0.10	2.3
0.15	2.6
0.20	2.9
0.25	3.2
0.30	3.7
0.35	3.7
0.40	3.7
0.45	3.7
0.50	3.7

The above six steps would complete the procedure for the construction of the surface flaw evaluation charts for 10 years, 20 years, or 30 years of operating life.

In the interest of prudence, Figure 4-2 only shows the allowable flaw depths for these inside surface flaws up to 20 percent of the section thickness.

TABLE 4-1

BASIC DATA FOR SURFACE FLAW EVALUATION AT UPPER SHELL TO CONE WELD SECTION

CONDITION	FLAW ORIENTATION	MINIMUM CRITICAL FLAW SIZE					
		CONTINUOUS FLAW		ASPECT RATIO = 6:1		ASPECT RATIO = 2:1	
		INCHES	$(\frac{a}{t})$	INCHES	$(\frac{a}{t})$	INCHES	$(\frac{a}{t})$
N/U/T *	CIRCUM.	a_c = 3.5	1.0	a_c = 3.5	1.0	a_c = 3.5	1.0
E/F **	CIRCUM.	a_i = 3.5	1.0	a_i = 3.5	1.0	a_i = 3.5	1.0

LEGEND:

a_c Minimum critical flaw size under normal conditions

a_i Minimum critical flaw size under faulted conditions

*Loss of Power

**Large Steamline Break with Loss of Power

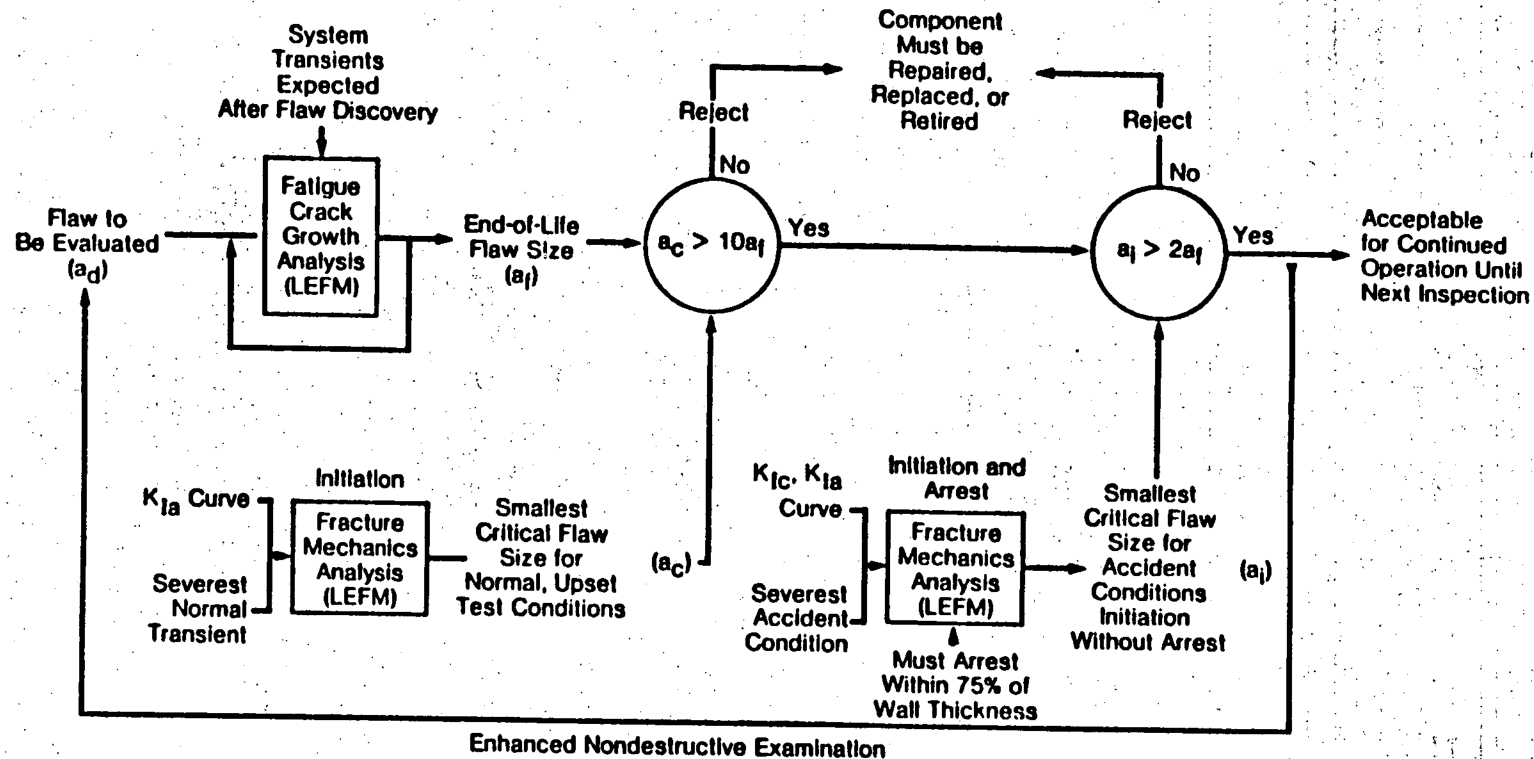


Figure 4-1 Schematic representation of Appendix A flaw evaluation process

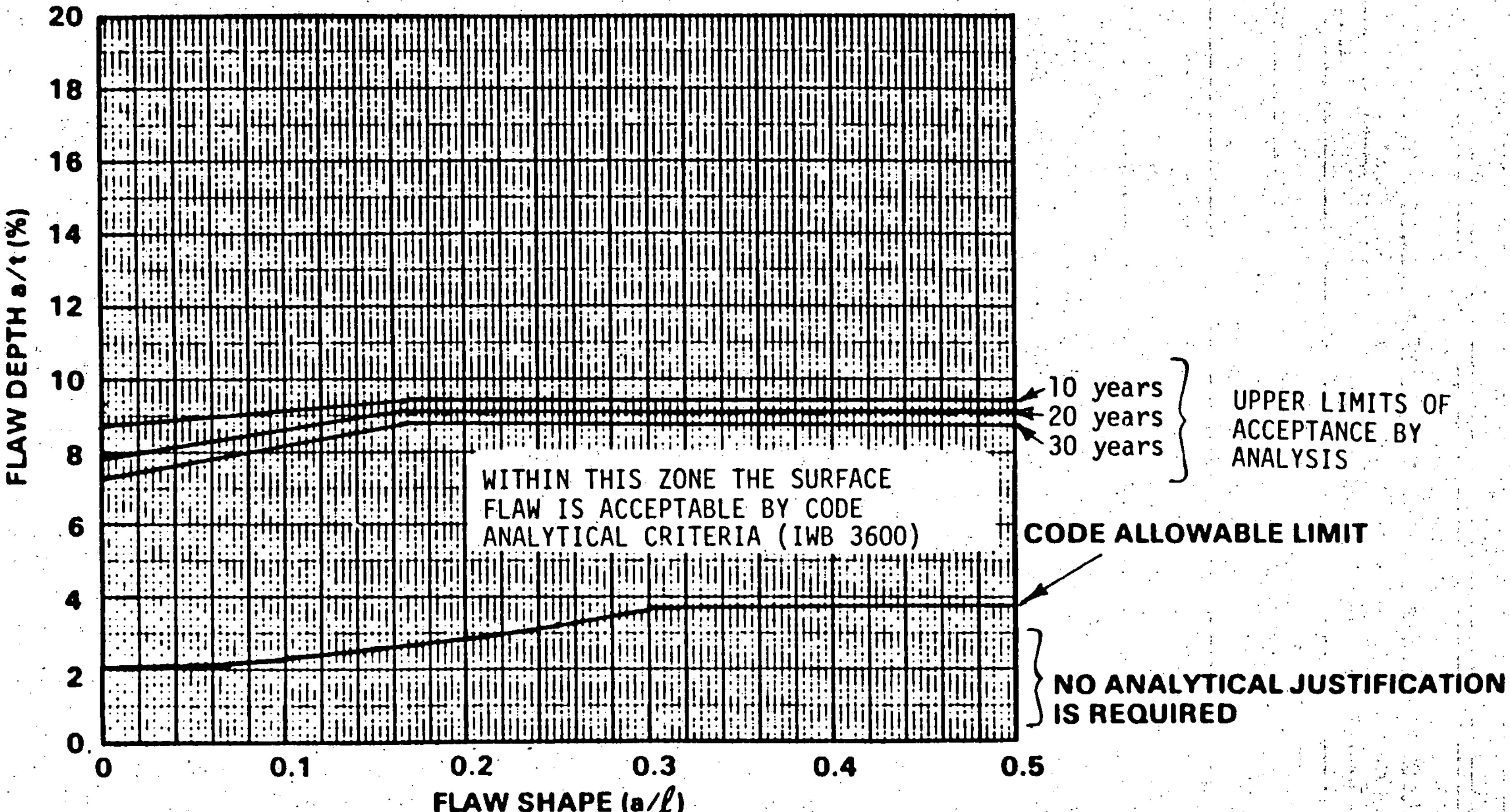


FIGURE 4-2 FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INSIDE SURFACE FLAWS IN THE UPPER SHELL TO CONE REGION

SECTION 5
EMBEDDED FLAW EVALUATION

5.1 SCOPE OF EVALUATION

Embedded flaw evaluations were performed for the upper shell to cone weld region. This section describes the development of the embedded flaw charts for that region.

5.2 EMBEDDED VS. SURFACE FLAWS

According to IWA-3300 of the ASME Code Section XI, a flaw is defined as embedded, as shown in Figure 5-1, whenever,

$$S \geq 0.4\ a$$

where

S - the minimum distance from the flaw edge to the nearest vessel wall surface

a - the embedded flaw depth, (defined as the semi-minor axis of the elliptical flaw.)

The surface proximity rules were liberalized with the 1980 code, allowing flaws as near the surface as four-tenths their width to be considered embedded. Specifically, the criterion for a flaw to be considered embedded was changed from $S > a$ to $S > 0.4\ a$, so substituting into the definition for δ we now find:

$$a = \delta - S$$

$$\delta \geq 1.4\ a$$

Therefore, the limit for a flaw to be considered embedded is $a_o = 0.714$.

A flaw lying within the embedded flaw domain is to be evaluated by the embedded flaw evaluation charts generated in this section of the handbook. On the other hand, a flaw lying beyond this domain should be evaluated as a surface flaw using the charts developed in Section 4 of the handbook instead. The demarcation lines between the two domains are shown graphically in Figure 5-2.

In other words, for any flaw indication detected by inservice inspection, the first step of evaluation is to define which category the flaw actually belongs to, then, choose the appropriate charts for evaluation.

5.3 CODE CRITERIA

As mentioned in Section 1, the criteria used in most of the cases for embedded flaws are of IWB-3612 of Code Section XI. Namely,

$K_I \leq \frac{K_{Ia}}{\sqrt{10}}$ For normal conditions (upset & test conditions inclusive)

$K_I \leq \frac{K_{Ic}}{\sqrt{2}}$ For faulted conditions (emergency conditions inclusive)

where

K_I = The maximum applied stress intensity factor for the flaw size a_f to which a detected flaw will grow, during the conditions under consideration.

K_{Ia} = Fracture toughness based on crack arrest for the corresponding crack tip temperature.

K_{Ic} = Fracture toughness based on fracture initiation for the corresponding crack tip temperature.

The above two criteria must be met simultaneously. In this handbook only the most limiting results have been used as the basis of the flaw evaluation charts.

5.4 BASIC DATA

In view of the criteria based on stress intensity factor, three basic groups of data are needed for construction of embedded flaw evaluation charts. They are: a_f, driving force (K_I), and fracture toughness (K_{Ia} and K_{Ic}).

K_{Ic} and K_{Ia} are the initiation and arrest fracture toughness (respectively) of the vessel material at which the flaw is located. They can be calculated by formulas:

$$K_{Ic} = 33.2 + 2.806 \text{ exp. } [.02(T-RT_{NDT} + 100°F)] \quad (1)$$

and

$$K_{Ia} = 26.8 + 1.233 \text{ exp. } [.0145(T-RT_{NDT} + 160°F)] \quad (2)$$

K_I is the maximum stress intensity factor for the embedded flaw of interest. The methods used for determining the stress intensity factors for embedded flaws have been referenced in Section 2.

Notice that both K_{Ic} and K_{Ia} are a function of crack tip temperature T, and the material property of RT_{NDT} at the tip of the flaw as discussed in Section 2. The upper shelf fracture toughness of the steam generator steel is assumed to be 200 ksi$\sqrt{in}$.

K_I used in the determination of the flaw evaluation charts is the maximum stress intensity factor of the embedded flaw under evaluation. It is important to note that the flaw size used for the calculation of K_I is not the flaw size detected by inservice inspection. Instead, it is the calculated flaw size which will have grown from the flaw size detected by inservice inspection. That means that the embedded flaw size used for the calculation of K_I had to be determined by using fatigue crack growth results, similar to the approach used for surface flaw evaluation, as illustrated in the previous section.

However, unlike the surface flaw case, the fatigue crack growth for an embedded flaw (even after 30 years of additional service life) is very small in comparison with that of a surface flaw with the same initial depth. Consequently, in the handbook evaluations, the detected flaw size has been used for evaluation by the charts without any appreciable error.* This simplifies the evaluation procedure without sacrificing the accuracy of the results. A detailed justification of this conclusion is provided in the next section.

5.5 FATIGUE CRACK GROWTH FOR EMBEDDED FLAWS

The environment of an embedded flaw is considered to be inert, or air. The crack growth rate for air environment is far smaller than that of the water environment, to which the surface flaw is conservatively considered to be exposed. Consequently, the fatigue crack growth for an embedded flaw must be far smaller than that of an inside surface flaw (of the same size and under the same transient conditions). Numerically, the fatigue crack growth of an embedded flaw is so low that the difference between the initial flaw depth and its final crack depth is negligible, as demonstrated in Table 3-1 for the upper shell to cone weld.

Therefore, in the construction of the evaluation charts for embedded flaws, the accuracy of the charts would not be impaired using the flaw size found by inservice inspection directly.

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* This conclusion holds for the range of flaw sizes acceptable by the rules of Section XI, IWB-3600. It would not necessarily hold for very large flaws of the order of 50 percent of the wall thickness.

5.6 TYPICAL EMBEDDED FLAW EVALUATION CHART

The details of the procedures for the construction of an embedded flaw evaluation chart are provided in the next section.

In this section, instructions for developing a chart are provided by going through a typical chart, step by step. This would help the users to become [illegible] with the characteristics of each part of the chart, and make it easier to apply. This example utilizes the surface/embedded flaw demarcation criteria of the code, as discussed earlier.

Following are the highlights of auxiliary charts used to construct the embedded flaw evaluation chart for the upper shell to cone weld region.

1. The absicissa of the chart in Figures 5-3, 5-4, and 5-5 represents the flaw depth a, of the embedded flaw.

2. As defined by code, embedded flaws with a depth less than $a_o = 0.714\ \delta$ should be considered as embedded flaws. Any embedded flaws beyond the domain of $a_o = 0.714\ \delta$, should be evaluated by means of surface flaw charts instead.

3. A key parameter for evaluating an embedded flaw is δ, the distance between the centerline of the embedded flaw and the nearest surface of the steam generator wall.

   A range of δ between $\frac{1}{16}t$ and $\frac{1}{4}t$ have been considered in constructing Figures 5-3, 5-4, and 5-5.

4. For each specific value of δ, such as $\frac{1}{8}t$, $\frac{3}{16}t$, $\frac{1}{4}t$, etc., a family of curves were plotted for a range of aspect ratios, for 3:1 through 10:1. This corresponds to a/ℓ values ranging from .333 to .100. For any specific flaw depth a at the abscissa, a corresponding value K_I at the ordinate can be found in Figures 5-3 through 5-5, for any distance to the surface, δ.

5. The range of aspect ratios from 3:1 to 10:1 was chosen to encompass the range of flaws which might be detected. Within this range, interpolation can be used for any other aspect ratio. Use the 3:1 curve as a lower bound and the 10:1 curve as an upper bound.

6. In developing this specific chart, the code acceptance limit line of $K_{Ia}/\sqrt{10}$ as a function of flaw depth is shown in Figures 5-3 through 5-5.

7. The intersection of the K_I curve with the code acceptance limit line is the maximum flaw size acceptable by code for the specific curve in accordance with $K_I \leq K_{Ia}/\sqrt{10}$ criteria from IWB 3612.

8. In view of Figures 5-3 through 5-5, it is seen that some of the curves intersect with the code acceptance limit line. That means that, up to a distance of $\delta = \frac{1}{4}t$ (= .875"), some of the embedded flaws are not acceptable by code criterion $K_I \leq K_{Ia}/\sqrt{10}$ so long as their depth is within the domain of $a_o = 0.714\ \delta$.

9. In accordance with the $a_c/10$ criteria from IWB 3611, all embedded flaws up to and including $a/t = 0.05$ are acceptable.

10. The criteria used for the construction of the charts are based on the least restrictive of IWB 3611 or IWB 3612 of Section XI of the ASME Code.

11. The maximum acceptable flaw size can be found from the chart by determining the abscissa of the intersection points, Namely, for $\delta = 0.25\ t$,

Aspect Ratio of the Flaw	a/ℓ	Maximum Acceptable Flaw Size a*(in.)
10:1	.100	.437
6:1	.167	.437 (= a_o = .437)
3:1	.333	.437

12. The maximum acceptable embedded flaw size for $\delta = \frac{1}{4}t$ has been depicted in Figure 5-2. This simple flaw evaluation chart, described in the following paragraph, is the type to be used for evaluation, as may be seen in Section 6.

These embedded flaw evaluation charts, constructed for the upper shell to cone weld region of the steam generators, are presented in Figure 5-2 and are repeated along with instructions in Section 6.

5.7 PROCEDURE FOR THE CONSTRUCTION OF EMBEDDED FLAW EVALUATION CHARTS

This section shows how an embedded flaw evaluation chart was constructed for the upper shell to cone weld region during the governing transient which is the loss of power. The example here is for the case of RT_{NDT} = 10°F.

Step 1

Calculate K_I values for embedded flaws of various size, various aspect ratios, and at various distances underneath the surface. In total, 135 cases were analyzed by closed form stress intensity factor expressions. These 135 cases are listed in Table 5-1.

Step 2

The K_I results of the 135 cases were tabulated in Table 5-2 and plotted in Figures 5-3 through 5-5.

---

*Maximum Acceptable Flaw Size a is $\frac{1}{8}t$ based on Section XI of the ASME Code

Step 3

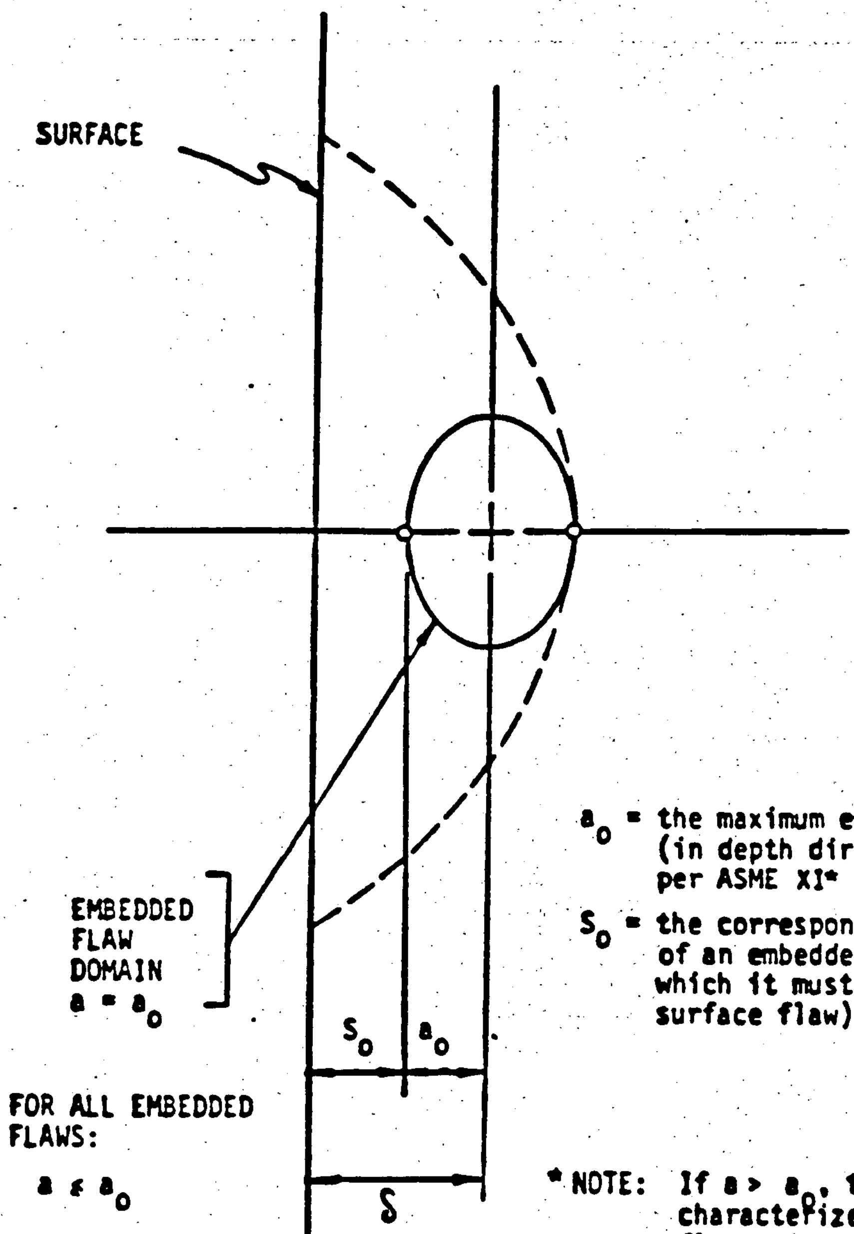
Determine the allowable flaw size, from $a_c/10$ or $K_I \leq K_{Ia}/\sqrt{10}$ criteria as determined by Figures 5-3 through 5-5. Similar results could be obtained for the emergency/faulted conditions, but it can be seen from the surface flaw evaluation that they will not be governing so they have not been included here.

The general method used to construct the chart in Figure 5-6 for Steam Generator Unit 34 which has an RT_{NDT} = 30°F and flaws with a/ℓ less than 0.1667 is the same as the method described previously for steam generators with RT_{NDT} = 10°F. However, a somewhat more restrictive chart results for flaws with a/ℓ less than 0.1667 when RT_{NDT} = 30°F. Specifically, these embedded flaws within the triangular region of Figure 5-6 would not be acceptable by the fracture evaluation. As a result, flaws with a/ℓ less than 0.1667 plotted within the triangular region would have to be repaired. Figure 5-2 can be used for flaws in Steam Generator Unit 34 with a/ℓ equal to or greater than 0.1667.

5.8 COMPARISON OF EMBEDDED FLAW CHARTS WITH ACCEPTANCE STANDARDS OF IWB-3500

The handbook charts for embedded flaw do not show the acceptance standards of Section XI, as the surface flaw charts do. Therefore, it is not clear from the charts themselves how much is gained from the analysis process over the standards tables contained in IWB-3500. Such a comparison cannot be made directly on the embedded flaw handbook charts, because the charts are applicable for a full range of sizes, shapes and locations. The purpose of this section is to provide such comparisons, and to discuss the results of those comparisons.

The handbook chart values have been compared with the acceptance standards tables in Figure 5-7. In this figure the values from Table IWB-3511-1 have been plotted as the base curve, and the limit curve for embedded flaws justified by analysis is shown as the other line. It can be seen that the range of embedded flaw shapes and depths justifiable by analysis is related to the flaw location within the wall.



a_o = the maximum embedded flaw size (in depth direction) allowable per ASME XI*

S_o = the corresponding minimum depth of an embedded flaw (less than which it must be considered a surface flaw)

*NOTE: If $a > a_o$, the flaw must be characterized as a surface flaw, with depth = $a + \delta$.

[a_o = 0.714δ for the 1980 Edition of the ASME Code and later editions]

Figure 5-1 Embedded vs. Surface Flaw

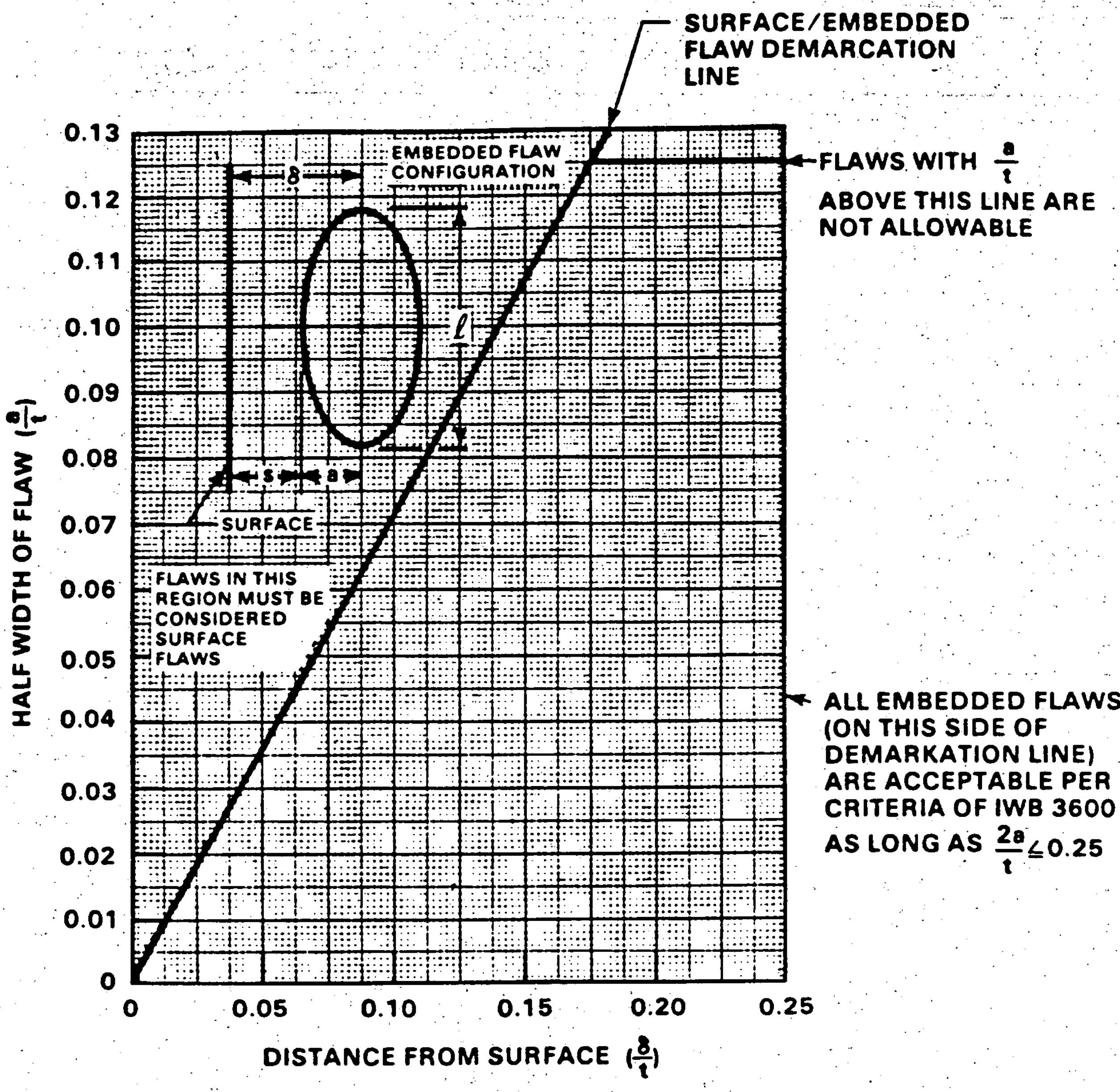
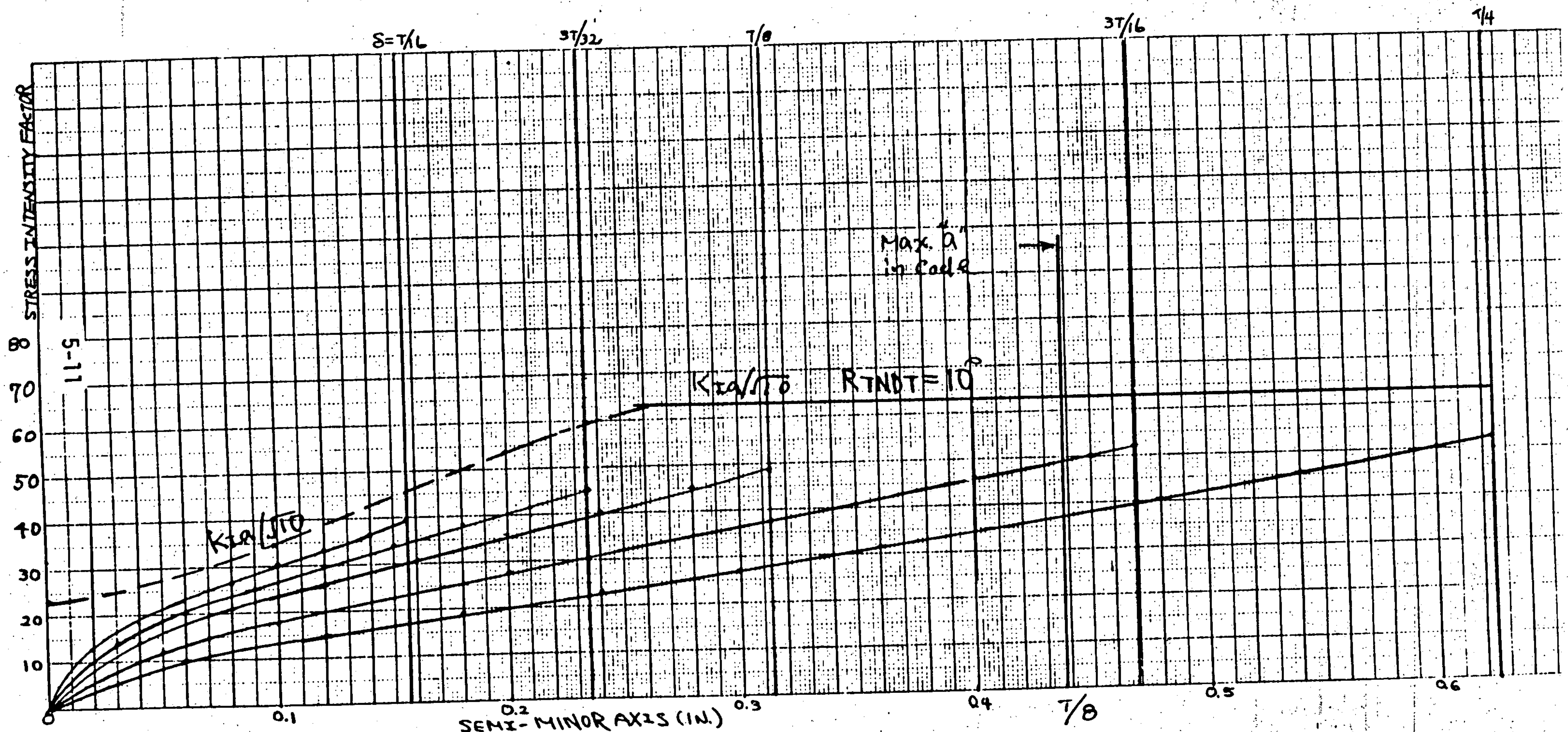


FIGURE 5-2 EMBEDDED FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INDICATIONS IN THE UPPER SHELL TO CONE

[See Figure 5-6 for application to Steam Generator Unit 34, for $a/\ell < 0.1667$]



5-11

FIGURE 5-3 STRESS INTENSITY FACTOR PLOTS FOR a/ℓ = 0.333 USED IN CONSTRUCTION OF EMBEDDED FLAW CHARTS

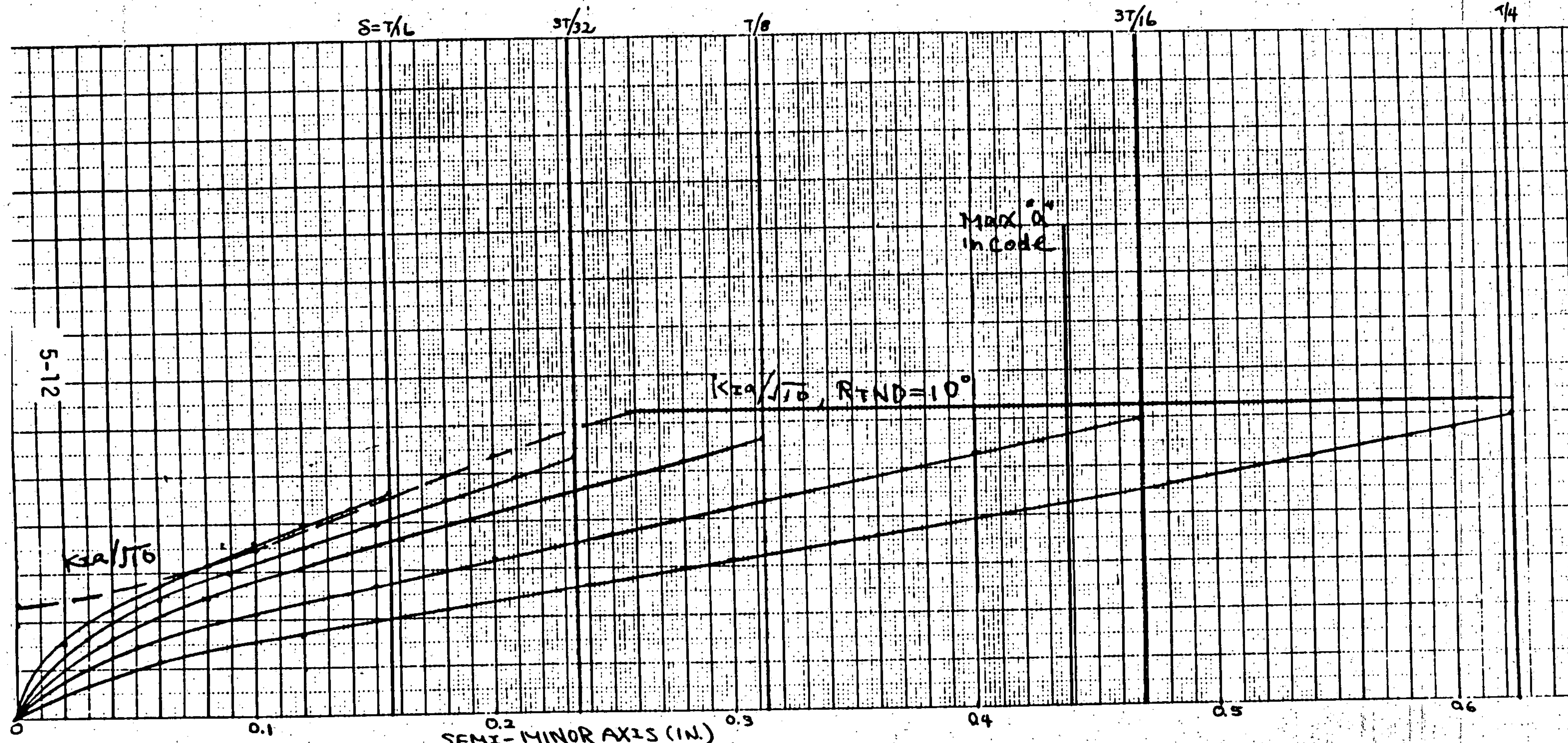


FIGURE 5-4 STRESS INTENSITY FACTOR PLOTS FOR a/ℓ = 0.1667, USED IN CONSTRUCTION OF FLAW EVALUATION CHARTS

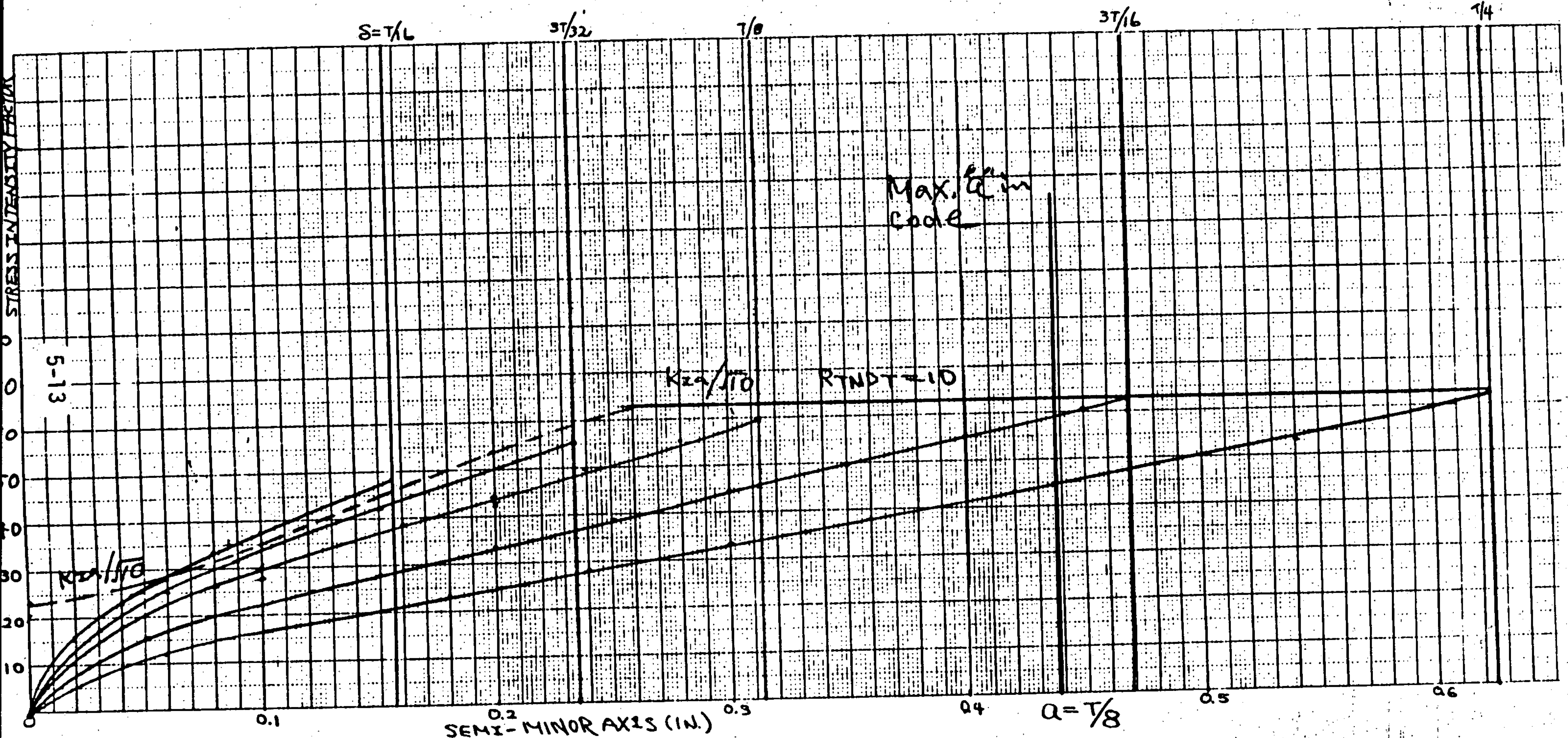


FIGURE 5-5 STRESS INTENSITY FACTOR PLOTS FOR $a/\ell = 0.10$, USED IN CONSTRUCTION OF FLAW EVALUATION CHARTS

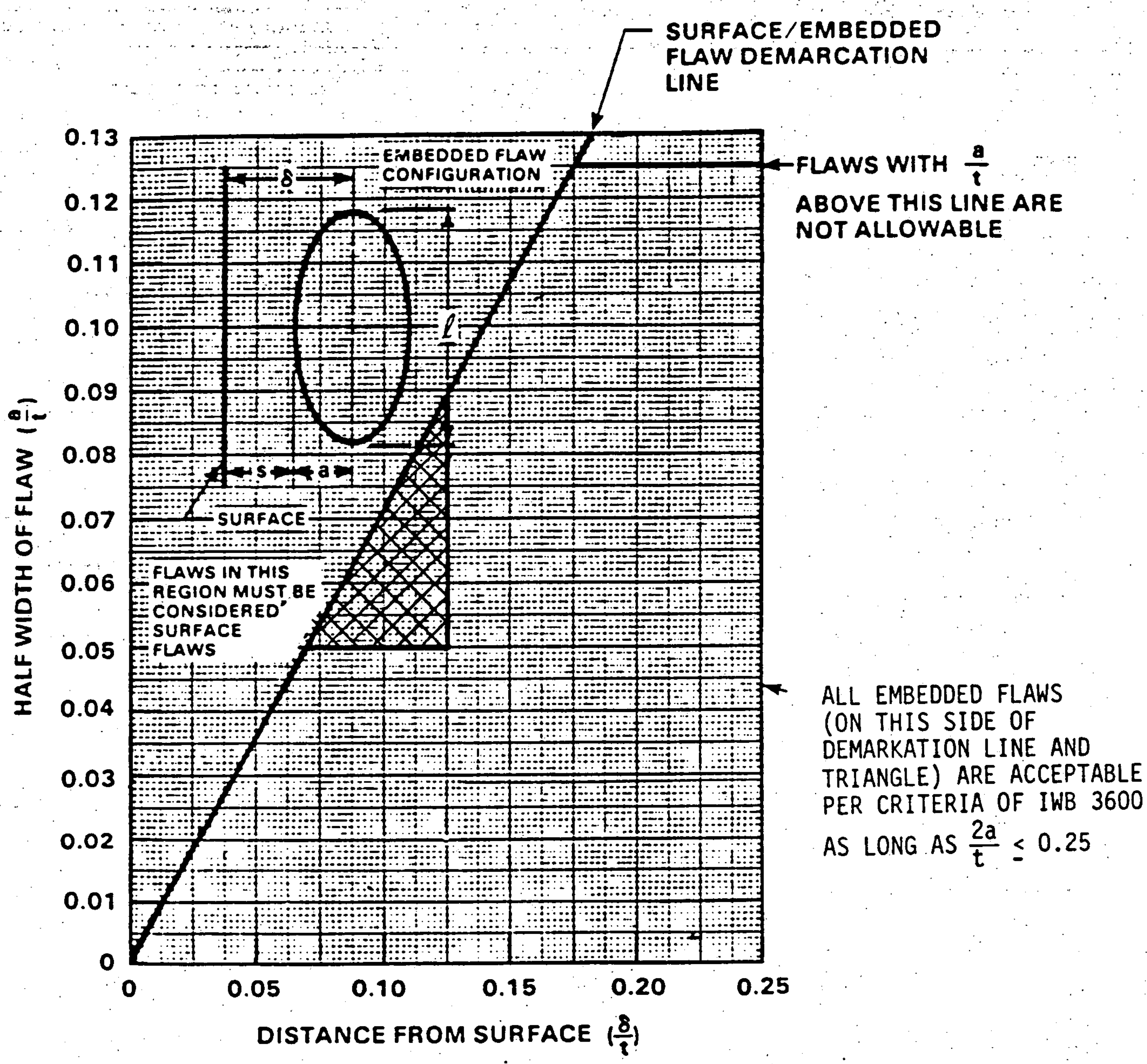


FIGURE 5-6 EMBEDDED FLAW EVALUATION CHART FOR CIRCUMFERENTIAL FLAWS IN STEAM GENERATOR 34 WITH a/ℓ LESS THAN 0.1667

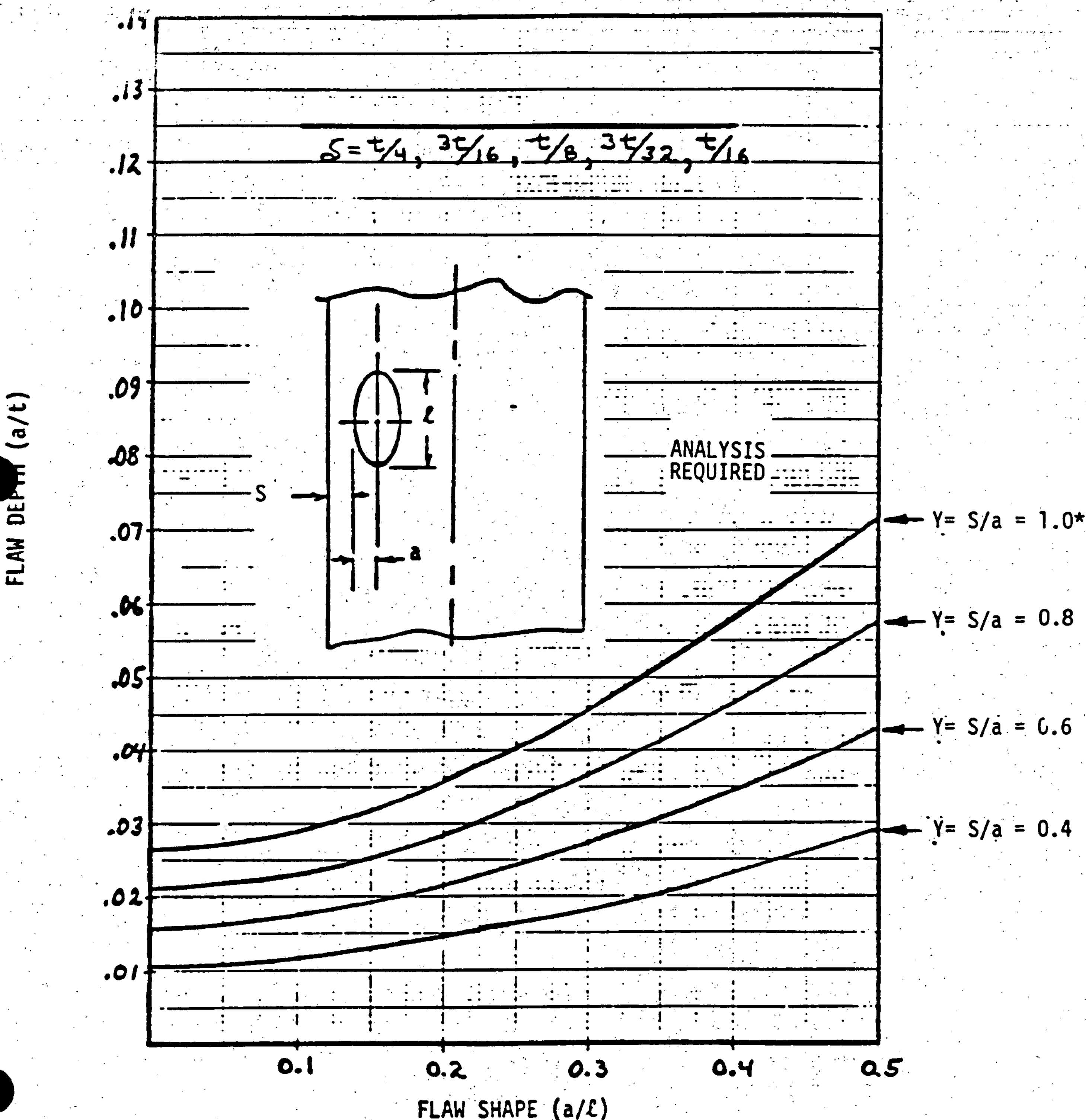


FIGURE 5-7 Acceptance Standards for Embedded Flaws, from Table IWB-3511-1

*Only Y = 1.0 curve applies to ASME Codes prior to 1980 Edition.

TABLE 5-1

EMBEDDED FLAW CASES ANALYZED FOR S.G. UPPER SHELL AND CONE WELD SECTION DURING LOSS OF POWER TRANSIENT

DISTANCE OF FLAW TO SURFACE (δ in)	EMBEDDED FLAW DEPTH (IN.)		
	A.R. 10:1	A.R. 6:1	A.R. 3:1
T/16 δ = 0.2188	0.02, 0.04 0.06, 0.08 0.10, 0.12 0.14, 0.1563	0.02, 0.04 0.06, 0.08 0.10, 0.12 0.14, 0.1563	0.02, 0.04 0.06, 0.08 0.10, 0.12 0.14, 0.1563
3T/32 δ = 0.3281	0.03, 0.06 0.09, 0.12 0.15, 0.18 0.21, 0.2344	0.03, 0.06 0.09, 0.12 0.15, 0.18 0.21, 0.2344	0.03, 0.06 0.09, 0.12 0.15, 0.18 0.21, 0.2344
T/8 δ = 0.4375	0.04, 0.08 0.12, 0.16 0.20, 0.24 0.28, 0.3125	0.04, 0.08 0.12, 0.16 0.20, 0.24 0.28, 0.3125	0.04, 0.08 0.12, 0.16 0.20, 0.24 0.28, 0.3125
3T/16 δ = 0.6562	0.05, 0.10 0.15, 0.20 0.25, 0.30 0.35, 0.40 0.45, 0.4687	0.05, 0.10 0.15, 0.20 0.25, 0.30 0.35, 0.40 0.45, 0.4687	0.05, 0.10 0.15, 0.20 0.25, 0.30 0.35, 0.40 0.45, 0.4687
T/4 δ = 0.875	0.06, 0.12 0.18, 0.24 0.30, 0.36 0.42, 0.48 0.54, 0.60 0.625	0.06, 0.12 0.18, 0.24 0.30, 0.36 0.42, 0.48 0.54, 0.60 0.625	0.06, 0.12 0.18, 0.24 0.30, 0.36 0.42, 0.48 0.54, 0.60 0.625

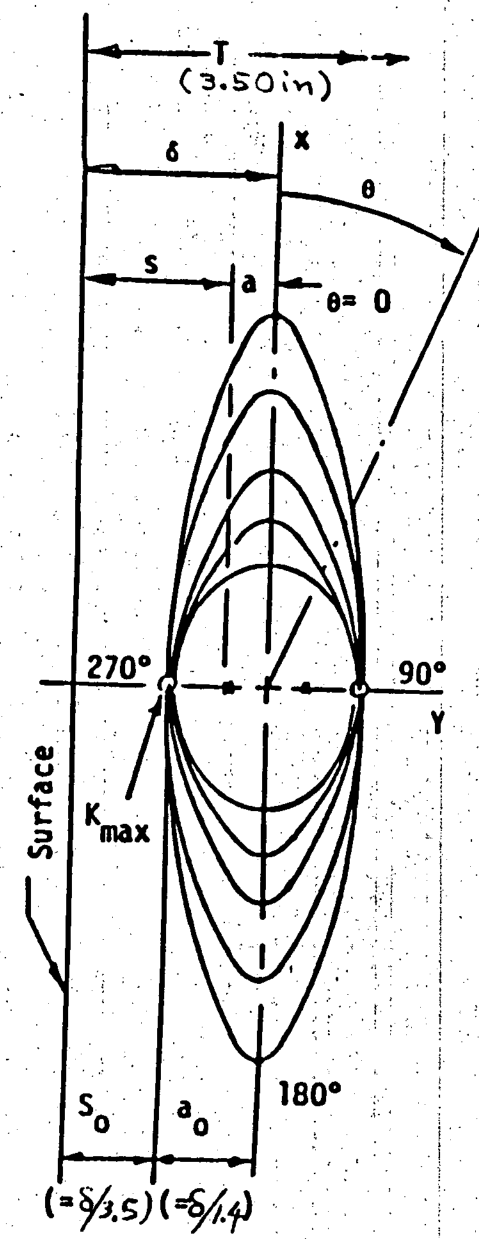


TABLE 5-2

STRESS INTEN[illegible]Y RESULTS FOR EMBEDDED FLAWS AT UPPER SHELL AND CONE WELD

OPERATING CONDITION	ORIENTATION OF FLAW	WALL THICKNESS
LOSS OF POWER TRANSIENT	CIRCUMFERENTIAL	T = 3.50 (in)

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)
T/16 δ = 0.2188	0.02	16.12	0.02	15.2	0.02	12.83
	0.04	23.06	0.04	21.76	0.04	18.39
	0.06	28.56	0.06	26.97	0.06	22.83
	0.08	33.37	0.08	31.52	0.08	26.71
	0.10	37.74	0.10	35.66	0.10	30.27
	0.12	41.82	0.12	39.54	0.12	33.60
	0.14	45.69	0.14	43.22	0.14	36.77

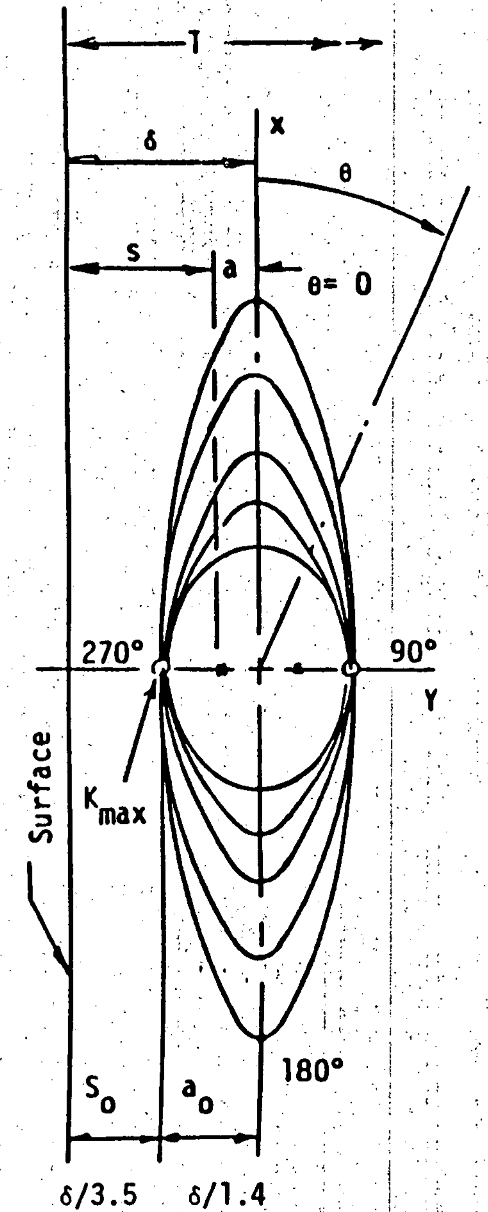


TABLE 5-2 (cont'd)

OPERATING CONDITION		ORIENTATION OF FLAW		WALL THICKNESS	
LOSS OF POWER		CIRCUMFERENTIAL		T = 3.50 (in)	

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of min-minor dia. (in)	K_{max} (ksi√in)
T/16	0.1563	48.73	0.1563	46.11	0.1563	39.28
3T/32 δ= 0.3281	0.03	17.55	0.03	16.56	0.03	13.99
	0.06	25.28	0.06	23.87	0.06	20.21
	0.09	31.53	0.09	29.79	0.09	25.28
	0.12	37.08	0.12	35.06	0.12	29.81
	0.15	42.22	0.15	39.95	0.15	34.03
	0.18	47.18	0.18	44.59	0.18	38.06

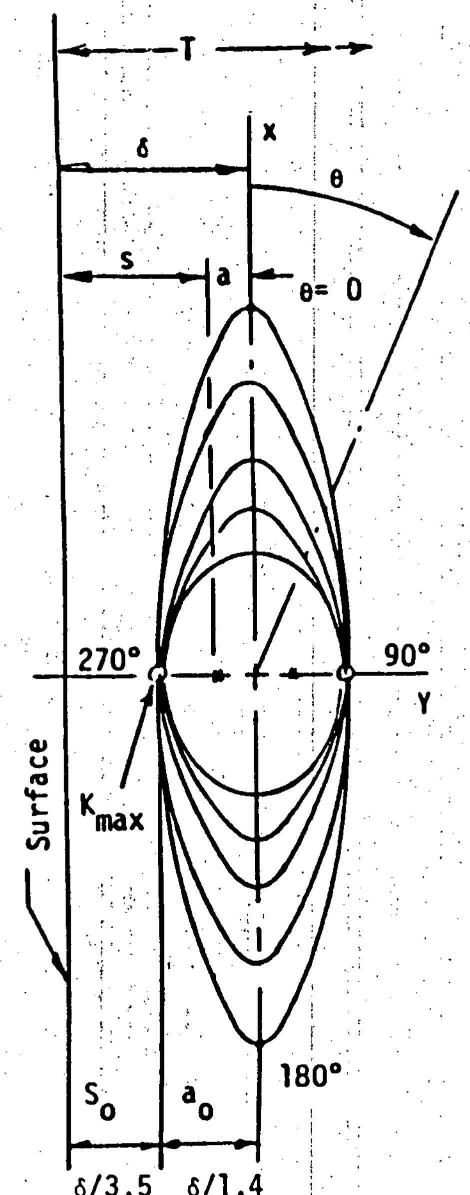


TABLE 5-2 (cont'd)

OPERATING CONDITION		ORIENTATION OF FLAW		WALL THICKNESS		
LOSS OF POWER		CIRCUMFERENTIAL		T = 3.50 (in)		
DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of min-minor dia. (in)	K_{max} (ksi√in)
3T/32	0.21	51.81	0.21	49.08	0.21	41.97
	0.2344	55.85	0.2344	52.66	0.2344	45.10
T/8 δ = 0.4375	0.04	17.91	0.04	16.90	0.04	14.29
	0.08	25.99	0.08	24.55	0.08	20.82
	0.12	32.66	0.12	30.88	0.12	26.27
	0.16	38.69	0.16	36.62	0.16	31.24
	0.20	44.38	0.20	42.05	0.20	35.97

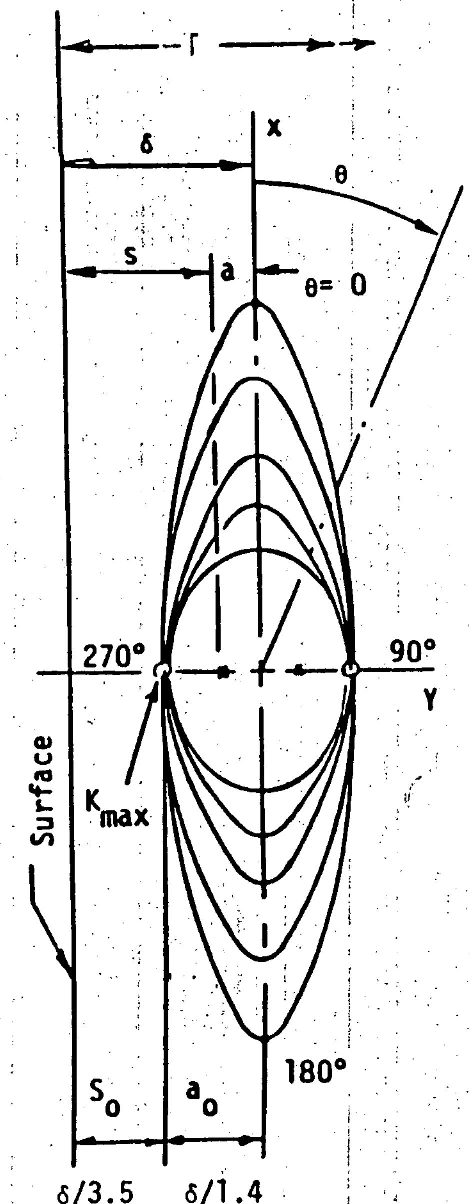


TABLE 5-2 (cont'd)

OPERATING CONDITION	ORIENTATION OF FLAW			WALL THICKNESS	
LOSS OF POWER	CIRCUMFERENTIAL			T = 3.50 (in)	

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of min- minor dia. (in)	K_{max} (ksi√in)
T/8	0.24	49.88	0.24	47.30	0.24	40.56
	0.28	55.28	0.28	52.47	0.28	45.10
	0.3125	59.62	0.3125	56.63	0.3125	48.77
3T/16 δ = 0.6562	0.05	15.16	0.05	14.32	0.05	12.12
	0.10	22.25	0.10	21.04	0.10	17.89
	0.15	28.26	0.15	26.76	0.15	22.85
	0.20	33.85	0.20	32.09	0.20	27.50

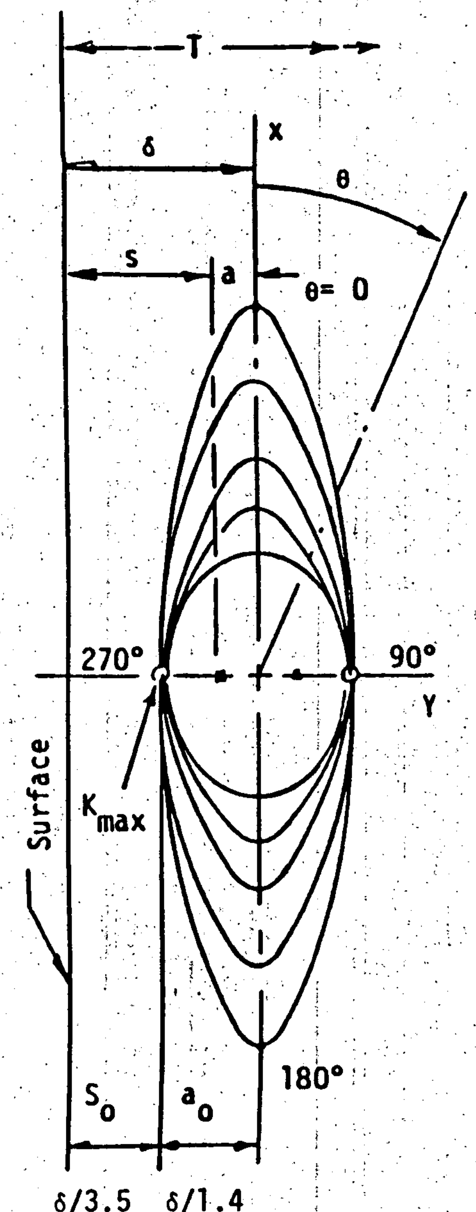


TABLE 5-2 (cont'd)

OPERATING CONDITION	ORIENTATION OF FLAW	WALL THICKNESS
LOSS OF POWER	CIRCUMFERENTIAL	T = 3.50 (in)

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of min-minor dia. (in)	K_{max} (ksi√in)
3T/16	0.25	39.25	0.25	37.25	0.25	32.03
	0.30	44.58	0.30	42.36	0.30	36.55
	0.35	49.92	0.35	47.49	0.35	41.10
	0.40	55.31	0.40	52.67	0.40	45.72
	0.45 0.4687	60.80 62.88	0.45 0.4687	57.95 59.96	0.45 0.4687	50.44 52.24
T/4 δ = 0.875	0.06	12.05	0.06	11.38	0.06	9.66
	0.12	17.95	0.12	16.99	0.12	14.50

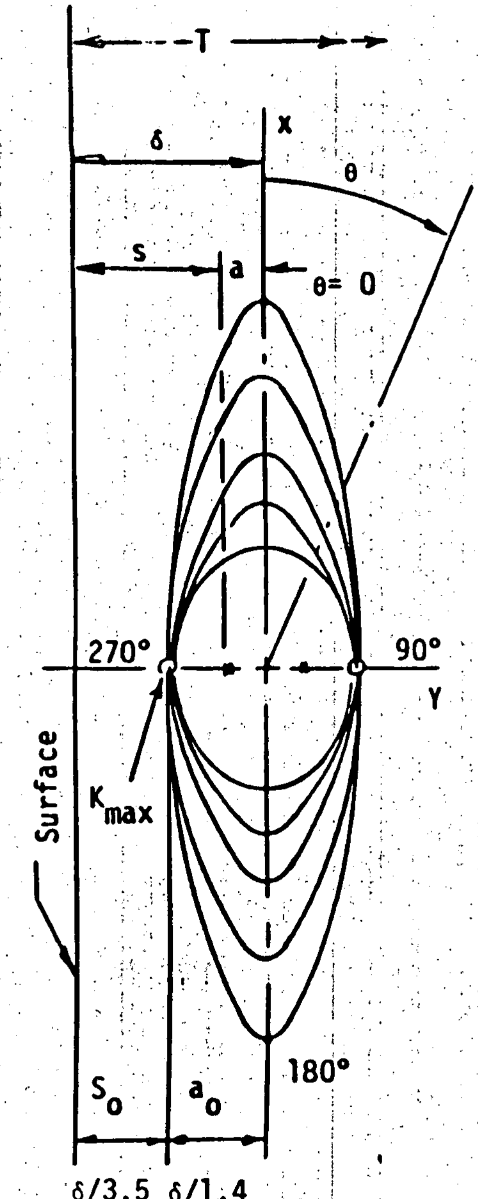


TABLE 5-2 (cont'd)

OPERATING CONDITION		ORIENTATION OF FLAW		WALL THICKNESS	
LOSS OF POWER		CIRCUMFERENTIAL		T = 3.50 (in)	

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi√in)	Half of minor dia. (in)	K_{max} (ksi√in)	Half of min-minor dia. (in)	K_{max} (ksi√in)
T/4	0.18	23.14	0.18	21.95	0.18	18.82
	0.24	28.12	0.24	26.71	0.24	23.02
	0.30	33.07	0.30	31.46	0.30	27.23
	0.36	38.08	0.36	36.28	0.36	31.54
	0.42	43.23	0.42	41.24	0.42	35.98
	0.48	48.53	0.48	46.35	0.48	40.59
	0.54	54.04	0.54	51.67	0.54	45.38

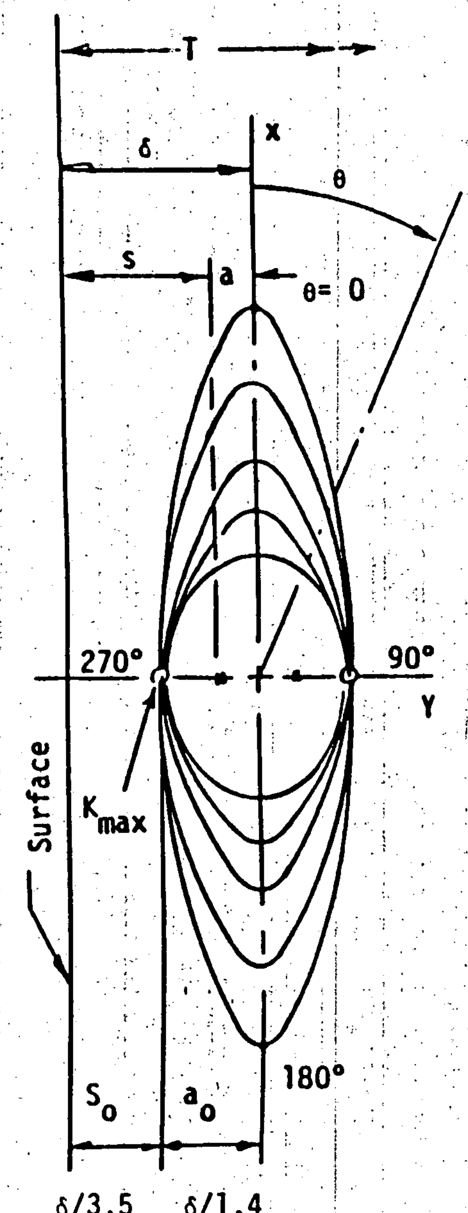
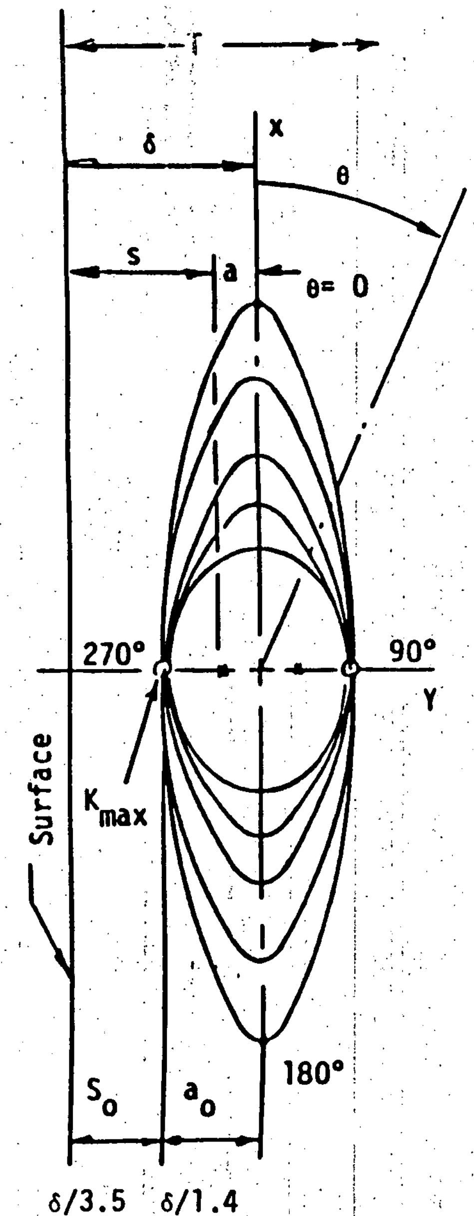


TABLE 5-2 (cont'd)

OPERATING CONDITION	ORIENTATION OF FLAW	WALL THICKNESS
LOSS OF POWER	CIRCUMFERENTIAL	T = 3.50 (in)

DISTANCE FROM FLAW MAJOR AXIS TO SURFACE (in)	MAXIMUM STRESS INTENSITIES FOR VARIOUS ASPECT RATIOS					
	10:1		6:1		3:1	
	Half of minor dia. (in)	K_{max} (ksi in)	Half of minor dia. (in)	K_{max} (ksi$\sqrt{in}$)	Half of min-minor dia. (in)	K_{max} (ksi$\sqrt{in}$)
T/4	0.60	59.76	0.60	57.19	0.60	50.39
	0.625	62.21	0.625	59.57	0.625	52.54



SECTION 6

FLAW EVALUATION CHARTS-UPPER SHELL TO CONE WELD

6.1 EVALUATION PROCEDURE

The evaluation procedures contained in ASME Section XI are clearly specified in paragraph IWB-3600. Use of the evaluation charts herein follows these procedures directly, but the steps are greatly simplified.

Once the indication is discovered, it must be characterized as to its location, length (ℓ) and depth dimension (a for surface flaws, 2a for embedded flaws), including its distance from the inside surface (S) for embedded indications. This characterization is discussed in further detail in paragraph IWA 3000 of Section XI.

The following parameters must be calculated from the above dimensions to use the charts (see Figure 1-2):

- o Flaw Shape parameter, $\frac{a}{\ell}$
- o Flaw depth parameter, $\frac{a}{t}$
- o Surface proximity parameter (for embedded flaws only), $\frac{\delta}{t}$

where

- t = wall thickness of region where indication is located
- ℓ = length of indication
- a = depth of surface flaw; or half depth of embedded flaw in the width direction
- δ = distance from flaw centerline to surface (for embedded flaws only) ($\delta = s + a$)
- S = smallest distance from edge of embedded flaw to surface

Once the above parameters have been determined and the determination made as to whether the indication is embedded or surface, then the two parameters may be plotted directly on the appropriate evaluation chart. Its location on the chart determines its acceptability immediately.

Important Observations on the Handbook Charts

Although the use of the handbook charts is conceptually straight forward, experience in their development and use has led to a number of observations which will be helpful.

Surface Flaws

The handbook chart for circumferential inside surface flaws is shown in Figure 6-1 and for circumferential outside surface flaws the chart is shown in Figure 6-2. The flaw indication parameters (whose calculation is described above) may be plotted directly on the chart to determine acceptability. The lower curve shown (labelled code allowable limit) is simply the acceptance standard from IWB 3500, which is tabulated in Section XI. If the plotted point falls below this line, the indication is acceptable without analytical justification having been required. If the plotted point falls <u>between</u> the code allowable limit line and the lines labelled "upper limits of acceptance by analysis" it is acceptable by virtue of its meeting the requirements of IWB 3600, which allow acceptance by fracture analysis. (Flaws between these lines would, however, require future monitoring per IWB 2420 of Section XI.) The analysis used to develop these lines is documented in this report. There are three of these lines shown in the charts, labelled 10, 20, and 30 years. The years indicate for how long the acceptance limit applies from the date that a flaw indication is discovered, based on fatigue crack growth calculations.

As may be seen for example in Figure 6-1, the chart gives results for circumferential surface flaw shapes up to a semi-circular flaw (a/ℓ = 0.5). For the unlikely occurrence of flaws which the value of a/ℓ exceeds 0.5, the limits on acceptance for a/ℓ = 0.5 should be used. The upper limits of acceptance have been set at (a maximum of) twenty percent of the wall thickness in all cases, as discussed in Section 4.

Embedded flaws

The evaluation charts for circumferential embedded flaws are shown in Figures 6-3 and 6-4. The heavy diagonal line in each figure can be used directly to determine whether the indication should be characterized as an embedded flaw or whether it is sufficiently close to the surface that it must be considered as a surface flaw (by the rules of Section XI). If the flaw parameters produced a plotted point below the heavy diagonal line, it is acceptable by analysis unless it occurred within the triangular region of Figure 6-4. As previously explained in Section 5.7, flaws within the triangular region of Figure 6-4 would not be acceptable and would have to be repaired. If the flaw is <u>above</u> the heavy diagonal line, it must be considered a surface flaw and evaluated using the surface flaw chart in Figure 6-1 or Figure 6-2.

The standards for flaw acceptance without analysis cannot be shown in the embedded flaw charts because of their generality. Therefore, they have been plotted separately in Figure 6-5.

Detailed examples of the use of the charts for both surface and embedded flaws are presented in the following sections.

Surface flaw Example

Suppose an indication has been discovered which is a circumferential surface flaw and has the following characterized dimensions:

$a = 0.12"$

$\ell = 1.2"$

$t = 3.5"$

The flaw parameters for the use of the charts are

$$\frac{a}{t} = .0343\ (3.43\%)$$

$$\frac{a}{\ell} = 0.10$$

By comparing these parameters with Figure 6-1, it is quickly seen that the indication is acceptable by analysis. To justify operation without repair it is necessary to submit this plot along with this document to the regulatory authorities.

Embedded Flaw Example

Assume that a circumferential embedded flaw of 0.24" x 5.00", located within 0.2817" from the surface, was detected. Determine whether this flaw should be considered as an embedded flaw.

$$2a = 0.24"$$
$$S = 0.2817"$$
$$\delta = S + a = 0.2817 + 1/2\ (0.24) = 0.4017"$$
$$t = 3.5"$$
$$\ell = 5.0"$$

and,

$$a = 1/2 \times 0.24"$$
$$= 0.12"$$

Using Figure 6-3:

$$\frac{a}{t} = \frac{0.12}{3.5} = 0.0343$$

$$\frac{\delta}{t} = \frac{0.4017}{3.5} = 0.115$$

Comparison of these parameters with Figure 6-3 indicates that the flaw must be considered embedded. Since it is below the demarcation line it is acceptable.

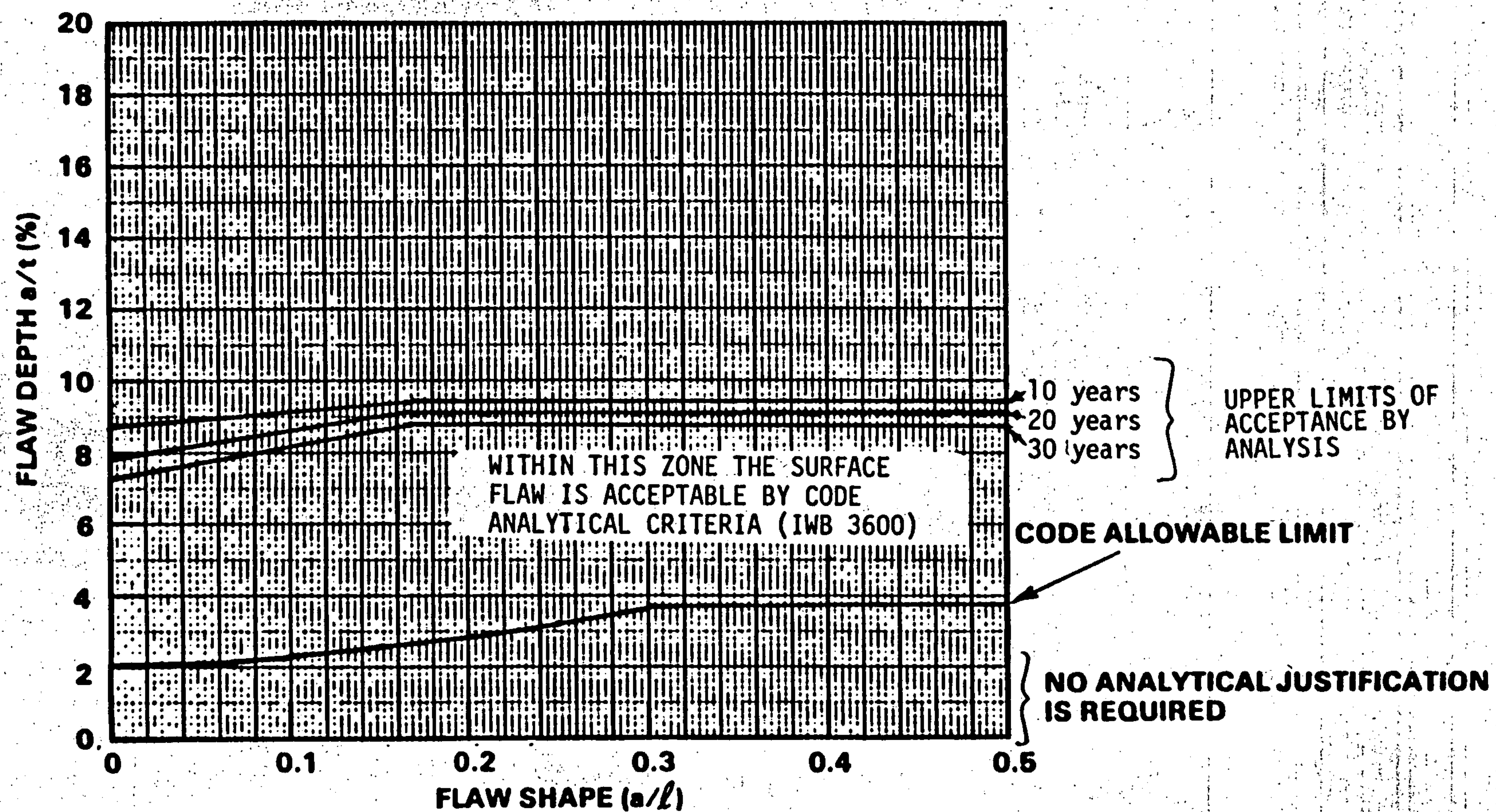


FIGURE 6-1 FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INSIDE SURFACE FLAWS IN THE UPPER SHELL TO CONE REGION

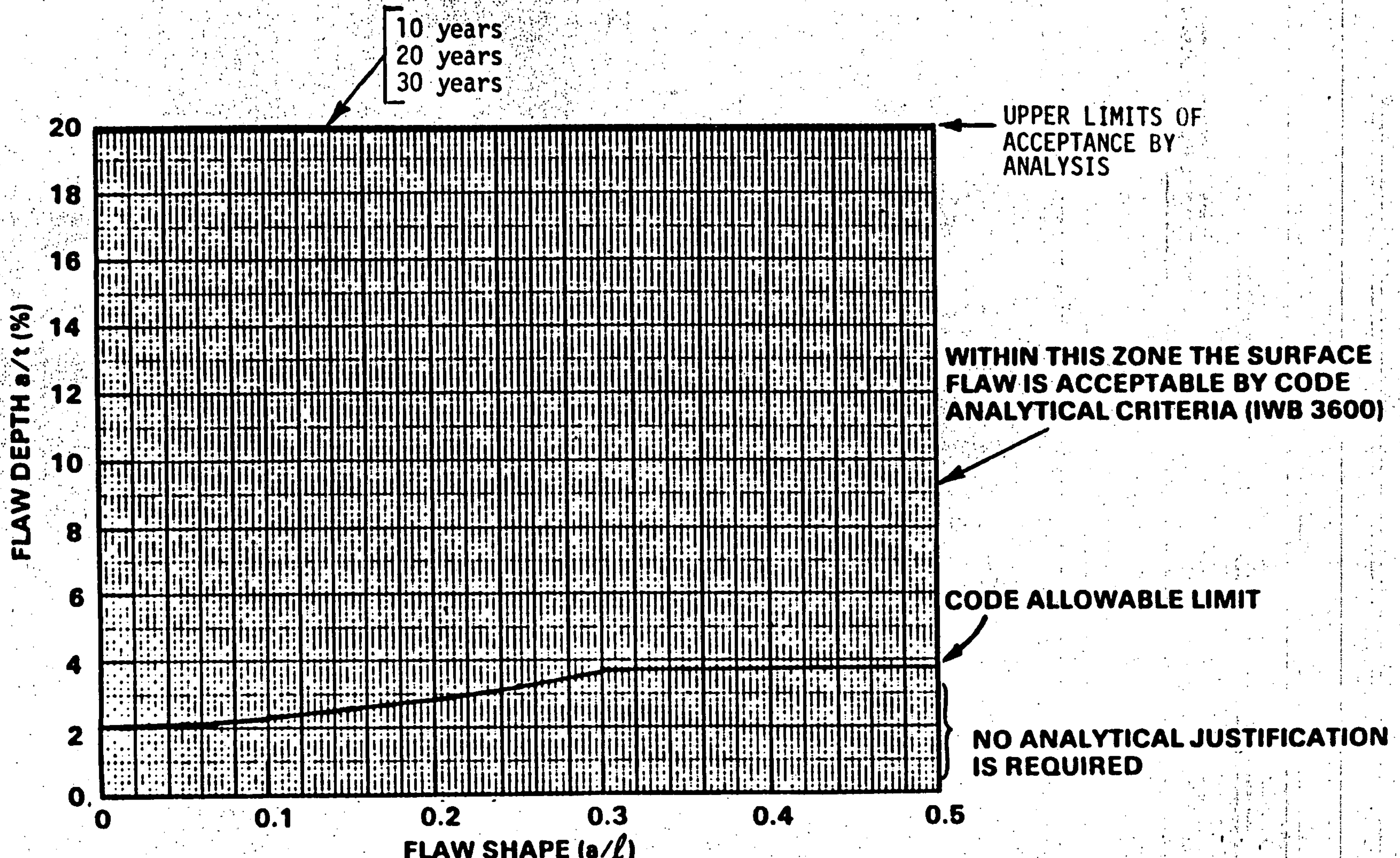


FIGURE 6-2 FLAW EVALUATION CHART FOR CIRCUMFERENTIAL OUTSIDE SURFACE FLAW IN THE UPPER SHELL TO CONE WELD

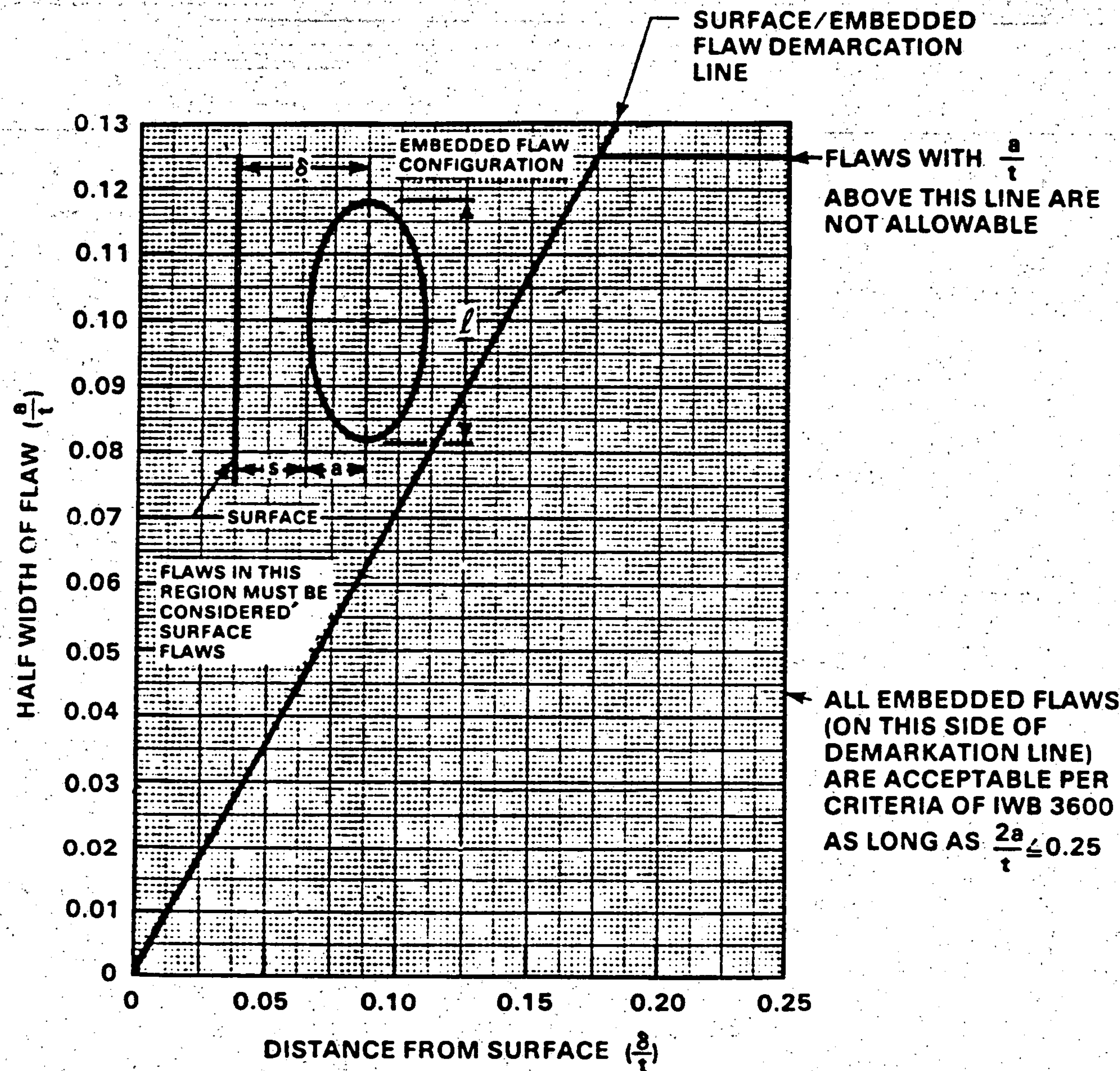


FIGURE 6-3 EMBEDDED FLAW EVALUATION CHART FOR CIRCUMFERENTIAL INDICATIONS IN THE UPPER SHELL TO CONE

[See Figure 6-4 for application to Steam Generator Unit 34, for $a/\ell < 0.1667$]

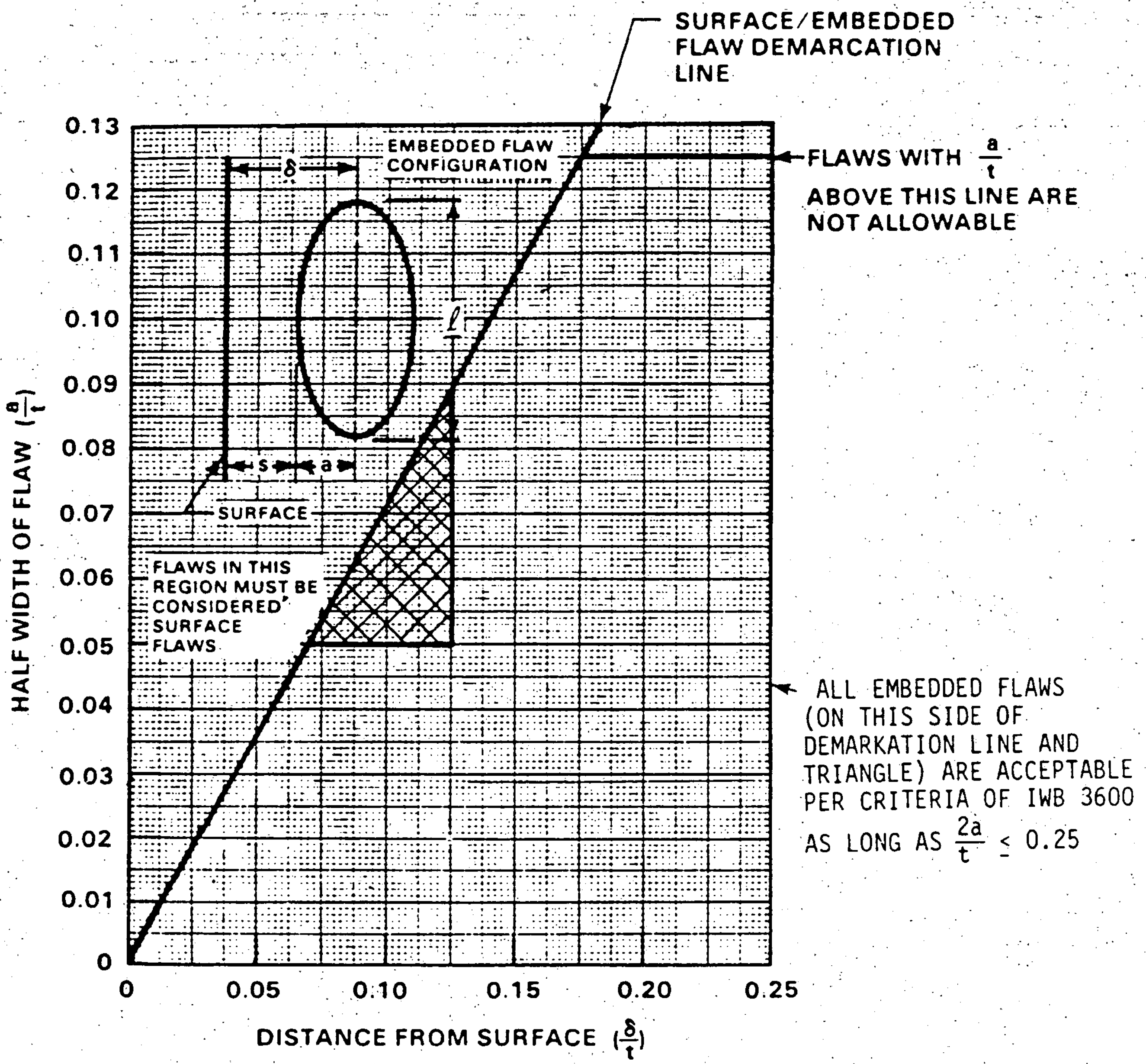


FIGURE 6-4 EMBEDDED FLAW EVALUATION CHART FOR CIRCUMFERENTIAL FLAWS IN STEAM GENERATOR 34 WITH a/ℓ LESS THAN 0.1667

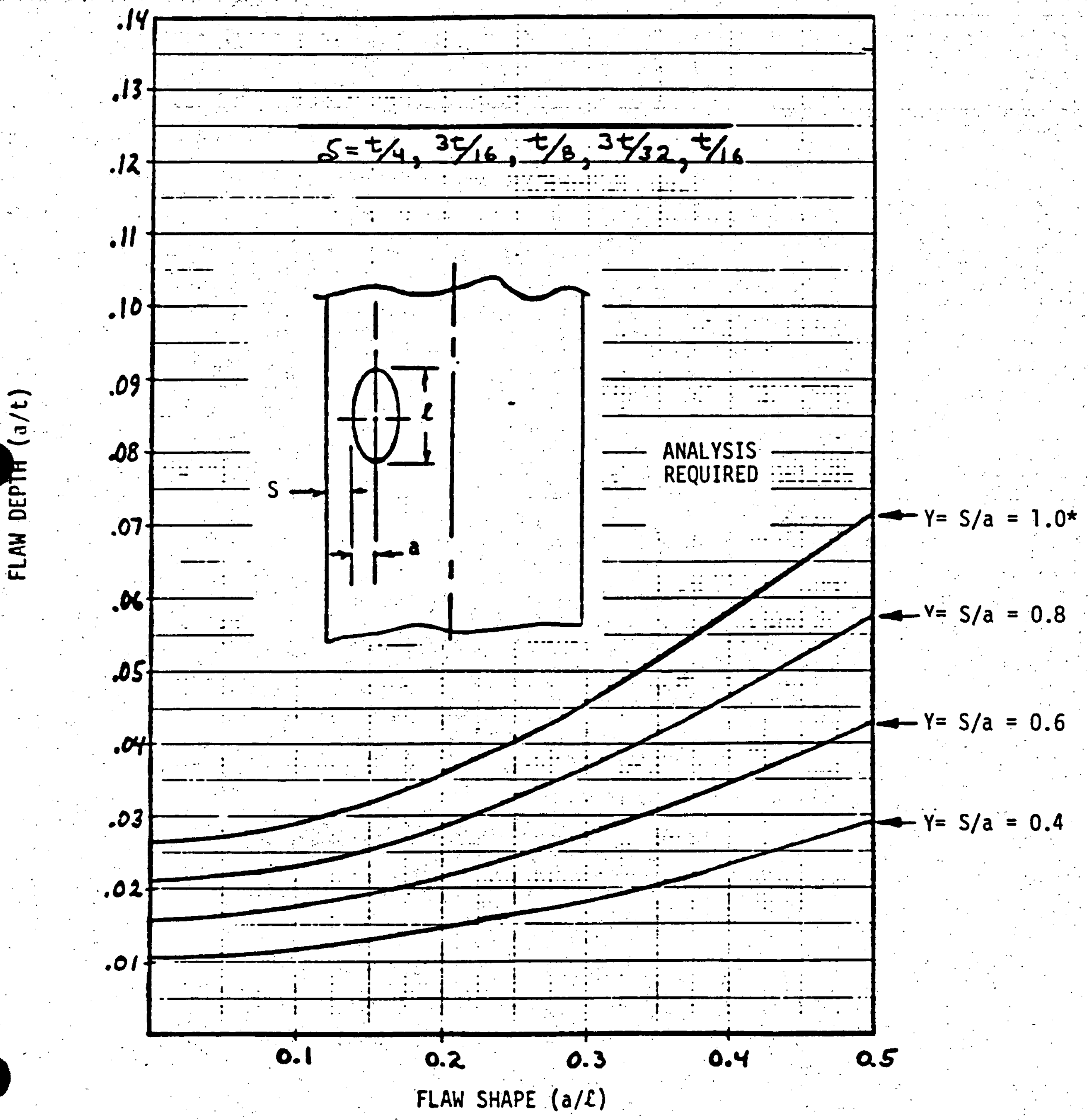


FIGURE 6-5 Acceptance Standards for Embedded Flaws, from Table IWB-3511-1

*Only Y = 1.0 curve applies to ASME Codes prior to 1980 Edition.

SECTION 7

REFERENCES

1. ASME Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components", 1974 Edition; 1983 edition (used for updated standards tables, and 1980 edition [Winter 1981 Addendum] (for revised reference crack growth curves).

2. McGowan, J. J. and Raymund, M., "Stress Intensity Factor Solutions for Internal Longitudinal Semi-elliptic Surface Flaw in a Cylinder Under Arbitrary Loading", ASTM STP 677, 1979, pp. 365-380.

3. Newman, J. C. Jr. and Raju, I. S., "Stress Intensity Factors for Internal Surface Cracks in Cylindrical Pressure Vessels", ASME Trans., Journal of Pressure Vessel Technology, Vol. 102, 1980, pp. 342-346.

4. Buchalet, C. B. and Bamford, W. H., "Stress Intensity Factor Solutions for Continuous Surface Flaws in Reactor Pressure Vessels", in Mechanics of Crack Growth, ASTM, STP 590, 1976, pp. 385-402.

5. Shah, R. C. and Kobayashi, A. S., "Stress Intensity Factor for an Elliptical Crack Under Arbitrary Loading", Engineering Fracture Mechanics, Vol. 3, 1981, pp. 71-96.

6. Lee, Y. S. and Bamford, W. H., "Stress Intensity Factor Solutions for a Longitudinal Buried Elliptical Flaw in a Cylinder Under Arbitrary Loads", presented at ASME Pressure Vessel and Piping Conference, Portland Oregon, June 1983. Paper 83-PVP-92.

7. Marston, T. U. et. "Flaw Evaluation Procedures: ASME Section XI" Electric Power Research Institute Report EPRI-NP-719-SR, August 1978.

8. U.S.N.R.C Standard Review Plan (Rev. 1), Section 5.3.2, Report NUREG 0800, July 1981.

9. Plane Strain Crack Toughness Testing of High Strength Metallic Materials, ASTM STP 410, March 1969.

APPENDIX A

MODIFICATION OF HYDROTEST AND LEAK TEST TEMPERATURES

If an indication is discovered in the Indian Point Unit 3 steam generators which is justified for further service without repair by the flaw evaluation charts of this report, an increase in the minimum temperature at which the hydrotest and leak tests must be conducted may be necessary to ensure the required margins of Section XI are maintained. In this appendix, charts are provided for determination of this temperature, which is a function of the size and location of the circumferential indications discovered. Separate treatments have been developed for embedded and surface indications.

A-1 Embedded Flaw Hydro and Leak Test Temperature Requirements

The charts herein provide a simple method for determining the required minimum temperature for any subsequent hydrotests (1486 psi) or leak tests (1125 psi). Once an indication has been characterized, its location within the wall of the steam generator (δ/t) determines the allowable hydrotest temperature.

This determination has been made for two different materials, with RT_{NDT} = 10°F and RT_{NDT} = 30°F. As discussed in Section 2 of this report, the lower value of RT_{NDT} = 10°F is applicable to all steam generators except unit number 34. Figure A-1 therefore covers all the steam generator vessels except unit 34, which is covered by Figure A-2. These figures cover the entire range of circumferential embedded flaw sizes and shapes.

A-2 Surface Flaw Hydro and Leak Test Temperatures

Figures A-3 and A-4 provide charts for the determination of hydrotest temperature requirements in the event that circumferential surface flaws are detected and shown to be acceptable by the surface flaw evaluation charts of Section 6.

Figures A-3 and A-4 show that hydrotests and leak tests at 120°F are allowed.

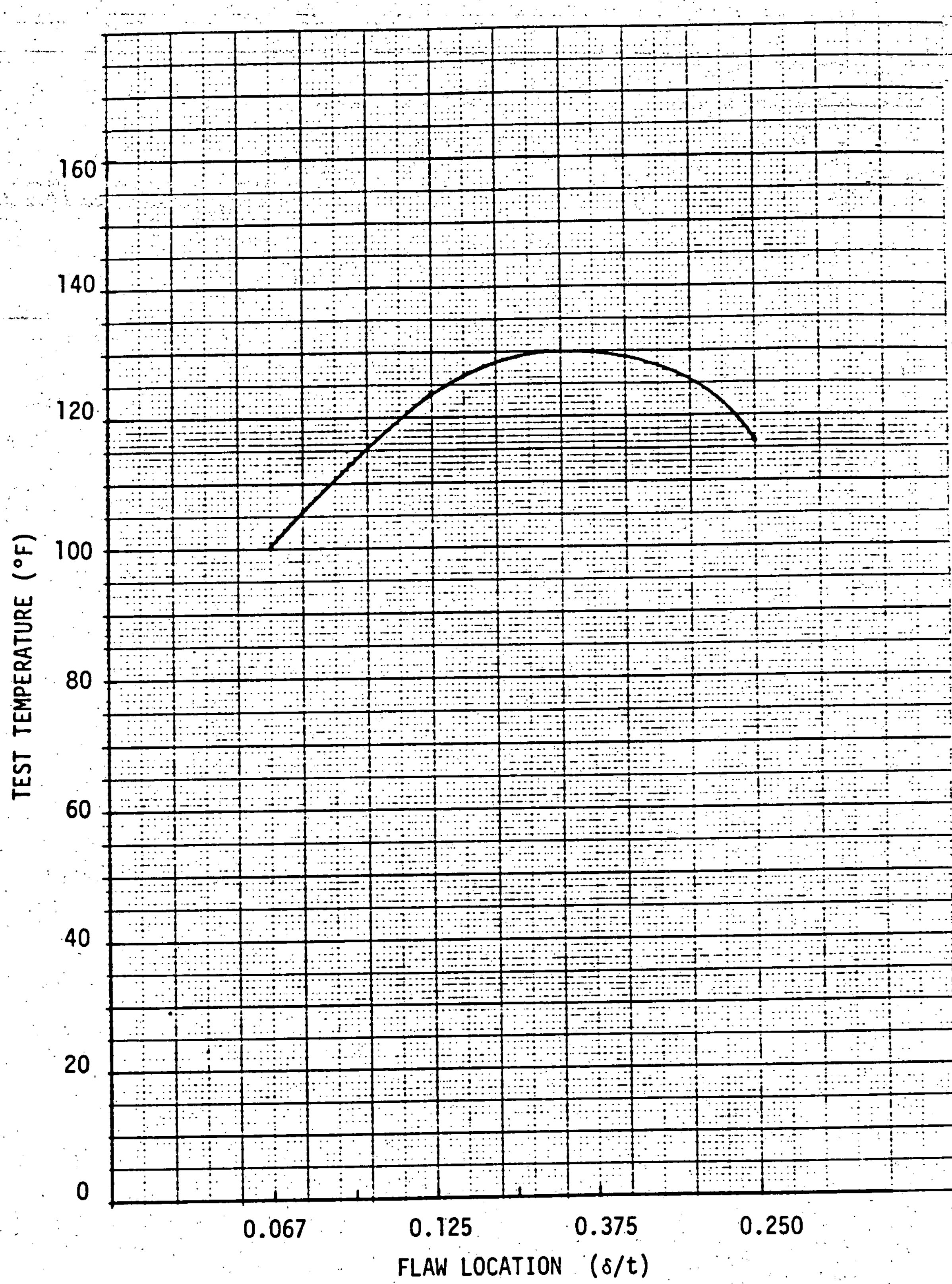


FIGURE A-1 DETERMINATION OF HYDROTEST AND LEAK TEST TEMPERATURES FOR CIRCUMFERENTIAL EMBEDDED FLAWS (FOR STEAM GENERATOR 34, USE FIGURE A-2)

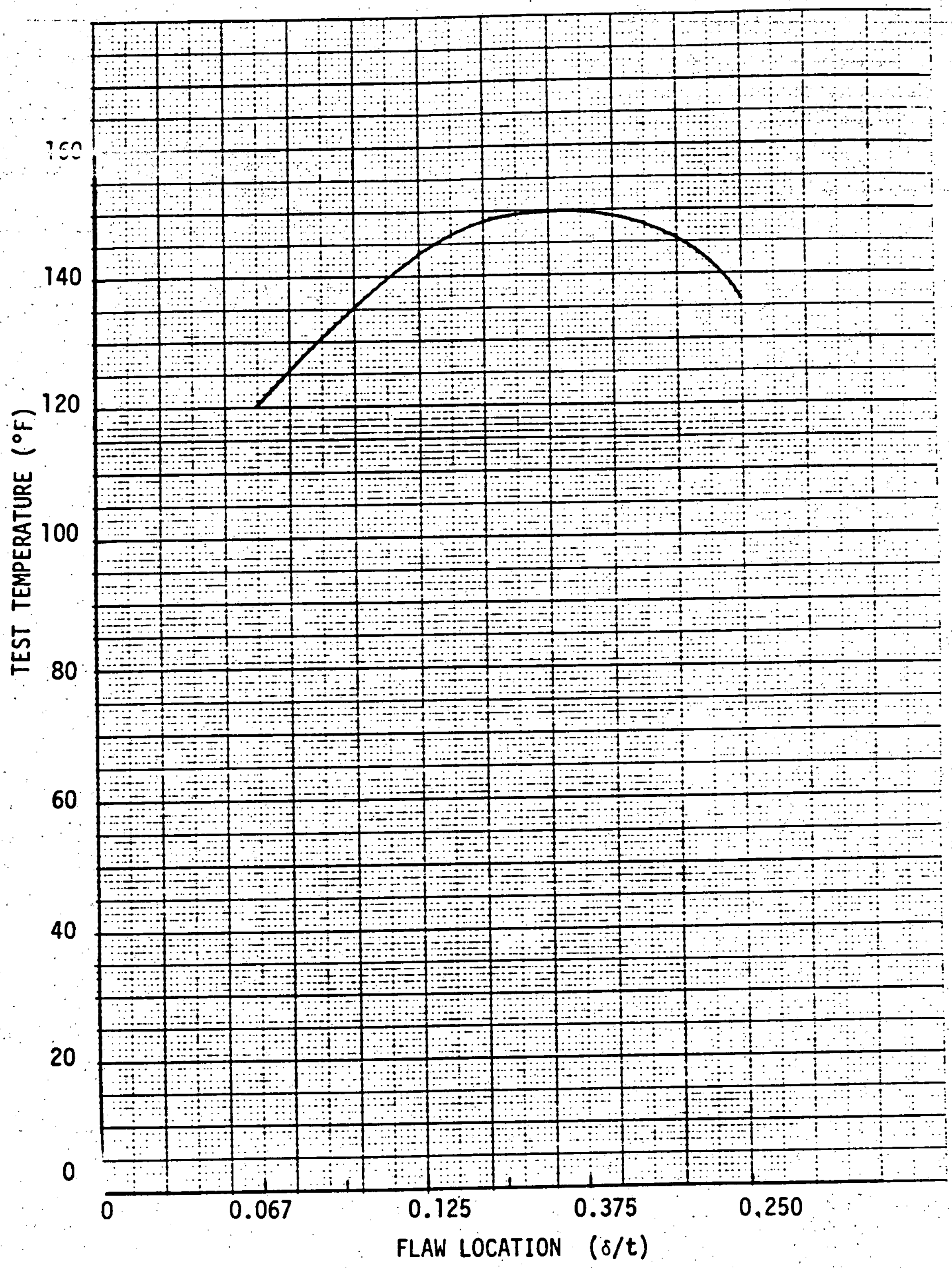


FIGURE A-2 DETERMINATION OF HYDROTEST AND LEAK TEST TEMPERATURES FOR CIRCUMFERENTIAL EMBEDDED FLAWS IN STEAM GENERATOR 34

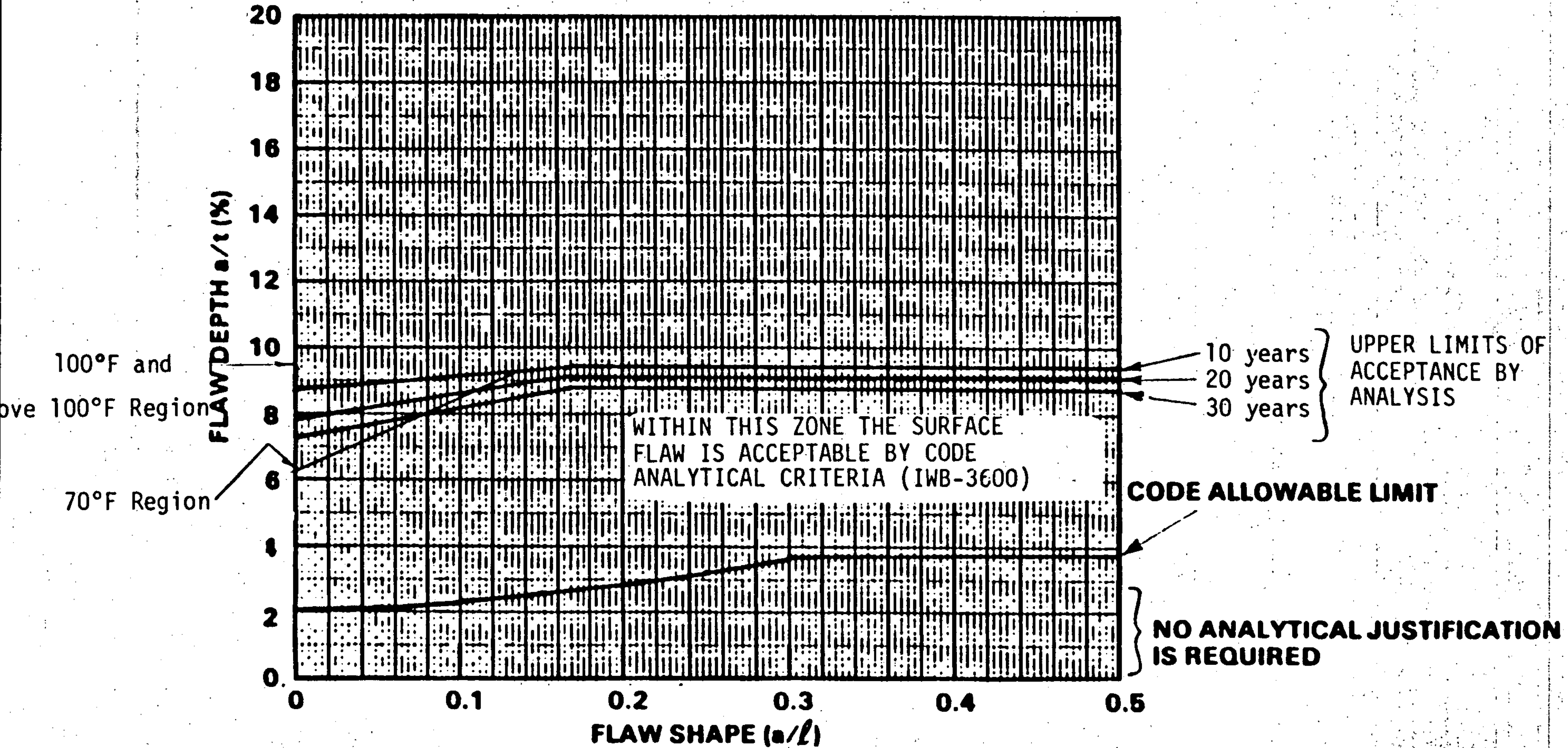


FIGURE A-3 DETERMINATION OF HYDRO AND LEAK TEST TEMPERATURES FOR CIRCUMFERENTIAL INSIDE SURFACE FLAWS (SEE FIGURE A-4 FOR CHART FOR STEAM GENERATOR 34)

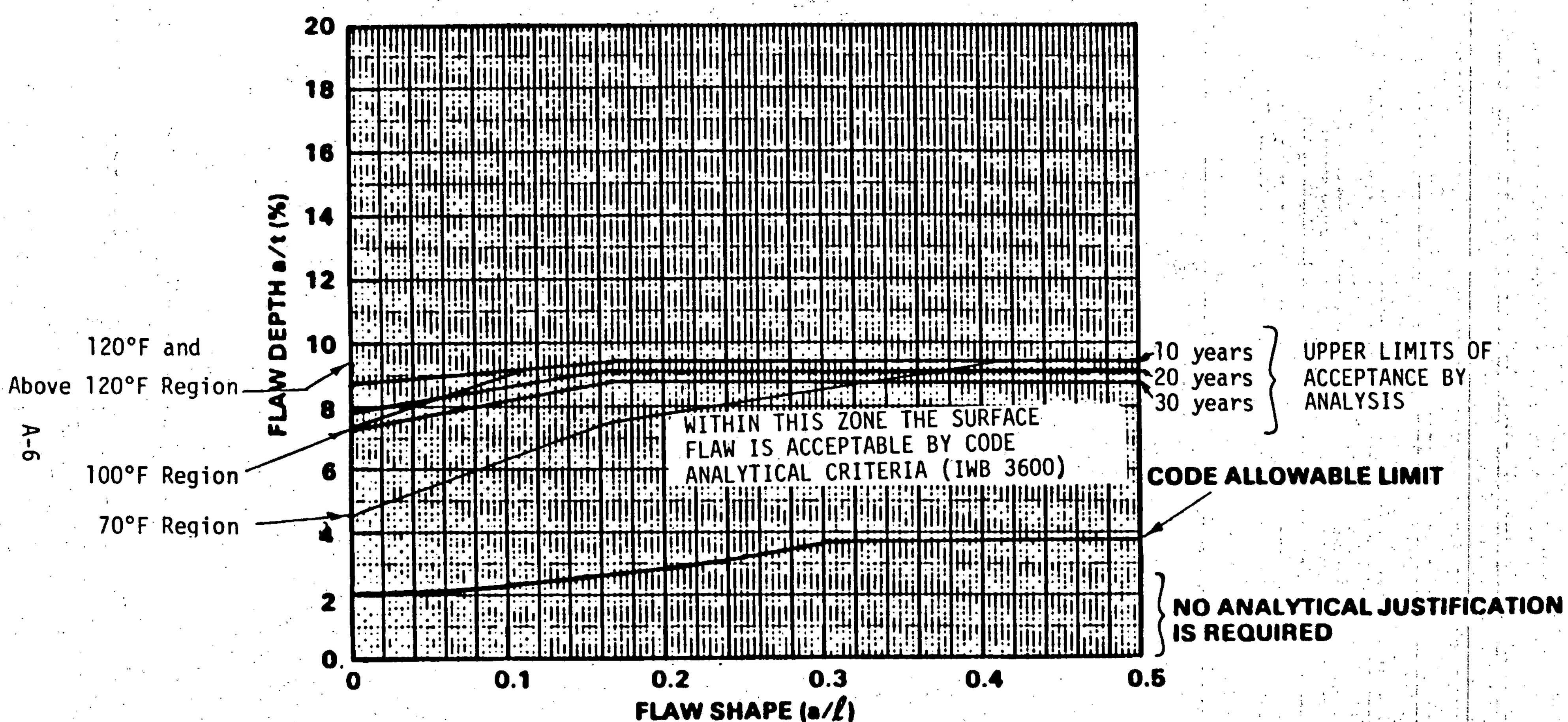


FIGURE A-4 DETERMINATION OF HYDRO AND LEAK TEST TEMPERATURES FOR CIRCUMFERENTIAL INSIDE SURFACE FLAWS IN STEAM GENERATOR 34

References

1. 1983 IP-3 Steam Generator Girth Weld Ultrasonic Examination Report, New York Power Authority.
2. 1984 Mid-Cycle (Cycle IV) IP-3 Steam Generator Girth Weld Ultrasonic Examination Report, New York Power Authority.

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QUALITY ASSURANCE

DEFICIENCY AND CORRECTIVE ACTION REPORT (DCAR)

INDIAN POINT 3 NUCLEAR POWER PLANT

Specification No.	Item Name/System Description:	Drawing No.	DCAR NO.
Tech. Spec. Amend. #47, Tbl 4.2-1	S/G #34 Ultrasonic Examination from OD Surface	INT-2-1100	85-038
TO: Joe Deroy	Cognizant Engr.	Mod. Procedure N/A	Work Request No. 6375
FROM: *Quality Assurance Superintendent*		QA Tag No. N/A	Purchase Order No N/A

DEFICIENCY:

Augmented Ultrasonic inspection from OD Surface at location on circumference 0" - 18" and 505" - 522" twelve reportable indications were noted, out of twelve indications six are unacceptable to ASME Sec. XI Code of 1974 edition. Location of these indications are 511.00" to 511.75" (3/4"), 511.68" to 512.50" (7/8"), 520.50 to 0.5" (2"), 503.00 to 514.00 (11"), 507.0" to 515.0" (8"), 511.5" to 513.0" (1.5")

REQUIREMENT:

ASME Sec. XI Code of 1974 Allowable planar indications Table IWB - 3511.1

ACTION REQUIRED

Initiator: [signature] *Date* 6/25/85 *QC Supervisor:* [signature] *Date* 6/25/85

DISPOSITION: [x] *Accept As Is* [ ] *Rework* [ ] *Repair* [ ] *Return to Vendor* [ ] *Scrap*

Cognizant Engineer: P. Peloquin

JUSTIFICATION/INSTRUCTIONS: See attached.

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JUL 24 1985
New York Power Authority
QA Department
I.P. #3 N.P.P.

CLOSED

Actions Will Be Completed ——— *Approved By:* [signature] *Date* 7/24/85

Disposition Concurrence (QA) [signature] *Date* 7/24/85

Repair/Rework Inspected By: N/A *Date* ______

[ ] CORRECTIVE/PREVENTATIVE ACTION REQUIRED - SEE NCA No. ______

ATTACHMENT TO DCAR NO. 85-038

The following indications are acceptable to Appendix A of 1974 edition of ASME XI Code as described in WCAP 10863-Handbook On Flaw Evaluation for IP-3 Steam Generators (copy attached):

- 511.00 "to 511.75" (3/4")
- 511.68 "to 512.50" (7/8")
- 520.50 "to 0.50" (2")
- 511.50 "to 513.00" (1.5")

The following indications, as well as the first three above, are attributed to ID geometry caused by tapered grind out areas, and were damped out in accordance with QAI 4.0 Rev. 1:

- 503.00 "to 514.00" (11")
- 507.00 "to 515.00" (8")

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DEFICIENCY AND CORRECTIVE ACTION REPORT (DCAR)

INDIAN POINT 3 NUCLEAR POWER PLANT

Specification No.	Item Name/System Description:	Drawing No.	DCAR NO.
Tech. Spec. Amend. #47, Tbl 4.2-1	S/G #32 Ultrasonic Examination from OD Surface	INT-2-1100	85-039

TO: Joe Deroy	Cognizant Engr.	Mod. Procedure N/A	Work Request No. 6377
FROM: *Quality Assurance Superintendent*		QA Tag No. N/A	Purchase Order No N/A

DEFICIENCY:

Augmented Ultrasonic inspection from OD Surface at location on circumference 316" to 334" and 348" to 365". Two reportable indications were noted, out of two indications one is unacceptable to ASME Sec XI Code of 1974 edition. Location of this indication is 321.50" to 324.38" (2.88").

REQUIREMENT:

ASME Sec. XI Code of 1974 Allowable planar indications Table IWB - 3511.1

ACTION REQUIRED

Initiator: [signature] *Date* 6/25/85 *QC Supervisor:* [signature] *Date* 6/25/85

DISPOSITION: [x] *Accept As Is* [ ] *Rework* [ ] *Repair* [ ] *Return to Vendor* [ ] *Scrap*

Cognizant Engineer: P. Peloquin

JUSTIFICATION/INSTRUCTIONS: Indication 321.50 " to 324.38" (2.88") is acceptable to Appendix A of 1974 edition of ASME XI Code as described in WCAP 10863 - Handbook On Flaw Evaluation for IP-3 Steam Generators (attached to DCAR 85-038).

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QA Department
IP3 N.P.P.

Actions Will Be Completed ________ *Approved By:* [signature] *Date* 7/24/85

Disposition Concurrence (QA) [signature] *Date* 7/24/85

Repair/Rework Inspected By: N/A *Date* ________

[ ] CORRECTIVE/PREVENTATIVE ACTION REQUIRED - SEE NCA No. ________

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DEFICIENCY AND CORRECTIVE ACTION REPORT (DCAR)

INDIAN POINT 3 NUCLEAR POWER PLANT

Specification No.	Item Name/System Description	Drawing No.	DCAR NO.
Tech. Spec. Amend. #47, Tbl 4.2-1	S/G #31 Ultrasonic Examination from OD Surface	INT-2-1100	85-051
TO: Joe Deroy	Cognizant Engr.	Mod. Procedure N/A	Work Request No. 6376
FROM: *Quality Assurance Superintendent*		QA Tag No. N/A	Purchase Order No N/A

DEFICIENCY:

Augmented Ultrasonic Second Sample inspection from OD Surface at location on circumference 24" to 60". One reportable indication was noted, and is unacceptable to ASME Sec XI Code of 1974 edition. Location of this indication is 30.625" to 31.625" (1.0").

REQUIREMENT:

ASME Sec. XI Code of 1974 Allowable planar indications Table IWB - 3511.1

ACTION REQUIRED

Initiator: [signature] *Date* 6/28/85 *QC Supervisor:* [signature] *Date* 6/28/85

DISPOSITION: ☒ *Accept As Is* ☐ *Rework* ☐ *Repair* ☐ *Return to Vendor* ☐ *Scrap*

Cognizant Engineer: P. Peloquin

JUSTIFICATION/INSTRUCTIONS:

Indication 30.63" to 31.63" (1.00") is acceptable to Appendix A of 1974 edition of ASME XI Code as described in WCAP 10863 - Handbook On Flaw Evaluation for IP-3 Steam Generators (attached to DCAR 85-038).

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Date Actions Will Be Completed ____ *Approved By:* [signature] *Date* 7/24/85

Disposition Concurrence (QA) [signature] *Date* 7/24/85

Repair/Rework Inspected By: N/A *Date* ____

☐ CORRECTIVE/PREVENTATIVE ACTION REQUIRED - SEE NCA No. ____

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DEFICIENCY AND CORRECTIVE ACTION REPORT (DCAR)

INDIAN POINT 3 NUCLEAR POWER PLANT

Specification No.	Item Name/System Description:	Drawing No.	DCAR NO.
Tech. Spec. Amend. #47, Tbl 4.2-1	S/G #34 Ultrasonic Examination from OD Surface	INT-2-1100	85-052
TO: Joe Deroy	Cognizant Engr.	Mod. Procedure N/A	Work Request No. 6375
FROM: *Quality Assurance Superintendent*		QA Tag No. N/A	Purchase Order No N/A

DEFICIENCY:

Augmented Ultrasonic Second Sample inspection from OD Surface at location on circumference 24" to 60" and 468" to 504". Four reportable indications were noted, and out of four indications two are unacceptable to ASME Sec XI Code of 1974 edition. Location of these indications are 53.125" to 54.125" (1.0") and 486.25" to 487.25" (1.0").

REQUIREMENT:

ASME Sec. XI Code of 1974 Allowable planar indications Table IWB - 3511.1

ACTION REQUIRED

Initiator: [signature] *Date* 6/28/85 *QC Supervisor:* [signature] *Date* 6/28/85

DISPOSITION: ☒ *Accept As Is* ☐ *Rework* ☐ *Repair* ☐ *Return to Vendor* ☐ *Scrap*

Cognizant Engineer: P. Peloquin

JUSTIFICATION/INSTRUCTIONS:

Indications 53.13" to 54.13" (1.0") and 486.25" to 487.25" (1.0") are acceptable to Appendix A of 1974 edition of ASME XI Code as described in WCAP 10863 - Handbook On Flaw Evaluation for IP-3 Steam Generators (attached to DCAR 85-038).

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Actions Will Be Completed ______ *Approved By:* [signature] *Date* 7/24/85

Disposition Concurrence (QA) [signature] *Date* 7/24/85

Repair/Rework Inspected By: N/A *Date* ______

☐ CORRECTIVE/PREVENTATIVE ACTION REQUIRED - SEE NCA No. ______

New York Power Authority

QUALITY ASSURANCE

DEFICIENCY AND CORRECTIVE ACTION REPORT (DCAR)

INDIAN POINT 3 NUCLEAR POWER PLANT

...ification No.	Item Name/System Description:	Drawing No.	DCAR NO.
T.S. Amend. #4 Table 4.2-1	S/G #34 Ultrasonic Exam From OD Surface	INT-2-1100	85-073

TO: Joe Deroy	Cognizant Engr. N/A	Mod. Procedure N/A	Work Request No. 6375
FROM: *Quality Assurance Superintendent*		QA Tag No. N/A	Purchase Order No N/A

DEFICIENCY:

Augmented ultrasonic third sample (100%) inspection from OD surface at location on circumference 60" to 168", 204" to 468" clockwise to 0" reference. Seven (7) reportable indications were noted, out of seven indications three (3) are unacceptable to ASME Sec. XI Code of 1974 edition. Location of these indications are 402.5" to 403.5" (1" long) 406" to 407.75" (1.75" long), 74.75" to 75.75" (1" long).

REQUIREMENT:

ASME Sec. XI of 1974, allowable planar indications Table IWB-3511.1.

ACTION REQUIRED

Initiator: [signature] *Date* 7/5/85 *QC Supervisor:* [signature] *Date* 7/5/85

DISPOSITION: [X] *Accept As Is* [ ] *Rework* [ ] *Repair* [ ] *Return to Vendor* [ ] *Scrap*

Cognizant Engineer: P. Peloquin

JUSTIFICATION/INSTRUCTIONS:

Indications 402.5" to 403.5" (1.0"), 406.0" to 407.75" (1.75"), and 74.75" to 75.75" (1.0") are acceptable to Appendix A of 1974 edition of ASME XI Code as described in WCAP 10863 - Handbook on Flaw Evaluation for IP-3 Steam Generators (attached to DCAR 85-038).

RECEIVED JUL 24 1985 New York Power Authority QA Department I.P. #3 N.P.P.

CLOSED

...e Actions Will Be Completed ______ *Approved By:* [signature] *Date* 7/24/85

Disposition Concurrence (QA) [signature] *Date* 7/24/85

Repair/Rework Inspected By: N/A *Date* ______

[ ] CORRECTIVE/PREVENTATIVE ACTION REQUIRED - SEE NCA No. ______